PROJECT MANUAL

DENVER INTERNATIONAL AIRPORT

CENTRAL UTILITY PLANT CHILLER ADDITION

CONTRACT NO. 201310046

PART I

PROJECT REQUIREMENTS

BOSCO CONSTRUCTORS, INC.

Issued for Construction July 2013

CITY & COUNTY OF DENVER
DEPARTMENT OF AVIATION

DENVER INTERNATIONAL AIRPORT

CENTRAL UTILITY PLANT CHILLER ADDITION
CONTRACT NO. 201310046

ADDENDUM NUMBER ONE

May 23, 2013

This Addendum Number Five supersedes and/or supplements all portions of the Contract Documents with which it conflicts. Bidders must acknowledge receipt of this addendum on page B-1 of the Bid Forms.

David LaPorte
Deputy Manager of
Airport Infrastructure Management

DENVER INTERNATIONAL AIRPORT

CENTRAL UTILITY PLANT CHILLER ADDITION
CONTRACT NO. 201310046

ADDENDUM NUMBER TWO

June 11, 2013

This Addendum Number Two supersedes and/or supplements all portions of the Contract Documents with which it conflicts. Bidders must acknowledge receipt of this addendum on page B-1 of the Bid Forms.

6/13/13

David LaPorte, Deputy Manager of Aviation
Airport Infrastructure Management (AIM)

CITY AND COUNTY OF DENVER
DEPARTMENT OF AVIATION
DENVER INTERNATIONAL AIRPORT
CENTRAL UTILITY PLANT CHILLER ADDITION
CONTRACT NUMBER 201310046

MASTER TABLE OF CONTENTS

NOTICE OF INVITATION FOR BIDS 1

INSTRUCTIONS TO BIDDERS 4

IB–1 INSTRUCTIONS TO BIDDERS 4
IB–2 BIDDING 4
IB–3 COMPLETING AND SIGNING BID FORMS 5
IB–4 UNACCEPTABLE BIDS 5
IB–5 ONLY ONE BID ACCEPTED 5
IB–6 OPENING OF BIDS 6
IB–7 CONSIDERATION OF BIDS 6
IB–8 INFORMAL AND UNBALANCED BIDS 6
IB–9 BASIS FOR SELECTING THE APPARENT LOW BIDDER 7
IB–10 NOTICE TO APPARENT LOW BIDDER - EXECUTION OF CONTRACT 7
IB–11 CONFORMED TECHNICAL SPECIFICATIONS AND CONTRACT DOCUMENTS 7
IB–12 QUANTITIES IN THE BID FORM ENTITLED SCHEDULE OF PRICES AND QUANTITIES (PART 2 OF THE BID FORMS) 8
IB–13 BID GUARANTEE; BONDS; INSURANCE 8
IB–14 RETURN OF BID GUARANTEE 9
IB–15 CONTRACTORS' BULLETIN BOARD 9
IB–16 SITE INSPECTION AND INVESTIGATIONS 9
IB–17 INTERPRETATION OF BID DOCUMENTS 10
IB–18 MATERIALS AND SUBSTITUTIONS 11
IB–19 WITHDRAWAL OF BID 11
IB–20 SUBCONTRACTOR LISTS IN BID 12
IB–21 PERMIT FEES 12
IB–22 TAXES 12
IB–23 NONDISCRIMINATION IN THE AWARD OF CITY CONTRACTS 13
IB–24 MINORITY/WOMEN BUSINESS ENTERPRISE (MBE/WBE) REQUIREMENTS 13
IB–25 WAGE RATE REQUIREMENTS 20
IB–26 CONSTRUCTION SCHEDULING 20
IB–27 EQUAL EMPLOYMENT OPPORTUNITY 20
IB–28 CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION 21
IB–29 INSURANCE REQUIREMENTS, OCIP PROGRAM, SAFETY MANUAL 21
IB-30 INVOICING 22

IB-31 PROJECT CONTROLS REQUIREMENTS....22
PREVAILING WAGES....27
BID FORMS....28
NOTICE TO APPARENT LOW BIDDER....57
C O N T R A C T....58
PERFORMANCE BOND....63
PAYMENT BOND....65
NOTICE TO PROCEED....67
FINAL RECEIPT....68
CONSTRUCTION CONTRACT GENERAL CONDITIONS 2011 Edition....69
SPECIAL CONDITIONS....75
SC-1 CONSTRUCTION CONTRACT GENERAL CONDITIONS....75
SC–2 DRAWINGS AND SPECIFICATIONS TO BE FURNISHED BY THE CITY....75
SC-3 REVISIONS TO G.C. 201....76
SC-4 CITY LINE OF AUTHORITY AND CONTACTS....76
SC–5 CONTRACTOR PERFORMANCE; SUBCONTRACTING....77
SC–6 COOPERATION WITH OTHERS....77
SC–7 PROSECUTION AND COMPLETION OF THE WORK:....77
SC–8 LIQUIDATED DAMAGES....77
SC–9 FACILITY SECURITY AND PERSONNEL ACCESS....78
SC-10 CONSTRUCTION ACCESS....80
SC–11 VEHICLE PERMITTING....80
SC–12 VENDORS AND SUPPLIERS....80
SC–13 COMMUNICATION DEVICES....81
SC–14 USE, POSSESSION OR SALE OF ALCOHOL OR DRUGS....81
SC-15 ATTORNEY'S FEES....81
SC–16 INSURANCE TO BE PROVIDED BY THE CONTRACTOR....81
SC–17 SUBCONTRACTOR RELEASES....83
SC–18 ADDITIONAL AFFIRMATIVE ACTION REQUIREMENTS, FEDERAL PROVISIONS....83
SC-19 ESTIMATED QUANTITIES OF UNIT PRICED ITEMS....83
SC-20 REVISIONS TO G.C. 1102....83
SC-21 LISTING OF ACCEPTABLE MANUFACTURERS....83
SC-22 ACCESSIBLE PARKING SPACES, ACCESS AISLES AND ROUTES OF TRAVEL....84
SC–23 SUBCONTRACTOR PAYMENTS AND SUBCONTRACTOR RELEASES – REQUIRED USE OF THE B2G CONTRACT MANAGEMENT SYSTEM....84
SC-24 PROJECT CONTROLS REQUIREMENTS....85
INSURANCE REQUIREMENTS....86

FINAL/PARTIAL RELEASE AND CERTIFICATE OF PAYMENT (SUBCONTRACTOR/SUPPLIER)....101

APPENDIX A CITY AND COUNTY OF DENVER EQUAL OPPORTUNITY CLAUSE 109

APPENDIX F: AFFIRMATIVE ACTION REQUIREMENTS EQUAL EMPLOYMENT OPPORTUNITY....111

EXHIBIT A STANDARD FEDERAL ASSURANCES....117

EXHIBIT B NONDISCRIMINATION IN AIRPORT EMPLOYMENT OPPORTUNITIES 119

EXHIBIT C: Certification for Contracts, Grants, Loans and Cooperative Agreements 120

PART II TECHNICAL PROVISIONS
(The following documents are published separately; they ARE NOT included in this document)

VOLUME 2:	**DIVISION 1: GENERAL REQUIREMENTS**
	DIVISION 2: Technical Specifications (See Index in Technical Specifications)
VOLUME 3:	**CONTRACT DRAWINGS**

CITY AND COUNTY OF DENVER
DEPARTMENT OF AVIATION
NOTICE OF INVITATION FOR BIDS
CONTRACT NO. 201310046
CENTRAL UTILITY PLANT CHILLER ADDITION

The Department of Aviation, City and County of Denver, has issued an Invitation for Bids for the construction project named above. Complete contract documents, including specifications, are available on the DIA Contract Procurement website at http://business.flydenver.com/bizops/bids.asp beginning May 20, 2013.

SEALED BIDS will be due no later than **2:00 p.m., June, 18, 2013,** Local Time, delivered in the triple wide trailer, located within the DIA South Campus at 7128 North Trussville Street, Unit A, Denver, CO 80249. Bids must be time stamped no later than 2:00 p.m., June 18, 2013, immediately after which a public bid opening will commence. Any bids to be submitted more than one hour prior to Bid Opening must be submitted at the office of Business Management Services, attention Nathan Jones, Room 8810, Airport Office Building (AOB), Denver International Airport, 8500 Peña Blvd., Denver, CO 80249-6340.

A MANDATORY PRE-BID CONFERENCE AND INSPECTION will be held at 2:00 p.m., May 28, 2013, in the City Conference Room, Main Terminal Building, Norwest corner of the inner core, Denver International Airport, Denver, CO 80249. A limited site visit will be conducted immediately following the Pre-Bid Conference. The site visit is not mandatory. Attendees must register for the site visit no later than 12:00 p.m. on May 22, 2013. To register, each attendee shall email Lee Walinchus (lee.walinchus@flydenver.com) the following information:

1. Name
2. Company name
3. Contact phone number
4. Date of birth
5. One of the following forms of identification:
    a. Airport badge number
    b. Driver's license number & expiration date

Badge attendees may be requested to assist in escorting the group. Be prepared, attendees will be subjected to the same security screening as airport passengers. The site visit will be conducted in an active construction area. All attendees are required to bring hard hats and safety glasses.

GENERAL STATEMENT OF WORK:

The project consists of expanding the cooling capacity of the Central Utility Plant at Denver International Airport. Elements of the project include:

- Provide two new, 2,500 ton, dual-compressor, VFD Chillers in Bay 4 of the Chiller Room.
- Provide new 4,160 kV electrical equipment for the new chillers
- Modify the plant control systems as required to integrate all new equipment into the plant control system (Johnson Controls, Inc.).
- Relocate existing Refrigerant Transfer Units within the Plant

- Disconnect electrical equipment that serves removed Chiller C-4 and associated Condenser Water Pump P-34.
- Provide new horizontal split case, VFD condenser water pump
- Provide new horizontal split case, VFD chilled water pump.
- Provide Variable Frequency Drives (VFD) to existing vertical turbine pumps P-23 & P-24.
- Construct new Electrical Room for new electrical equipment and drives in Bay 6 of the Boiler Room.
- Reduce size of existing Break Room and Tool Room in Pump Room to allow for installation of new chilled water pump.

This project requires completion prior to allow for new Terminal Complex buildings and infrastructure expansions.

PREQUALIFICATION: Each bidder must be pre-qualified in the category of 2.A Building General OR 2.C Building Mechanical at the $9,000,000.00 level. Prequalification applications are due at least ten (10) calendar days prior to the bid opening date. Prequalification applications must be submitted to the Department of Public Works, Prequalification Section, 201 West Colfax Avenue, Department 506, Denver, Colorado 80202. To view the Rules and Regulations and to obtain a prequalification application, please visit our website at www.denvergov.org/prequalification or call 720-865-2539 for prequalification information ONLY.

MINORITY/WOMEN BUSINESS ENTERPRISE GOAL: Pursuant to Article III, Division 1 of Chapter 28 of the Denver Revised Municipal Code, the Project goal of 25% must be met with certified participants, or through the demonstration of a sufficient good faith effort. For compliance with good faith requirements, the M/WBE percentage solicitation level required for this project is 100%.

As its best interests may appear, the Manager of Aviation reserves the right to reject any or all bids and to waive informalities in bids.

Publication Dates: May 20, 21 & 22, 2013
Published in The Daily Journal

DO NOT PUBLISH ANYTHING BELOW THIS LINE

Manager of Aviation	Date
Deputy Manager for Airport Infrastructure Management	Date
Director, Division of Small Business Opportunity	Date

INSTRUCTIONS TO BIDDERS
CITY AND COUNTY OF DENVER
DEPARTMENT OF AVIATION

IB–1 INSTRUCTIONS TO BIDDERS

These Instructions to Bidders are a part of the Contract Documents and are intended to serve as a guide to bidders. They are general in nature and may be amended or supplemented as needed to support any one specific invitation to bid. Each bidder shall prepare its bid in strict compliance with all requirements of the Contract Documents and by careful application of these instructions.

IB–2 BIDDING

The bound copy of these Contract Documents contains Bid Forms and Bid Data Forms. The bidder must complete these Bid Forms and submit them as its bid.

Each bid must be enclosed in a sealed envelope, addressed to the Manager of Aviation, showing on the face of the envelope the name of the bidder, the project number, and descriptive title of the work for which the offer is made. The Notice of Invitation for Bids identifies where and when the bid must be delivered.

Addenda to the contract documents will be issued by publication in their entirety on the DIA Contract Procurement Website, http://business.flydenver.com/bizops/bids.asp, from which each addendum document may be downloaded by planholders. Such addenda may include replacements for or additions to some or all of the pages of the Bid Forms, and all Bid Form pages added by addendum shall be submitted with the Bid Forms. Either a complete addendum or a notice of its issuance will be posted on the Contractor's Bulletin Board. Prior to submitting bids, Bidders shall read the Contractor's Bulletin Board and/or DIA Contract Procurement website to confirm that they have received all addenda.

If Sensitive Security Information ("SSI") will be provided to potential bidders prior to award of the Contract, each bidder shall be required to comply with Department of Aviation, Standard Policies and Procedures No. 6003, "Contractor Protection of Sensitive Security Information," or its successor. A copy of this Policies and Procedures document will be provided with the Bid Documents, or upon request by the Department of Aviation, Business Management Services Office.

Each bidder shall submit the following, completed and executed in accordance with the Contract Documents:

(1) the separately bound Bid Forms booklet;

(2) all Bid Form pages not bound in such booklet which are included in any addendum to the Contract Documents;

(3) the Bidder's Bid Bond or Bid Guarantee in conformance with IB-13; and

(4) the Bidder/Contractor Disclosure Form described in IB-29 and included with the Bid Forms, unless the Bidder has a current disclosure form on file with the City Clerk.

IB–3 COMPLETING AND SIGNING BID FORMS

The bidder must complete the Bid Forms by legibly writing or printing in ink, words or figures, or both if required, all the bidder's offered prices for performing the work. All blank spaces which require a response of the bidder must be properly filled in. In filling out the Bid Forms, the bidder should avoid making changes to the extent possible, but, if changes are necessary, any interlineation, white outs, or erasures should be initialed.

For any contracts containing unit prices, the bidder shall specify in the Bid Forms a unit price for each item for which a quantity is given and shall write in figures the products of the respective unit prices and quantities in the "Amount" column provided for that purpose.

Each bidder must sign the Bid Forms and give the bidder's current business address. If an individual, the signature must be of the individual offering the bid; if a partnership, the signature must be that of a general partner; and if a joint venture, by each joint venture participant in their individual capacity as a corporation, partnership, or individual; if a corporation, both the president or a vice president and the secretary must sign and the seal of the corporation must be affixed. Signatures of other persons may be acceptable if the Bid contains evidence satisfactory to the Manager to prove that the other persons are authorized to bind the bidder.

IB–4 UNACCEPTABLE BIDS

The City will not accept Bids from bidders in arrears to the City upon debt or contract, or which are defaulters (as surety or otherwise) upon any obligation to the City, or that are deemed irresponsible or unreliable by the Manager of Aviation. A history or pattern of litigation against the City and County of Denver by any bidder, proposed subcontractor, interested party, or any person, firm, or corporation affiliated with any bidder, among other items, will be considered by the Manager in determining the responsibility and reliability of bidders. Bidders may be required to submit satisfactory evidence that they have a practical knowledge of the particular work bid upon and that they have the necessary financial resources to complete the proposed work.

IB–5 ONLY ONE BID ACCEPTED

The City will accept only one Bid for the same work from any one bidder. This includes Bids that may be submitted under different names by one firm or corporation. Evidence of collusion among bidders shall be grounds for exclusion of any bidder who is a participant in any such collusion.

IB–6 OPENING OF BIDS

Bidders are invited to be present at the bid opening which shall occur in the triple wide trailer, located within the DIA South Campus at 27301 E. 71st Avenue, Unit #2, Denver, CO 80249 on the date set forth in the Notice of Invitation for Bids.

IB–7 CONSIDERATION OF BIDS

After the Bids are opened and read and any discrepancies have been reviewed, bids will be compared based on the Total Contract Bid Amount written on page B-1 of the Bid Letter.

If a discrepancy exists between a price or amount written in words and the price or amount written in figures, the price or amount written in words shall govern, except that in the case where a price or amount shown in figures has been crossed out and replaced with a new, legible, initialed figure, the initialed figure shall govern.

Any bid discrepancies which the City corrects in accordance with the general rules described above shall be corrected with the understanding that the Apparent Low Bidder waives any claims against the City because of the bidder's mistakes in its bid.

The City reserves the right to waive informalities, to reject any and all bids, and to advertise for new bids where it is in the best interest of the City.

IB–8 INFORMAL AND UNBALANCED BIDS

Bids shall be considered informal and may be rejected for the following reasons:

(a) If the bid is on a form other than the Bid Forms furnished by the City, or if the form is altered or any part thereof is detached.

(b) If there are unauthorized additions, conditional or alternate bids, or irregularities of any kind which may tend to make the bid incomplete, indefinite, or ambiguous.

(c) If the bidder fails to acknowledge in the bid receipt of any or all addenda current on the date of opening of bids.

(d) If the bid does not contain a unit price or lump sum amount for each item listed except in the case of authorized alternative items.

(e) If there is an interlineation, white out, or erasure in the Bid Forms.

(f) If the bid is unbalanced so that (1) each pay item does not reasonably carry its own proportion of cost, or (2) any pay item contains an inadequate or unreasonable price.

IB–9 BASIS FOR SELECTING THE APPARENT LOW BIDDER

The selection of the Apparent Low Bidder will be made on the basis of the lowest responsive bid by a qualified bidder whose bid complies with all of the requirements prescribed herein. The lowest bidder shall be determined by the Base Bid Amount. This selection shall be subject to the approval of such resulting contract in accordance with the Charter and ordinances of the City and County of Denver.

IB–10 NOTICE TO APPARENT LOW BIDDER - EXECUTION OF CONTRACT

The Apparent Low Bidder will be given written notice of such status on the form included in the Bid Documents within sixty (60) days from the date of opening of bids.

The Apparent Low Bidder shall execute the contract and return it to the City along with the required bonds and insurance forms within five (5) consecutive working days from and including the date of the Notice to Apparent Low Bidder. When the executed contract and the required bonds and insurance certificates are received, approval for the City to contract with the Apparent Low Bidder shall be sought in accordance with the Charter of the City and County of Denver. Such notice shall not create any rights in the Apparent Low Bidder to any contract with the City.

IB–11 CONFORMED TECHNICAL SPECIFICATIONS AND CONTRACT DOCUMENTS

The bidder understands that the City may elect, in its sole discretion, to deliver either one of the contract documents described below for execution.

(a) A bound document containing the original Bid Documents and all of the prebid addenda, or

(b) A bound document containing Part I of the original Bid Documents, the portions of the addenda which apply to Part I, and a single conformed set of Technical Specifications and Contract Documents which are produced by posting or made available on CD or other electronic means otherwise incorporating in Part II of the original Bid Documents all of the changes to Part II which are described in the prebid addenda. If the City elects to prepare a conformed set of Technical Specifications and Contract Drawings, the following provision shall be incorporated in the Conformed Technical Specifications after the first page of its Table of Contents:

CONFORMED CONSTRUCTION DOCUMENTS

The Technical Specifications and the Contract Drawings which were included in the Bid Documents, hereinafter referred to as the "bid Document Specifications and Drawings," have been conformed by the City. The conformed Technical Specifications and Contract Drawings were prepared by posting or otherwise incorporating the changes noted in the prebid addenda into the Bid Document Specifications and Drawings to form a single set of construction documents. This set of construction documents is attached hereto and is hereinafter referred to in this document as the "Issued for Construction Documents."

The City's objective in preparing the Issued for Construction Documents is to produce a single set of documents that the Contractor and City will use during construction and that will facilitate the administration of the Contract. The city, however, recognizes that discrepancies between the Issued for Construction Documents and the prebid addenda could occur. Therefore, the Contractor and City agree that both parties shall have 90 days after a fully executed contract is delivered to the Contractor to identify any such discrepancies.

If the Contractor identifies any discrepancy, it shall describe it in a written notice delivered to the City's Project Manager within the 90-day period. If the City agrees that a discrepancy exists, the City shall correct the Issued for Construction Documents in accord with the written notice to assure that the Issued for Construction Documents accurately reflect and are consistent with the Bid Document Specifications and Drawings and changes thereto reflected in the prebid addenda.

If the City identifies a discrepancy, it shall describe it in a written notice delivered to the Contractor's Superintendent within the above-described 90-day period. The City shall, thereafter, correct the Issued for Construction Documents in accord with the written notice. If the Contractor disagrees with any City proposed correction or any City refusal to accept a Contractor proposed correction, the Contractor shall have the right to submit a Contractor Change Request and request a Change order in accordance with General Condition 1103.

During the 90-day period, the Bid Document Specifications and Drawings and the prebid addenda shall be part of the Contract Documents and are incorporated herein by this reference. After the 90-day period has elapsed, the parties (1) agree that the Issued for Construction Documents, as corrected pursuant to this provision, accurately reflect all of the changes to the Bid Document Specifications and Drawings contained in the addenda, and (2) agree that the Bid Document Specifications and Drawings and the portions of the prebid addenda which pertain thereto shall no longer be considered Contract Documents.

IB–12 QUANTITIES IN THE BID FORM ENTITLED SCHEDULE OF PRICES AND QUANTITIES (PART 2 OF THE BID FORMS)

Except for items designated as Lump Sum, the quantities appearing in the Bid Forms are approximate only and are included for the purpose of comparing of bids.

Payment to the Contractor will be based on the actual quantities of work performed, measured, and accepted or materials furnished in accordance with the Contract Documents.

Any of the estimated quantities of work and materials shown in the Bid Forms may each be increased, decreased, or omitted as provided in the General Conditions, Special Conditions, or Technical Specifications.

IB–13 BID GUARANTEE; BONDS; INSURANCE

As a guarantee of good faith on the part of the bidder, each Bid must be accompanied by a Bid guarantee consisting of either a certified or cashier's check made payable without condition to the order of the City and County of Denver or a bid bond written by an approved corporation surety in favor of the City and County of Denver. If the Bid of a bidder is acceptable and the bidder is notified by the Manager of Aviation that it is considered to be the Apparent Low Bidder and said bidder fails to (1) execute a contract in the form prescribed, (2) furnish the payment and performance bonds described in Title 15 of the General Conditions, (3) furnish the required evidence of insurance described in Title 16 of the General Conditions or in the Special Conditions, or (4) satisfy any other condition precedent to contract execution within its power within five (5) working days after such notice is made by the City, said bid guarantee shall be forfeited to the City as liquidated damages and not as a penalty. The bid

guarantee shall be in the amount of five percent (5%) of the Total Contract Bid Amount written in the Bid Letter of the Bid Forms. A Bid Bond form for execution by the bidder is supplied with each set of contract documents. IF A BID BOND IS USED, IT MUST BE THE FORM OF BID BOND SUPPLIED WITH THE CONTRACT DOCUMENTS.

IB–14 RETURN OF BID GUARANTEE

As soon as bid prices have been compared, bid guarantees of all except the three lowest bidders will be returned. When the Apparent Low Bidder executes the contract and delivers to the City satisfactory performance and payment bonds and required insurance documentation, and any other conditions precedent to contract execution by the City have been satisfied, including, where applicable, City Council contract approval, the bid guarantees of the three lowest bidders shall be returned to them.

IB–15 CONTRACTORS' BULLETIN BOARD

It shall be conclusively presumed that the Bidder did, before submitting a bid, read all addenda, posted decisions, and other information items relevant to the Bid which appeared on the Contractor's Bulletin Board and the DIA Contract Procurement website at http://business.flydenver.com/bizops/bids.asp.

The Contractor's Bulletin Board is located at Denver International Airport, 8500 Peña Blvd., Denver, CO 80249-6340, on the wall south of the entrance to the Airport Office Building (AOB). The AOB entrance is reached by way of the corridor leading to Concourse A from the North end of the Terminal on Level 6, and is located west of the Concourse A security screening area. The AOB entrance and the Contractor's Bulletin Board are both located outside the security screening area.

IB–16 SITE INSPECTION AND INVESTIGATIONS

Prior to submitting an offer, the bidder shall inspect the work site and its surroundings. A site visit will be undertaken at the time of the pre-bid conference. Requests for additional site visits must be made at least five (5) working days prior to the bid opening and such visits must be requested in a letter sent to Lee Walinchus, Airport Infrastructure Management Office, 7th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, Colorado, 80249-6340. For purposes of the contract, it shall be conclusively presumed that the bidder has made a thorough inspection of the site and has waived the right to later claim extra payment or time extensions for conditions which would have been evident during that inspection.

Drawings and specifications, defining the work to be done, were prepared on the basis of interpretation by design professionals of information derived from investigations of the work site and site condition data provided by the City. Such information and data are subject to sampling errors, and the interpretation of the information and data depends to a degree on the judgment of the design professional. In view of this, the

bidder is invited to make additional investigations as the bidder's judgment dictates the need for such investigations. If the bidder desires to perform site investigations, it shall request in writing the right to do so. This request shall be sent to PMname, Airport Infrastructure Management Office, 7th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, Colorado, 80249-6340; fax number: 303-342-2683.

Because the bid information cannot be guaranteed, the Contractor shall have assumed the risks attendant to successful performance of the work except for the risk of encountering differing site conditions which are defined in the General Conditions and shall never make claim for additional payments or time extensions on the grounds that the nature or amount of work to be done was not understood by the bidder at the time of bidding.

IB–17 INTERPRETATION OF BID DOCUMENTS

During the Bid period, Bidder shall request, in writing, clarification or interpretation of any apparent errors or omissions in the contract documents, any apparent inconsistencies between different provisions of the contract documents, or any other point in the contract documents which the Bidder believes requires clarification or interpretation by the City. Any such request must be submitted in writing by email to contract.procurement@flydenver.com, must have the words "Request for Clarification" and "Contract No. 201310046" in the email subject line, and must be received not later than ten (10) calendar days before the date and time set for receipt of Bids. For purposes of the contract, it shall be conclusively presumed that prior to bidding, the Bidder requested clarification or interpretation of any apparent errors, inconsistencies, or other point in the contract documents believed to require clarification or interpretation, and has waived the right to later claim extra payment or time extensions on account of any such error, omission, inconsistency, or other matter in the contract documents.

Information about any interpretation or clarification made by the City in response to such request will be posted on the DIA Contract Procurement website, http://business.flydenver.com/bizops/bids.asp.. It shall be the Bidder's responsibility to ensure it has reviewed all such interpretations or clarifications. After Bids are opened, all Bidders must abide by the decision of the Manager of Aviation or his authorized representative as to the interpretation or clarification. If the Manager of Aviation or his authorized representative determines that his decision or interpretation requires that an addendum to the Bid documents be issued, such addendum will be posted on the DIA Contract Procurement website and either the complete addendum or a notice of its issuance will be posted on the Contractor's Bulletin Board. It shall be the Bidder's responsibility to ensure it has received all such addenda, and each Bidder must acknowledge receipt of all addenda on the Bid Forms when it submits its Bid.

The City shall not be bound by and the Bidder shall not rely on any oral interpretation or clarification of the Bid Documents.

IB–18 MATERIALS AND SUBSTITUTIONS

It is often convenient and practical to specify materials and equipment to be incorporated into the work by a proprietary name or by the name of its manufacturer. When so specified and further qualified by the phrases "or equal" or "or equivalent," it shall be understood that such specification is not intended to limit the material and equipment selection process. Rather, the specification is intended to indicate a standard of quality and capability which will be accepted. However, all bidders desiring to use materials other than the specified material must obtain the written approval of the Project Manager. All such requests for approval of equal or equivalent material must be made in writing and, except as hereinafter provided, be received by the Designer of Record, Dennis Whitney, Burns & McDonnell Engineering, Inc., 9785 Maroon Circle, Suite 400, Centennial, CO 80112; phone 303-474-2223; and Lee Walichus, Project Manager, Airport Infrastructure Management, Denver International Airport, 7th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, Colorado 80249-6340, fax 303-342-2683, not later than ten (10) days prior to the date and time set for opening of bids so that all such approvals will be included in addenda to insure full and complete disclosure to all potential bidders of all approved equal or equivalent materials. All requests for approval of equal or equivalent material shall contain adequate technical data to clearly demonstrate equivalency. Incomplete submittals will not be reviewed. Requests must be submitted on the attached form titled "Request for 'or equal' Approval." Requests containing inadequate or incomplete information will not be considered.

If the bidder is awarded the contract and elects to use an "OR EQUAL" which has been added by addendum, the bidder shall be deemed to have warranted that;

(a) the use of the "OR EQUAL" fulfills the specification requirements contained in the Contract Documents.

(b) the installation of the "OR EQUAL" will not impact the spatial requirements for the Work or the scheduling of work performed by the City or other contractors.

Additionally, the bidder agrees that it shall modify any building system(s) (HVAC, structural, electrical, etc.) impacted by the use of an "OR EQUAL" at no cost to the City or other contractors under contract with the City and shall make no claims for delay or disruption arising out of such modification.

IB–19 WITHDRAWAL OF BID

A bidder may withdraw its Bid at any time prior to the time for opening of bids set forth in the Notice of Invitation for Bids by making written request to the Manager of Aviation. After the expiration of the bid period, no bid can be withdrawn for one hundred twenty (120) calendar days after the date bids are opened or until after a contract for the work described in these Bid Documents is fully executed by the City,

whichever date is earlier.

Such a request must be signed by persons authorized to bind the bidder as defined in IB–3, "Completing and Signing Bid Forms."

IB–20 SUBCONTRACTOR LISTS IN BID

The bidder shall, on the forms included in the Bid Forms, identify each element of the work which the bidder plans to subcontract, provide an estimate of the total cost to perform each element, and include the name and address of the proposed subcontractor.

IB–21 PERMIT FEES

The Contractor agrees to pay the permit fees associated with the construction of this project described in General Condition 316, and in the Special Conditions and Technical Specifications.

IB–22 TAXES

1. General. Bidders are referred to the General Conditions, G.C. 323, as to taxes to which they may be subject in performing the Work under this contract, including but not limited to sales and use taxes and the Denver Occupational Privilege Tax. The following instructions are to be considered along with the General Conditions and not in lieu of them.

2. Sales and Use Tax. Construction and building materials sold to contractors and subcontractors for use on structures, roads, streets, highways, and other public works owned by the City and County of Denver at Denver International Airport are exempt from state, RTD, and Cultural Facilities District sales and use taxes. However, such materials will be subject to sales and use taxes imposed by the City and County of Denver.

3. Exemption Certificates – Sales and Use Tax. It is responsibility of the Contractor and its subcontractors to apply to the Colorado Department of Revenue ("CDOR") for a certificate, or certificates, of exemption indicating that their purchase of construction or building materials is for a public project, and to deliver to the City copies of such applications as soon as possible after approval by the CDOR. Bidders shall not include in their bid amounts the exempt State, RTD, and Cultural Facilities District Sales and Use Taxes.

4. Denver Occupational Privilege Tax. Any employee working for a contractor or a subcontractor who earns over $500 working in Denver during a calendar month is subject to the payment of the Employee Occupational Privilege Tax. The Contractor and any subcontractor must pay the Business Occupational Privilege Tax for each of its employees who are subject to such tax.

IB–23 NONDISCRIMINATION IN THE AWARD OF CITY CONTRACTS

It is the policy of the City and County of Denver to prohibit discrimination in the award of construction contracts and subcontracts for public improvements. Further, the City and County of Denver encourages contractors to utilize minority and women owned businesses and to divide the construction work into economically feasible units or segments to allow the most opportunity for subcontracting.

IB–24 MINORITY/WOMEN BUSINESS ENTERPRISE (MBE/WBE) REQUIREMENTS

Divisions 1 and 3, Article III of Chapter 28 of the Denver Revised Municipal Code (Sections 28-31 to 28-36 and 28-52 to 28-90, D.R.M.C.) (the "Ordinance") apply to this Project and are incorporated into this Contract by reference. Generally, the Ordinance provides for the adoption of a good faith goals program, to be administered by the Division of Small Business Opportunity (DSBO), devised to provide increased bidding opportunities for Minority/Women Business Enterprises (MBE/WBEs). As such, each bidder must comply with the terms and conditions of the Ordinance in making its bid and, if awarded the Contract, in performing all Work thereunder. A bidder's failure to comply with the Ordinance, any Rules or Regulations promulgated pursuant thereto, or any additional requirement contained herein shall render the bid non-responsive and shall constitute cause for rejection. Failure by the contractor awarded the contract to comply with Ordinance requirements during the performance of the contract is a material breach of the contract, which may result in the termination of this contract, the imposition of sanctions or such other remedy, as deemed appropriate by DSBO. Copies of the Ordinance and its accompanying Rules and Regulations are available for the use and review of bidders from DSBO.

In order to comply with the bid requirements of the Ordinance, a bidder shall either meet the established project goal or, in the alternative, demonstrate that the bidder has made sufficient good faith efforts to meet the goal in accordance with the Ordinance. In preparing a bid to meet the established Project goal, bidders should consider the following instructions relating to compliance with the Ordinance:

1. Under the Ordinance, the Director of DSBO ("Director") is directed to establish project goals for expenditures on construction, reconstruction and remodeling work performed for the City and County of Denver. The specific goal for this project is stated in the Notice of Invitation for Bids bound herein.

2. In preparing its bid, each bidder shall list on the Bid Form pages entitled "List of Proposed Minority/Women Business Enterprise Bidders, Subcontractors, Suppliers, Manufacturers, Manufacturers' Representatives or Brokers" the name, address, work description/supply, committed level of participation and other required information for each MBE/WBE of any tier which the bidder intends to use in performing the work on this Project. **Only the MBE/WBEs identified and the precise levels of participation listed for each on the Bid**

Form page, at the time of bid opening, will be considered in determining whether the bidder has met the designated participation goal. Additional, revised or corrected participation submitted after bid opening will not be considered. MBE/WBE bidders may count self-performance or joint venture activity in meeting the MBE/WBE project goal, but only for the scope of work performed as a commercially useful function and at a percentage level the MBE/WBE will be performing itself.

3. All MBE/WBEs listed on the Bid Form must be properly certified by the City on or before the date bids are opened in order to count towards meeting the designated goal. DSBO maintains an MBE/WBE Construction Directory ("Directory"), which is a current listing of MBE/WBEs that have been certified by the City. A copy of the Directory is available from DSBO, located at 201 W. Colfax, Dept. 907, Denver, Colorado, or on the website located at www.denvergov.org/DSBO and will also be made available at the pre-bid meeting. Bidders are encouraged to use the Directory to assist in locating MBE/WBEs for the work and supplies required on the Project. Bidders are reminded that changes may be made to the Directory at any time in accordance with the City's MBE/WBE Ordinance and procedures established to administer this program, and that a current copy of the Directory must always be used in preparing a bid. MBE/WBE certification or listing in the Directory is not a representation or warranty by the City as to the qualifications of any listed MBE/WBE.

4. In accordance with the provisions of the Ordinance, DSBO will evaluate each bid to determine the responsiveness of the bid to the requirements of the Ordinance. In determining whether a bidder's committed level of participation meets or exceeds the stated MBE/WBE goal, DSBO shall base its calculation of applicable amounts and percentages on the total base bid amount, not including any listed alternates, of each bid as follows:

   a. The bid information provided by the agency will be used to determine the total base bid amount of each bid. Each bidder's total base bid amount will be multiplied by the MBE/WBE percentage established for the project to determine the exact dollar amount of required MBE/WBE participation for the Project. This amount will then be compared against the exact dollar amounts for the MBE/WBEs committed for participation by the bidder. If the total dollar amount of participation listed meets or exceeds the established MBE/WBE dollar amount goal listed, then DSBO will determine that the goal has been met.

   b. In addition, DSBO will determine the exact commitment percentage for each listed MBE/WBE by dividing the dollar amount listed for each MBE/WBE by the total base bid dollar amount submitted by the bidder. These individual percentages, when totaled for all listed

MBE/WBEs, will establish the total committed percentage level of MBE/WBE participation that the bidder must comply with during the life of the contract. In all cases, the committed percentage level of MBE/WBE participation must equal or exceed the assigned MBE/WBE goal for the Project.

c. In providing the exact dollar amount of participation for each listed MBE/WBE, a bidder should take care never to round up in determining whether or not the total of these amounts meets or exceeds the established percentage goal. The goal must be met or exceeded by dollar amounts and percentages in order for DSBO to determine that the bidder has met or exceeded the applicable MBE/WBE goal.

d. As previously mentioned, compliance with the MBE/WBE goal will be determined on the base bid alone. If a bid contains alternates, participation contained in any alternate will not count towards satisfaction of the Project goal. However, should any designated alternate be selected by the City for inclusion in the contract ultimately awarded, the MBE/WBE goal percentage level submitted at bid time, on the base bid, will also apply to the selected alternates and must be maintained for the life of the contract on the total contract amount, including any alternate work. Thus, even though such participation will not be considered in evaluating bids, bidders are urged to consider participation in preparing bids for designated alternates.

e. On projects where force account or allowance bid items have been included, bidders must meet the MBE/WBE goal percentage based upon the total base bid, including all such items that are submitted to the City. However, when a force account or allowance is designated by the City to be either performed or purchased from a specific company, the bidder may back out the dollar amount of the force account or allowance from the total base bid and meet the MBE/WBE goal on the remaining reduced amount.

f. On bids that, at the time of bid opening, are equal to or exceed Five Million Dollars ($5,000,000.00), including any alternates that may be selected, only sixty percent (60%) of the value of the commercially useful function performed by MBE/WBE suppliers shall count toward satisfaction of the Project goal. On Projects under Five Million Dollars ($5,000,000.00) the value of the commercially useful function of MBE/WBE supplier(s) will count at a one hundred percent (100%) level. Manufacturers' representatives and packagers shall be counted in the same manner as brokers.

g. **In utilizing the MBE/WBE participation of a Broker,** only the bona

fide commissions earned by such Broker for its performance of a commercially useful function will count toward meeting the Project goals. The bidder must separate the bona fide brokerage commissions from the actual cost of the supplies or materials provided to determine the actual dollar amount of participation that can be counted towards meeting the goal.

5. On or before the third (3rd) working day after bid opening, all of the Bidders are required to submit an executed "MBE/WBE Letter of Intent" for each MBE/WBE listed on the Bid Form as a joint venture member, subcontractor, supplier, manufacturer, manufacturers' representative or broker of any tier. An MBE/WBE Bidder needs to submit a Letter of Intent for any portion of self-performed work to count towards MBE/WBE utilization. , Each Letter of Intent shall be submitted only for the MBE/WBEs listed at the time of bid opening, since this is the only participation that will be counted toward satisfaction of the project goal. A form for the MBE/WBE Letter of Intent is included with the Bid Form. The MBE/WBE Letter of Intent is a written communication from the Bidder to the City evidencing an understanding that the Bidder has or will enter into a contractual relationship with the MBE/WBE or that its subcontractor(s) and supplier(s), manufacturer(s), manufacturers' representative(s) and broker(s) will do so. Each MBE/WBE Letter of Intent shall be accompanied by a copy of the City and County of Denver's MBE/WBE certification letter for each proposed MBE/WBE identified at bid time. Bidders are urged to carefully review these Letters before submission to the City to ensure that they are properly completed and executed by the appropriate parties.

In preparing a bid to demonstrate a good faith effort, bidders should consider the following instructions relating to compliance with the Ordinance:

1. If any Bidder has not met the designated Project goal at the time the bids are opened or elects to present a good faith effort in lieu of or in addition to attempting to satisfy the designated Project goal, that Bidder shall submit, on or before the third (3rd) working day after the bid opening a detailed statement, with supporting documentation, setting forth its good faith efforts, made prior to bid opening, attempting to meet the established goal in accordance with Section 28-62 of the Ordinance. This statement shall address each of the items in Subsection (b) of that Section and any additional criteria that the DSBO Director may establish by rule or regulation. A Bidder who fails to meet the Project goal and cannot show that it made a good faith effort to meet the goal shall be considered non-responsive.

2. The statement of good faith efforts shall include a specific response to each of the following as further defined by rule or regulation. A Bidder may include any additional information the Bidder believes may be relevant. Failure of a Bidder to show good faith efforts as to any one of the following items shall

render its overall good faith showing insufficient and its bid non-responsive. Items (1) through (10) of Section 28-62, Subsection (b) of the Ordinance are set forth below:

(1) If prebid or preselection meetings are scheduled by the City at which MBEs and WBEs may be informed of subcontracting or joint venture opportunities under a proposed contract to be bid, or procured pursuant to the competitive selection process, attendance at such prebid or preselection meetings is not mandatory (unless required otherwise by the City); however, bidders and proposers are responsible for the information provided at these meetings.

(2) The bidder or proposer must solicit through all reasonable and available means, the interest of all MBEs and WBEs certified in the scopes of work of the contract. The bidder or proposer must solicit the interest of such MBEs and WBEs within sufficient time, prior to the bid opening or date of final project-specific proposal in the case of a competitive selection process, to allow such MBEs and WBEs to respond to the solicitation. The bidder or proposer must determine with certainty if the MBEs and WBEs are interested by demonstrating appropriate steps to follow up initial solicitations.

(3) The bidder or proposer must select portions of the work of the contract to be performed by MBEs and WBEs in order to increase the likelihood that the project goal will be achieved. This includes, where appropriate, breaking out contract work items into economically feasible units to facilitate MBE and WBE participation as subcontractors or joint venturers, and for bidder or proposer self-performed work, as suppliers, manufacturers, manufacturer's representatives and brokers, all reasonably consistent with industry practice, even when the bidder or proposer would otherwise prefer to perform these work items with its own forces. The bidder or proposer must identify what portions of the contract will be self-performed and what portions of the contract will be opened to solicitation of bids, proposals and quotes from MBE and WBEs. All portions of the contract not self-performed must be solicited for MBE and WBE participation. The ability or desire of a bidder or proposer to perform the work of a contract with its own forces does not relieve the bidder or proposer of the responsibility to meet the project goal or demonstrate good faith efforts to do so.

(4) The bidder or proposer, consistent with industry practice, must provide MBEs and WBEs at a clearly stated location with timely, adequate access to and information about the plans, specifications, and requirements of the contract, including bonding and insurance requirements, if any, to assist them in responding to a solicitation.

(5) The bidder or proposer must negotiate in good faith with interested MBEs and WBEs and provide written documentation of such negotiation with each such MBE or WBE.

(6) For each MBE or WBE which contacted the bidder or proposer or which the bidder or proposer contacted or attempted to subcontract or joint venture with, consistent with industry practice, the bidder or proposer must supply a statement giving the reasons why the bidder or proposer and the MBE or WBE did not succeed in negotiating a subcontracting, supplier, manufacturer, manufacturer's representative, broker or joint venture agreement, as applicable.

(7) The bidder or proposer must provide verification that it rejected each non-utilized MBE and WBE because the MBE or WBE did not submit the lowest bid or it was not qualified. Such verification shall include a verified statement of the amounts of all bids received from potential or utilized subcontractors, suppliers, manufacturers, manufacturer's representatives, brokers or joint venturers on the contract, whether or not they are MBEs or WBEs. In making such a determination of not being qualified, the bidder or proposer shall be guided by the definition of qualified in section 28-54(42), but evidence of lack of qualification must be based on factors other than solely the amount of the MBEs or WBEs bid. For each MBE or WBE found not to be qualified by the bidder or proposer, the verification shall include a statement giving the bidder's or proposer's reasons for its conclusion. A bidder's or proposer's industry standing or group memberships may not be the cause of rejection of an MBE or WBE. A bidder or proposer may not reject an MBE or WBE as being unqualified without sound reasons based on a reasonably thorough investigation and assessment of the MBEs or WBEs capabilities and expertise.

(8) If requested by a solicited MBE or WBE, the bidder or proposer must make reasonable efforts to assist interested MBEs and WBEs in obtaining bonding, lines of credit, or insurance as required by the City or by the bidder or proposer, provided that the bidder or proposer need not provide financial assistance toward this effort.

(9) If requested by a solicited MBE or WBE, the bidder or proposer must make reasonable efforts to assist interested MBEs and WBEs in obtaining necessary and competitively priced equipment, supplies, materials, or related assistance or services for performance under the contract, provided that the bidder or proposer need not provide financial assistance toward this effort.

(10) The bidder or proposer must use the DSBO MBE/WBE directories to identify, recruit, and place MBEs and WBEs.

In accordance with the provisions of the Ordinance, the bidder agrees that it is committed to meeting either the MBE/WBE participation goal or the MBE/WBE participation set forth in its statement of good faith efforts. This commitment must be expressly indicated on the "Commitment to Minority/Women Business Enterprise Participation" form included with the Bid Form. This commitment includes the following understandings:

1. The bidder understands it must maintain MBE/WBE goals throughout the performance of the Contract pursuant to the requirements set out in D.R.M.C. 28-72.

2. The bidder understands that it must establish and maintain records and submit regular reports, as required, that will allow the City to assess progress in achieving the MBE/WBE participation goal.

3. The bidder understands that if change orders or any other contract modifications are issued under the contract, the bidder shall have a continuing obligation to immediately inform DSBO in writing of any agreed upon increase or decrease in the scope of work of such contract, upon any of the bases discussed in Section 28-73 of the Ordinance, regardless of whether such increase or decrease in scope of work has been reduced to writing at the time of notification.

4. The bidder understands that if change orders or other contract modifications are issued under the contract, that include an increase in scope of work of a contract for construction, reconstruction, or remodeling, whether by amendment, change order, force account or otherwise which increases the dollar value of the contract, whether or not such change is within the scope of work designated for performance by an MBE/WBE at the time of contract award, such change orders or contract modification shall be immediately submitted to DSBO for notification purposes. Those amendments, change orders, force accounts or other contract modifications that involve a changed scope of work that cannot be performed by existing project subcontractors or by the contractor shall be subject to a goal for MBE/WBEs equal to the original goal on the contract which was included in the bid. The contractor shall satisfy such goal with respect to such changed scope of work by soliciting new MBE/WBEs in accordance with Section 28-73 of the Ordinance as applicable, or the contractor must show each element of modified good faith set out in Section 28-75 (c) of the Ordinance. The contractor or consultant shall supply to the director the documentation described in Section 28-75 (c) of the Ordinance with respect to the increased dollar value of the contract.

All bidders are charged with knowledge of and are solely responsible for complying with each and every provision of the Ordinance in making a bid and, if awarded, in performing the work described in the Contract Documents. Failure to comply with

these provisions could constitute cause for rejection of a bid or subject the selected contractor to sanctions set forth in the Ordinance. These instructions are intended only to generally assist the bidder in preparing and submitting a compliant bid. Should any questions arise regarding specific circumstances, bidders must consult the Ordinance or contact the Project's designated DSBO representative at (303) 342-2180.

IB–25 WAGE RATE REQUIREMENTS

Pursuant to Section 20-76 of the Revised Municipal Code, the bidder selected to perform this contract shall pay mechanics, laborers and workers employed directly upon the site of the work the full amounts accrued at the time of payment, computed wage rates not less than those shown on the current prevailing wage rate schedule included in the contract bid documents and any addenda thereto. If the City's Career Service Board issues a modification to those wage rates more than ten (10) days prior to the scheduled bid opening, those modifications will be published in an addendum issued by the City to all prospective bidders. The City may, in its sole discretion, determine on a case-by-case basis whether wage rate modifications issued by the Career Service Board ten (10) days or less before the bid opening will be included in an addendum. If they are included in an addendum, the City may, in its sole discretion, elect to postpone the date of bid opening.

If the term of the contract extends for more than one year, the minimum City prevailing wage rates that contractors and subcontractors shall pay during any subsequent yearly period or portion thereof shall be the wage rates in effect on the yearly anniversary date of the contract which begins such subsequent period. In no event shall any increases in prevailing wages after the first anniversary of the contract result in any increased liability on the part of the City and the possibility and risk of any such increase is assumed by all contractors entering into such contract with the City.

IB–26 CONSTRUCTION SCHEDULING

The bidder should refer to the General Conditions, Special Conditions, and Division I of the Technical Specifications for scheduling requirements for this contract.

IB–27 EQUAL EMPLOYMENT OPPORTUNITY

1. Article III, Division 2 of Chapter 28 applies to this contract. It is the policy of the City to provide equal opportunity in employment without regard to race, color, creed, sex, national origin, religion, marital status, or political opinion or affiliation. It is hereby deemed and declared to be for the public welfare and in the best interest of the City to require bidders, contractors and subcontractors soliciting and receiving, directly or indirectly, compensation from or through the City, for the performance of such contracts, to meet certain affirmative action and equal employment opportunity requirements. Additionally, contractors and subcontractors that hold any contracts which are federally-assisted shall be

required to adhere to the Department of Labor's Contract Compliance program under Executive Order 11246 as defined in the regulations of the Secretary of Labor at 41 CFR Chapter 60-4.

2. After the Notice to Apparent Low Bidder has been issued, the Apparent Low Bidder shall submit the following to the Division of Small Business Opportunity:

   (a) A statement that the bidder shall implement the affirmative action steps set forth in the Rules and Regulations and Bid Conditions of the Manager of Public Works pertaining to Equal Employment Opportunity, attached hereto, or the bidder's affirmative action plan which meets these requirements, and

   (b) A projection of its anticipated workforce for this contract on the attached "EEO Questionnaire." Both of these submittals are required before the Division of Small Business Opportunity will approve the Notice to Proceed.

3. The bidder which is awarded this contract shall comply with the provisions and requirements, including the goals of minority and female participation and specific affirmative action steps, set forth in the Rules and Regulations and Bid Conditions of the Manager of Public Works pertaining to Equal Employment Opportunity, as said rules and regulations may be amended or readopted from time to time by the Manager of Public Works or the Director of the Division of Small Business Opportunity.

IB–28 CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION

The bidder certifies, by submission of its bid or acceptance of this contract, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or involuntarily excluded from participation in any government contract by any Federal, State, or local government department or agency. It further agrees by submitting its bid that it will include this clause without modification in all lower tier transactions, solicitations, proposals, contracts, and subcontracts. Where the bidder or any lower tier participant is unable to certify to this statement, it shall attach an explanation to its bid.

IB–29 INSURANCE REQUIREMENTS, OCIP PROGRAM, SAFETY MANUAL

In preparing its Bid, the Bidders shall assure that insurance requirements contained in the Contract Documents are met. In accordance with the provisions of General Contract Condition 1601, INSURANCE, the minimum insurance requirements for this Contract are set forth in the form **CITY AND COUNTY OF DENVER INSURANCE CERTIFICATE** contained in the Special Conditions Section of the Contract Documents. Bidders are urged to consider in preparing a bid hereunder that the Contractor and all subcontractors performing Work on the Project must comply with each condition, requirement or specification set forth in the form certificate,

unless such requirements are specifically excepted in writing by the City's Risk Management Administrator. The Contractor must either include all subcontractors performing work hereunder as insureds under each required policy or obtain a separate certificate for each subcontractor. The City reserves the right to request copies of these certificates at any time.

All certificates required by this Contract shall be sent directly to Denver International Airport, Business Management Services, via the following email address: ContractDocs@flydenver.com. The City project/Contract number and project description shall be noted on the certificate of insurance. The City reserves the right to require complete, certified copies of all insurance policies required by this Contract at any time.

City may at its sole option provide an Owner Controlled Insurance Program (OCIP), which coverage City agrees will be primary over any other insurance provided by an enrolled party. A copy of the OCIP proposed coverage and Safety Manual are included in the Contract Documents. Bidder should review the proposed coverage and Safety Manual in preparing its bid. Bidder shall submit an "add alternate" for additional insurance costs if the City determines not to provide an OCIP.

IB-30 INVOICING

All invoices must be submitted electronically in PDF format to ContractAdminInvoices@Flydenver.com. If using an invoice transmittal form, submit that form in EXCEL format. Submitting your invoices to ContractAdminInvoices@Flydenver.com starts the official prompt payment process step one. Any invoices submitted to other parties will not be considered part of the process and all other methods of invoice submittal will be rejected.

IB-31 PROJECT CONTROLS REQUIREMENTS

The Contractor will be required to use Primavera Contract Management (PCM) and Primavera P6 to comply with the requirements of DIA's Project Controls System. The Project Controls System is Airport Infrastructure Management's tool for project and information management, data analysis and document control. Denver International Airport will be responsible for providing the licensing and training for PCM. The Contractor will be responsible for providing Primavera P6. The Contractor will also be responsible for providing and maintaining the computer hardware, software and system environment capable of supporting Project Controls System requirements including as the minimum: internet connection; Microsoft Internet Explorer 8 or better; Microsoft Office 2010; Oracle Java JRE 1.7.0 Update 5 and Adobe Acrobat X Pro. This is the only project management system that will be accepted.

REQUEST FOR "OR EQUAL" APPROVAL

Contract No.: 201310046
Title: CENTRAL UTILITY PLANT CHILLER ADDITION

This request, **in duplicate**, must be received by the City Project Manager and Designer of Record at the following addresses, by noon at least 10 days prior to bid date.

City Project Manager:	Designer of Record:
Lee Walinchus Airport Infrastructure Management Office Denver International Airport 7th Floor, Airport Office Building 8500 Peña Boulevard Denver, CO 80249-6240 Fax: 303-342-2683	Dennis Whitney Burns & McDonnell Engineering, Inc. 9785 Maroon Circle, Suite 400 Centennial, CO 80112 303-474-2223

To be completed and signed by requesting party:

Specification Section/Drawing Number:	Page No./Paragraph No./Subparagraph No.:
Specified Product:	Specified Manufacturer:
	Specified Model No.:
"Or Equal" Product:	"Or Equal" Manufacturer:
	"Or Equal" Model No.
Reason for "Or Equal" substitution:	
Prior Applications [Installations of at least 3 years length]: (1) Project:_____ Date:_____ (2) Project:_____ Date:_____ (3) Project:_____ Date:_____	

[PAGE 1 OF 2 PAGES]

General product literature/catalog cuts/drawings or other appropriate information detailing the "Or Equal" product with respect to the project specifications must be attached to this form for approval.

I have reviewed the attached product literature and certify the following:

(1) That the above described "Or Equal" product fulfills the specification requirements as detailed in the Contract Documents.
(2) That the installation of the above described "Or Equal" product in no way impacts the spatial requirements of the project.
(3) That I, if selected as the Contractor, shall modify any building system(s) (HVAC, structural, electrical, etc.) impacted by the use of the above described "Or Equal" product at no additional cost to the City and County of Denver and shall make no claim for delay with respect to any such modification.
(4) That the above described "Or Equal" product meets all physical and performance attributes of the specified material or equipment except (if no difference, so state):

REQUESTING PARTY: _____

Date: _____ By: _____

Title: _____

For City use:

☐ Approved ☐ Disapproved Date: _____
Reason for disapproval [if applicable]:

DESIGNER OF RECORD:
[Signature]

PROJECT MANAGER: Date:
[Signature]

DEPUTY MANAGER: Date:
[Signature]

Bidder(s) Notified By Addendum No. Date:

EEO QUESTIONNAIRE
Contract No: 201310046

1. Name of Business: _____

2. Address: _____

3. City, State, Zip Code: _____

4. Telephone Number: (_____) _____

5. Name and title of your firm's EEO Contact: _____

6. Are you an affiliate or a subsidiary of another business organization (branches, etc.)?
   ☐ Yes ☐ No

7. Type of business you are engaged in: _____

8. Does the organization have a procedure for resolving discrimination complaints?
   ☐ Yes ☐ No

9. Has your firm been charged with discrimination within the past eighteen (18) months?
   ☐ Yes ☐ No

10. Is your firm required to submit an EEO-1 annually to the EEOC?
    ☐ Yes ☐ No

11. Are you now working or have you worked on a City and County of Denver contract during the past twelve (12) months? If yes, complete the following information:

Type of Contract	Contract Number	Total Cost of Each Contract

(You may use additional sheets if necessary)

PROJECTION OF ANTICIPATED WORKFORCE
Contract No. 201310046

12. List the number of anticipated new employees needed by the contractor to perform this contract by trade/craft positions.

ANTICIPATED NUMBER OF NEW EMPLOYEES FOR THIS CONTRACT

Trade Craft	Estimated Total Manpower	Estimated Total Hours	Number of Employees Minority/Female	Total Estimated Employees Minority/Female
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

13. What is the anticipated number of employees from the apparent low bidder's current work force to be utilized to perform this contract?_____

14. Estimate manpower utilization for the project below:

ESTIMATE OF MANPOWER UTILIZATION

Trade Craft	Estimated Total Manpower	Estimated Total Hours	Number of Employees Minority/Female	Total Estimated Employees Minority/Female
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

15. Will the estimated total manpower (anticipated new hires and current staff to be utilized on this contract) meet the City's minority employment and female employment goals?

Yes_____ No_____

PREVAILING WAGES

The Prevailing Wage Schedule(s) which apply to this contract are contained in the pages immediately following this page.
These pages are not included in the page numbering of this contract document.

DENVER
THE MILE HIGH CITY

Career Service Authority
Denver's Human Resource Agency

201 W. Colfax, Department 412
Denver, CO 80202
p: 720.913.5751
f: 720.913.5720
www.denvergov.org/csa

TO: All Users of the City of Denver Prevailing Wage Schedules

FROM: Seth Duhon-Thornton, Staff Human Resources Professional

DATE: Friday March 15, 2013

SUBJECT: Latest Change to Prevailing Wage Schedules

Please be advised, prevailing wage rates for some building, heavy, and highway construction trades have not been updated by the United States Department of Labor (DOL) since March 1, 2002. The Career Service Authority Board, in their meeting held on April 21, 2011, approved the use of the attached supplemental wage rates until prevailing wage rates for these classifications of work are again published by the United States Department of Labor in accordance with the Davis-Bacon Act. The rates will be provided as a supplemental to the Davis-Bacon Building rates issued by CSA.

The attached Prevailing Wage Schedule is effective as of **Friday March 15, 2013** and applies to the City and County of Denver for **BUILDING CONSTRUCTION PROJECTS** (does not include residential construction consisting of single family homes and apartments up to and including 4 stories) in accordance with the Denver Revised Municipal Code, Section 20-76(c).

General Wage Decision No. CO130004
Superseded General Decision No. CO20120004
Modification No.03
Publication Date: 03/08/2013
(5 pages)

Unless otherwise specified in this document, apprentices shall be permitted only if they are employed pursuant to, and individually registered in, a bona fide apprenticeship program registered with the U.S. Department of Labor (DOL). The employer and the individual apprentice must be registered in a program, which has received prior approval, by the DOL. Any employer, who employs an apprentice and is found to be in violation of this provision, shall be required to pay said apprentice the full journeyman scale.

For questions call (720) 913-5018

Attachments as listed above.

General Decision Number: CO130004 03/08/2013 CO4

Superseded General Decision Number: CO20120004

State: Colorado

Construction Type: Building

County: Denver County in Colorado.

BUILDING CONSTRUCTION PROJECTS (does not include residential construction consisting of single family homes and apartments up to and including 4 stories)

Modification Number	Publication Date
0	01/04/2013
1	01/11/2013
2	02/15/2013
3	03/08/2013

ASBE0028-001 10/01/2012

	Rates	Fringes
Asbestos Workers/Insulator (Includes application of all insulating materials, protective coverings, coatings and finishings to all types of mechanical systems)	$ 28.98	13.03

BRCO0007-001 01/01/2011

	Rates	Fringes
BRICKLAYER	$ 22.13	9.89

BRCO0007-005 06/01/2011

	Rates	Fringes
TILE SETTER	$ 25.15	9.18

CARP0001-004 05/01/2009

	Rates	Fringes
Carpenters: Acoustical, Drywall Hanging/Framing and Metal Stud, Form Building/Setting	$ 26.60	8.89

CARP1607-002 06/01/2012

	Rates	Fringes

MILLWRIGHT.....$ 28.95 11.10

ELEC0068-002 12/01/2012

	Rates	Fringes
ELECTRICIAN (Includes Low Voltage Wiring and Installation of Fire alarms, Security Systems, Telephones, Computers and Temperature Controls)	$ 32.10	12.53

ELEV0025-002 01/01/2013

	Rates	Fringes
Elevator Constructor	$ 39.59	25.685

FOOTNOTE:
a. Employer contributes 8% of basic hourly rate for over 5 years' service and 6% basic hourly rate for 6 months' to 5 years' service as Vacation Pay Credit.

PAID HOLIDAYS: New Year's Day; Memorial Day; Independence Day; Labor Day; Veterans Day; Thanksgiving Day; Friday after Thanksgiving Day; and Christmas Day.

ENGI0009-003 06/25/2012

	Rates	Fringes
Power equipment operator - crane		
141 tons and over	$ 25.48	8.62
50 tons and under	$ 24.42	8.62
51 to 90 tons	$ 24.57	8.62
91 to 140 tons	$ 24.72	8.62

IRON0024-001 07/01/2011

	Rates	Fringes
IRONWORKER, STRUCTURAL	$ 23.80	10.91

LABO0720-003 05/01/2009

	Rates	Fringes
Laborers:		
Concrete/Mason Tenders	$ 16.52	6.84

PAIN0079-002 08/01/2012

	Rates	Fringes

Drywall Finisher/Taper
Hand.....$ 18.69 6.37
Tool.....$ 19.04 6.37
Painters:.....$ 17.99 6.37
PAPERHANGER.....$ 18.69 6.37

PAIN0930-001 07/01/2012

	Rates	Fringes
GLAZIER	$ 27.77	7.42

PLAS0577-001 08/01/2011

	Rates	Fringes
Cement Mason/Concrete Finisher	$ 23.00	10.75

PLUM0003-001 07/01/2012

	Rates	Fringes
PLUMBER (Excluding HVAC work)	$ 33.18	11.44

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* PLUM0208-001 01/01/2013

	Rates	Fringes
PIPEFITTER (Including HVAC pipe)	$ 30.10	11.52

SFCO0669-001 01/01/2013

	Rates	Fringes
SPRINKLER FITTER	$ 32.44	18.60

SHEE0009-001 01/01/2011

	Rates	Fringes
Sheet metal worker (Includes HVAC duct and installation of HVAC systems)	$ 31.66	10.98

SUCO2001-011 12/20/2001

	Rates	Fringes
Carpenters: All Other Work	$ 16.12	2.84
Ironworkers: Reinforcing	$ 18.49	3.87

Laborers:
Brick Finisher/Tender.....$ 12.78 1.41
Common.....$ 10.62 2.09

Power equipment operators:
Mechanic.....$ 18.48

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

Career Service Authority
Supplemental to the Davis-Bacon *Building* Construction Project rates
(Specific to the Denver projects)

Supp #100, Date: 03-02-2012

Classification		Base	Fringe
Boilermakers		$30.97	$21.45
Power Equipment Operators (Concrete Mixers):			
	Less than 1 yd	$23.67	$10.67
	1 yd and over	$23.82	$10.68
	Drillers	$23.97	$10.70
	Loaders over 6 cu yd	$23.82	$10.68
	Oilers	$22.97	$10.70
Soft Floor Layers		$16.70	$9.81
Ironworkers (Ornamental)		$24.80	$10.03
Plasters		$24.60	$12.11
Plaster Tenders		$10.79	-
Laborers: Concrete Saw		$13.89	-
Power Equipment Operators:			
	Backhoe	$23.67	$10.67
	Loader up to and incl 6 cu yd	$23.67	$10.67
	Motor Grader	$23.97	$10.70
	Roller	$23.67	$10.67
Truck Drivers (Dump Trucks):			
	6 to 14 cu yds	$19.14	$10.07
	15 to 29 cu yds	$19.48	$10.11
	Flatbed	$19.14	$10.07
	Semi	$19.48	$10.11

- To determine the Tile Setters-Marble Mason-Terrazzo mechanic rates—Use Davis Bacon-Building rates adopted by the Career Service Board.
- To determine the Tile Finisher-Floor Grinder-Base Grinder—Use current Career Service Prevailing Wage Schedules.
- Caulkers—Receive rate prescribed for craft performing operation to which caulking is incidental .i.e. glazier, painter, brick layer, cement mason.
- Use the "Carpenters—All Other Work" rates published by the federal Davis Bacon rates for batt insulation, pre-stress concrete and tilt up concrete walls, Roofers (including foundation waterproofing).
- Use the "Laborer—Common", rates published by the federal Davis Bacon rates for General Housekeeping, Final Cleanup and Fence Installer.

DENVER INTERNATIONAL AIRPORT
BID FORMS

CONTRACT NAME: CENTRAL UTILITY PLANT CHILLER ADDITION
Contract No.: 201310046

BID LETTER

BIDDER Bosco Constructors, Inc.

Manager of Aviation
City and County of Denver
Business Management Services (Procurement) Office
Airport Office Building, Room 8810
Denver International Airport
8500 Peña Boulevard
Denver, Colorado 80249

This letter is in response to the Notice of Invitation for Bids first published on May 20, 2013, for Contract No. 201310046, Denver International Airport, CENTRAL UTILITY PLANT CHILLER ADDITION.

The project consists of expanding the cooling capacity of the Central Utility Plant at Denver international Airport. Elements of the project include:

- Provide two new, 2,500 ton, dual-compressor, VFD Trane Chillers in Bay 4 of the Chiller Room.
- Provide new 4,160 kV electrical equipment for the new chillers
- Modify the plant control systems as required to integrate all new equipment into the plant control system (Johnson Controls, Inc.).
- Relocate existing Refrigerant Transfer Units within the Plant
- Disconnect electrical equipment that serves removed Chiller C-4 and associated Condenser Water Pump P-34.
- Provide new horizontal split case, VFD condenser water pump
- Provide new horizontal split case, VFD chilled water pump.
- Provide Variable Frequency Drives (VFD) to existing vertical turbine pumps P-23 & P-24.
- Construct new Electrical Room for new electrical equipment and drives in Bay 6 of the Boiler Room.
- Reduce size of existing Break Room and Tool Room in Pump Room to allow for installation of new chilled water pump.

This project requires completion prior to allow for new Terminal Complex buildings and infrastructure expansions.

The undersigned Bidder declares that it has carefully examined the location of the proposed work and has carefully read and examined all of the Contract Documents which include, but are not limited to, the Contract Drawings, Technical Specifications, Construction Contract General

Conditions, Special Conditions, Instruction to Bidders, and EEO provisions, and hereby proposes to furnish all labor, materials, equipment, tools, transportation and services, and to discharge all duties and obligations necessary and required to perform and complete the Work as required in the Contract Documents which are provided herewith and by this reference made a part hereof for the prices shown in the bid forms and totaled below:

BASE BID Amount (**insurance costs includes OCIP**): Six million two hundred eighteen thousand three hundred seventy eight Dollars and No Cents ($ 6,218,378).

ALTERNATE Amount (**price adjustment if City does not provide OCIP**): Six million two hundred eighteen thousand three hundred seventy eight Dollars and No Cents ($ 6,218,378).

The undersigned acknowledges receipt, understanding and full consideration of the following addenda to the Contract Documents:

Addenda Nos.: 1 and 2

The undersigned agrees that this bid is a firm offer to the City to perform and complete the Contract described above which cannot be withdrawn for one hundred twenty (120) calendar days after the bids are opened or until after a contract for the work described in these bid documents is fully executed by the City, whichever date is earlier.

The undersigned Bidder hereby agrees to appear at Denver International Airport, Business Management Services Office, Room 8810, Airport Office Building, at any time within five (5) working days from the date of a written notice from the Manager to do so, mailed and/or faxed to the business address of Bidder and at that time the Bidder shall: (1) deliver an executed Contract which conforms with this bid; (2) furnish the required performance and payment bonds in the sum of the Total Contract Bid Amount shown above, executed by a surety company acceptable to the Manager; and (3) furnish the required insurance documents.

Enclosed herewith is a bid guarantee, as defined in the Instructions to Bidders, in the amount of which bid guarantee the undersigned Bidder agrees is to be paid to and become the property of the City as liquidated damages should the bid be considered to be the best by the City and the undersigned Bidder notified that it is the apparent low bidder and it fails to enter into contract in the form prescribed and to furnish the required performance and payment bonds and evidences of insurance within five (5) working days as stipulated above.

Attached and incorporated herein as the proposed Schedule of Prices and Quantities and Bid Data Forms. All of the forms must be completed. Bidder acknowledges that the City may incorporate, at its option, any or all of the data submitted by the Bidder into a contract arising out of this Bid.

The undersigned Bidder acknowledges the right of the City to waive informalities in the bids, to reject any or all bids submitted, and to re-advertise for bids.

The undersigned certifies that it has examined and is fully familiar with all of the provisions of the Contract Documents and is satisfied that they are accurate; that it has carefully checked all words and figures and all statements made in these Bid forms; and that it has satisfied itself with respect to the actual site conditions and the nature and location of the Work, the general and local conditions which may be encountered in the performance of the Work, and other matters which in any way affect the Work or the cost thereof.

This bid is submitted upon the declaration that neither, I (we), nor, to the best of my (our) knowledge, none of the members of my (our) firm or company have either directly or indirectly entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this bid.
Dated this 25 day of June, 2013.

BUSINESS ADDRESS OF BIDDER: 6568 South Racine Circle, Suite 100

City, State, Zip Code: Centennial, Co 80111

Telephone Number of Bidder: (303) 799-1221

Fax Number of Bidder: (303) 799-4544

Email Address: jbosco@boscoconstructors.com

Social Security or Employer Id. No. of Bidder: 84-1144548

SIGNATURE OF BIDDER:

If a Corporation:

PRINT NAME OF CORPORATION:

Bosco Constructors, Inc.

Attest:
(Corporate Seal)

a _____ Corporation

Secretary

By: _____
President

If a Limited Liability Company:

PRINT NAME OF LIMITED LIABILITY COMPANY:

_____

Organized in the State of _____

By: _____
Manager

If a Partnership:

PRINT NAME OF PARTNERSHIP:

_____

By:_____
General Partner

If an Individual:

_____, doing

business as _____

Signature:

_____

If a Joint Venture, signature of all Joint Venture partners is required:

PRINT NAME OF JOINT VENTURE:

_____

Joint Venture Partner --
Name of Firm:

_____
Corporation ( ) or Partnership ( )

By:_____
Signature

Title:_____

Required for a corporation:

ATTEST:
(Corporate Seal)

_____
Secretary

Joint Venture Partner –
Name of Firm:

_____
Corporation ( ) or Partnership ( )

Joint Venture Partner --
Name of Firm:

_____
Corporation ( ) or Partnership ( )

By:_____
Signature

Title:_____

Required for a corporation:

ATTEST:
(Corporate Seal)

_____
Secretary

Joint Venture Partner –
Name of Firm:

_____
Corporation ( ) or Partnership ( )

By:_____
Signature

Title:_____

Required for a corporation:

ATTEST:
(Corporate Seal)

_____
Secretary

By:_____
Signature

Title:_____

Required for a corporation:

ATTEST:
(Corporate Seal)

_____
Secretary

SCHEDULE OF PRICES AND QUANTITIES

The Schedule of Prices and Quantities which apply to this contract are contained in the pages immediately following this page.
These pages are not included in the page numbering of this contract document.

(NOT APPLICABLE TO THIS CONTRACT)

DENVER INTERNATIONAL AIRPORT

CENTRAL UTILITY PLANT CHILLER ADDITION
Contract No. 201310046

BID DATA FORMS

Bidder shall submit its Bid Data in accordance with the format shown on each of the following Bid Data Forms. Bidder shall prepare and use as many sheets as are necessary to provide the information required. Bidder shall ensure that each page of its Bid Data is completed and properly identified with the Bid Data form name, Bidder's name, and page number.

DENVER INTERNATIONAL AIRPORT

CENTRAL UTILITY PLANT CHILLER ADDITION
Contract No. 201310046

Bid Data Forms
INFORMATION ABOUT CONTRACTOR

1. Name of Bidder/Contractor: Bosco Constructors, Inc.

2. Type of business entity: Corporation
NOTE: If bidder is a **partnership** or **joint venture**, give full names of all partners or joint venturers. Bid must be signed by all joint venturers. If bidder is a **limited liability company**, bid must be signed by authorized manager (may be signed by member-manager if LLC is organized to allow management by members).

3. Prequalified by City and County of Denver as Construction Contractor :
Categories: 2A
Monetary Limit: 9,000,000

4. Address of Contractor:
6568 South Racine Circle, Suite 100
Centennial, CO 80111

Telephone: 303-799-1221 Fax: 303-799-4544

Email Address: jbosco@boscoconstructors.com

5. Established where and when: May 30, 1990 Colorado

6. Contractor's Banks: Community Banks of Colorado

7. Principal Officers of Contractor (managers and members if LLC):

Name: Joseph Bosco

Title: President

Name: Pat Tarnow

Title: VP/Controller

Name: _____

Title: _____

Name: _____

Title: _____

8. Bidder's/Contractor's City and County of Denver Contractor License if it has obtained one: License No.: 20090

Class: B

A contractor license is required prior to start of construction but not prior to bid submittal.

9. Bidder's/Contractor's state of incorporation (state of organization if an LLC or partnership): Colorado

10. Bidder's Surety: Western Surety Company

11. Surety's State of Incorporation: South Dakota

12. Address of Contractor in other areas (if different from No. 4): _____

13. Name and address of person to receive payments: Bosco Constructors, Inc.
Pat Tarnow
6568 South Racine Circle, Suite 100
Centennial, CO 80111

14. If the Bidder/Contractor is a joint venture, it shall attach a certified copy of the joint venture agreement. The joint venture agreement will not be included as a Contract Document.

15. The Bidder/Contractor shall identify all applicable labor agreements (if any) to be used in the performance of the Work:

N/A

Bidder Bosco Constructors, Inc.

DENVER INTERNATIONAL AIRPORT

CENTRAL UTILITY PLANT CHILLER ADDITION
Contract No. 201310046

Bid Data Forms

LIST OF PROPOSED SUBCONTRACTORS

Bidder shall list below the name, business address, work assignment and dollar value of each subcontractor which will perform work or labor or provide services to the Bidder relating to this contract in an amount greater than one and one-half percent of the Bidder's total bid. Only one subcontractor for each portion of the work shall be listed. Any proposed subcontractors to be utilized by the Bidder that are certified as a Minority/Women Business Enterprise shall also be listed on the "List of Proposed Subcontractors" attached to these Bid Forms.

If the bidder does not identify a subcontractor to perform portions of the work which could be subcontracted on this form, the Bidder, if it is awarded the contract, agrees not to subcontract such portions that exceed one and one half percent of the total bid amount until the Contractor has advised the Deputy Manager of Aviation - Airport Infrastructure Management("Deputy Manager") in writing of the reasons why the subcontractor was not listed in the bid and complied with the requirements of General Condition 502.

If the bidder is awarded the contract and does not enter into a subcontract with a subcontractor listed below, the Contractor agrees not to subcontract any of the work assignment identified for that subcontractor until the Contractor has advised the Deputy Manager in writing of the reasons why a different subcontractor is being used and has obtained approval of the Deputy Manager of the substitution. This requirement does not affect the applicability of General Condition 502.

Subcontractor	Work Assignment	Subcontract Dollar Value
NAME: JCOR Mechanical ADDRESS: 15800 West 6th Ave Golden, Co 80401 PHONE: 303-271-9787	Mechanical	1,630,757

Subcontractor	Work Assignment	Subcontract Dollar Value
NAME: HP Construction ADDRESS: 2200 Tower Rd Aurora, Co 80011 PHONE: 303 340 1434	Masonry	48,000
NAME: DMD ADDRESS: 5417 E. 52nd Ave Commerce City Co 80022 PHONE: 303 885-7594	Metals	159,981
NAME: C & G Construction ADDRESS: 1111 Osage St Denver, Co 80204 PHONE: 303-466-7179	Painting	75,000
NAME: Johnson Controlls ADDRESS: 10289 W. Centennial Rd Littleton, Co 80127 PHONE: 303-868-5587	Controlls	481,862
NAME: Kei Company ADDRESS: 207 Curtis St Denver Co 80205 PHONE: 303-934-5631	Electrical	528,541
NAME: ADDRESS: PHONE:		
NAME: ADDRESS: PHONE:		
NAME: ADDRESS: PHONE:		

(This page can be duplicated if additional sheets are required.)

Bidder Bosco Constructors, Inc.

DENVER INTERNATIONAL AIRPORT

CENTRAL UTILITY PLANT CHILLER ADDITION
Contract No. 201310046

Bid Data Forms
EQUAL OPPORTUNITY REPORT STATEMENT

Each Bidder shall complete and sign the Equal Opportunity Report Statement. A Bid may be considered unresponsive and may be rejected, in the Owner's sole discretion, if the Bidder fails to provide the fully executed Statement or fails to furnish required data. The Bidder shall also, prior to award, furnish such other pertinent information regarding its own employment policies and practices as well as those of its proposed subcontractors as the FAA, the Owner, or the Executive Vice Chairman of the President's Committee may require.

The Bidder shall furnish similar Statements executed by each of its first-tier and second-tier subcontractors and shall obtain similar compliance by such subcontractors, before awarding subcontracts. No subcontract shall be awarded to any non-complying subcontractor.

Equal Opportunity Report Statement
as Required in 41 CFR 60-1.7(b)

The Bidder shall complete the following statements by checking the appropriate blanks. Failure to complete these blanks may be grounds for rejection of bid:

1. The Bidder has _X_ has not ___ developed and has on file at each establishment affirmative action programs pursuant to 41 CFR 60-1.40 and 41 CFR 60-2.

2. The Bidder has _X_ has not ___ participated in any previous contract or subcontract subject to the equal opportunity clause prescribed by Executive Order 11246, as amended.

3. The Bidder has ___ has not _X_ filed with the Joint Reporting Committee the annual compliance report on Standard Form 100 (EEO-1 Report).

4. The Bidder does ___ does not _X_ employ fifty or more employees.

Dated: June 25, 2013

Bosco Constructors, Inc.
(Name of Bidder)

By: _____

Title: President

Bidder Bosco Constructors, Inc.

DENVER INTERNATIONAL AIRPORT

CENTRAL UTILITY PLANT CHILLER ADDITION
Contract No. 201310046

Bid Data Forms

CERTIFICATION OF NON-SEGREGATED FACILITIES
(Must be completed and submitted with the Bid)

The Bidder certifies that it does not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not permit its employees to perform their services at any location under its control where segregated facilities are maintained. The Bidder certifies further that it will not maintain or provide for its employees segregated facilities at any of its establishments, and that it will not permit its employees to perform their services at any location under its control, where segregated facilities are maintained. The Bidder agrees that a breach of this certification is a violation of the equal opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, restrooms and washrooms, restaurants and other eating areas, parking lots, drinking fountains, recreation or entertainment areas, transportation and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or any other reason. The Bidder agrees that (except where it has obtained identical certification from proposed subcontractors for specific time period) it will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding $10,000 which are not exempt from the provisions of the equal opportunity clause, and that it will retain such certification in its files.

DATED: June 25, 2013

Bosco Constructors, Inc.
(Name of Bidder)

By: _____

Title: President

Bidder BOSCO CONSTRUCTORS, INC.

DENVER INTERNATIONAL AIRPORT
CENTRAL UTILITY PLANT CHILLER ADDITION
Contract No. 201310046

BID BOND

KNOW ALL MEN BY THESE PRESENTS

THAT BOSCO CONSTRUCTORS, INC., 6568 South*, as Principal, and WESTERN**, a corporation organized and existing under and by virtue of the laws of the State of South Dakota, and authorized to do business within the State of Colorado as Surety, are held and firmly bound unto the City and County of Denver, Colorado, as Obligee, in the full and just sum of Five Percent (5%) of the*** Dollars and _____ Cents ($_____) lawful money of the United States, for the payment of which sum, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents:

WHEREAS, the said Principal is herewith submitting its Bid, dated on June 25, 2013, for the construction of Contract No. 201310046, CENTRAL UTILITY PLANT CHILLER ADDITION, Denver International Airport, as set forth in detail in the contract documents for the City and County of Denver, Colorado, and said Obligee has required as a condition for receiving said Bid that the Principal deposit specified bid security in the amount of not less than five percent (5%) of the amount of said Bid, as it relates to work to be performed for the City, conditioned that in event of failure of the Principal to execute the Contract for such construction and furnish required Performance and Payment Bond if the Contract is offered him, that said sum be paid immediately to the Obligee as liquidated damages, and not as a Penalty, for the Principal's failure to perform.

The condition of this obligation is such that if the aforesaid Principal shall, within the period specified therefor, on the prescribed form presented to him for signature, enter into a written Contract with the Obligee in accordance with his bid as accepted, and give Performance and Payment Bond with good and sufficient surety or sureties, upon the form prescribed by the Obligee, for the faithful performance and the proper fulfillment of said Contract, or in the event of withdrawal of said bid within the time specified, or upon the payment to the Obligee of the sum determined upon herein, as liquidated damages and not as a Penalty, in the event the Principal fails to enter into said Contract and give such Performance and Payment Bond within the time specified, then this Obligation shall be null and void, otherwise to remain in full force and effect.

[END OF PAGE]

*Racine Circle, Suite 100, Centennial, Colorado 80111
**SURETY COMPANY
***Total Amount of the Bid

Signed, sealed and delivered this 25th day of June, 2013.

Attest:

By: _____
Secretary
[SEAL if bidder a corporation]

PRINCIPAL BOSCO CONSTRUCTORS, INC.

By: _____
President

SURETY WESTERN SURETY COMPANY

By: _____
Attorney-in-Fact Cynthia M. Burnett

(ATTACH POWER OF ATTORNEY)

Power of Attorney shall be certified as to the date of bid.

Western Surety Company

POWER OF ATTORNEY APPOINTING INDIVIDUAL ATTORNEY-IN-FACT

Know All Men By These Presents, That WESTERN SURETY COMPANY, a South Dakota corporation, is a duly organized and existing corporation having its principal office in the City of Sioux Falls, and State of South Dakota, and that it does by virtue of the signature and seal herein affixed hereby make, constitute and appoint

Douglas John Rothey, Cynthia M Burnett, Individually

of Littleton, CO, its true and lawful Attorney(s)-in-Fact with full power and authority hereby conferred to sign, seal and execute for and on its behalf bonds, undertakings and other obligatory instruments of similar nature

- In Unlimited Amounts -

and to bind it thereby as fully and to the same extent as if such instruments were signed by a duly authorized officer of the corporation and all the acts of said Attorney, pursuant to the authority hereby given, are hereby ratified and confirmed.

This Power of Attorney is made and executed pursuant to and by authority of the By-Law printed on the reverse hereof, duly adopted, as indicated, by the shareholders of the corporation.

In Witness Whereof, WESTERN SURETY COMPANY has caused these presents to be signed by its Vice President and its corporate seal to be hereto affixed on this 22nd day of October, 2012.

WESTERN SURETY COMPANY

Paul T. Bruflat, Vice President

State of South Dakota
County of Minnehaha } ss

On this 22nd day of October, 2012, before me personally came Paul T. Bruflat, to me known, who, being by me duly sworn, did depose and say: that he resides in the City of Sioux Falls, State of South Dakota; that he is the Vice President of WESTERN SURETY COMPANY described in and which executed the above instrument; that he knows the seal of said corporation; that the seal affixed to the said instrument is such corporate seal; that it was so affixed pursuant to authority given by the Board of Directors of said corporation and that he signed his name thereto pursuant to like authority, and acknowledges same to be the act and deed of said corporation.

My commission expires

June 23, 2015

J. MOHR
NOTARY PUBLIC
SOUTH DAKOTA

J. Mohr, Notary Public

CERTIFICATE

I, L. Nelson, Assistant Secretary of WESTERN SURETY COMPANY do hereby certify that the Power of Attorney hereinabove set forth is still in force, and further certify that the By-Law of the corporation printed on the reverse hereof is still in force. In testimony whereof I have hereunto subscribed my name and affixed the seal of the said corporation this 25th day of June, 2013.

WESTERN SURETY COMPANY

L. Nelson, Assistant Secretary

Form F4280-7-2012

Authorizing By-Law

ADOPTED BY THE SHAREHOLDERS OF WESTERN SURETY COMPANY

This Power of Attorney is made and executed pursuant to and by authority of the following By-Law duly adopted by the shareholders of the Company.

Section 7. All bonds, policies, undertakings, Powers of Attorney, or other obligations of the corporation shall be executed in the corporate name of the Company by the President, Secretary, and Assistant Secretary, Treasurer, or any Vice President, or by such other officers as the Board of Directors may authorize. The President, any Vice President, Secretary, any Assistant Secretary, or the Treasurer may appoint Attorneys in Fact or agents who shall have authority to issue bonds, policies, or undertakings in the name of the Company. The corporate seal is not necessary for the validity of any bonds, policies, undertakings, Powers of Attorney or other obligations of the corporation. The signature of any such officer and the corporate seal may be printed by facsimile.

LIST OF PROPOSED MINORITY/WOMEN BUSINESS ENTERPRISE BIDDERS, SUBCONTRACTORS, SUPPLIERS (MANUFACTURERS) OR BROKERS

CITY OF DENVER
DEPARTMENT OF AVIATION
CONTRACT NO. 201310046

The undersigned Bidder proposes to utilize the following Minority/Women Business Enterprises (MBE/WBEs) for the project. All listed firms are **CURRENTLY** certified by the City and County of Denver. Only the level of MBE/WBE participation listed at the bid opening will count toward satisfaction of the project goal. Only bona fide commissions may be counted for Brokers. MBE/WBE prime bidders must detail their bid information below. Please copy and attach this page to list additional MBE/WBEs for this project.

The undersigned bidder hereby certifies that the subcontractors and suppliers listed below have full knowledge that their names have been offered as subcontractors and suppliers for the work, and the bidder further certifies that the dollar amount of work to be performed by the MBE/WBE/DBEs was furnished to the bidder prior to the bid opening. The undersigned bidder agrees that after the bid opening, it shall submit to the City executed and completed MBE/WBE/DBE letters of Intent within three working days for an MBE/WBE project, or within five working days for a DBE project, for each of its MBE, WBE and DBE subcontractors. The Letter of Intent form is contained in the Contract Documents.

CHECK BOX IF APPLICABLE:

	MBE/WBE Prime Bidder

Business Name:_____
Address:_____
Type of Service:_____
Contact Person:_____
Dollar Amount: $_____ Percent of Project:_____%

CHECK ONE BOX:

✓	Subcontractor	or		Supplier	Or		Manufacturer	or		Broker

Business Name: NOR Mechanical
Address: 15800 West 5th Ave Golden, Co 80401
Type of Service: Mechanical
Contact Person: Josh Overstreet
Dollar Amount: $ 1,630,754 Percent of Project: 26 %

CHECK ONE BOX:

☐ Subcontractor or ☐ Supplier or ☐ Manufacturer or ☐ Broker

Business Name:____
Address:____
Type of Service:____
Contact Person:____
Dollar Amount: $ Percent of Project:__________%

CHECK ONE BOX:

☐ Subcontractor or ☐ Supplier or ☐ Manufacturer or ☐ Broker

Business Name:____
Address:____
Type of Service:____
Contact Person:____
Dollar Amount: $ Percent of Project:__________%

CHECK ONE BOX:

☐ Subcontractor or ☐ Supplier or ☐ Manufacturer or ☐ Broker

Business Name:____
Address:____
Type of Service:____
Contact Person:____
Dollar Amount: $ Percent of Project:__________%

CHECK ONE BOX:

☐ Subcontractor or ☐ Supplier or ☐ Manufacturer or ☐ Broker

Business Name:____
Address:____
Type of Service:____
Contact Person:____
Dollar Amount: $ Percent of Project:__________%

CHECK ONE BOX:

☐ Subcontractor or ☐ Supplier or ☐ Manufacturer or ☐ Broker

Business Name:____
Address:____
Type of Service:____
Contact Person:____
Dollar Amount: $ Percent of Project:__________%

This bid is submitted upon the declaration that neither, I (we), nor, to the best of my (our) knowledge, none of the members of my (our) firm or company have either directly or indirectly entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this bid.

Business Address of Bidder: 6568 South Racine Circle, Suite 100

City, State, Zip Code: centennial, CO 80111

Telephone Number of Bidder: 303-799-1221 Fax No. 303-799-4544

Social Security or Federal Employer ID Number of Bidder: 84-1144548

Name and location of the last work of this kind herein contemplated upon which the Bidder was engaged: Terminal AHU Upgrades 8500 Pena Blvd, Denver, CO

For information relative thereto, please refer to:

Name: Bruce Evans

Title: Project Manager

Address: 8500 Pena Blvd, Denver, CO

Dated this 25 day of June , ~~3002~~ XXX 2013

Signature of Bidder:

If an Individual: _____

doing business as _____

If a Partnership: _____

by: _____, General Partner.

If a Corporation: Bosco Constructors, Inc,

a _____, Corporation,

by: _____, its President.

Attest:

_____

Secretary (Corporate Seal)

If a Joint Venture, signature of all Joint Venture participants.

Firm:_____

Corporation ( ), Partnership ( ) or ( ) Limited Liability Company

By:_____ (If a Corporation)
Attest:

Title:_____ _____
Secretary (Corporate Seal)

Firm:_____

Corporation ( ), Partnership ( ) or ( ) Limited Liability Company

By:_____ (If a Corporation)
Attest:

Title:_____ _____
Secretary (Corporate Seal)

Firm:_____

Corporation ( ), Partnership ( ) or ( ) Limited Liability Company

By:_____ (If a Corporation)
Attest:

Title:_____ _____
Secretary (Corporate Seal)

CITY AND COUNTY OF DENVER
DEPARTMENT OF AVIATION

COMMITMENT TO MINORITY/WOMEN BUSINESS ENTERPRISE PARTICIPATION

CONTRACT NO. 201310046

The undersigned has satisfied the MBE and WBE participant requirements in the following manner: (please check the appropriate space)

☑ The Bidder is committed to a minimum of 25 % **MBE and WBE** utilization on the Project, and will submit Letters of Intent for each MBE and WBE listed in the Bid Forms within three (3) working days after the bid opening.

☐ The Bidder is unable to meet the project goal of ___% MBE and WBE participation and is committed to a minimum of _____% **MBE and WBE** utilization on this project. The Bidder understands that it must submit a detailed statement of its good faith efforts, which occurred prior to the bid opening, to meet the project goal, and must submit Letters of Intent for each MBE/WBE listed in the Bid Forms within three (3) working days after the bid opening.

Bidder: Bosco Constructors, Inc.
Name of Firm

By: _____ President
Signature Title

Address: 6568 South racine Circle, Suite 100
Street

Centennial, CO 80111
City / State / Zip Code

Telephone: 303-799-1221 303-799-4544
Phone Fax

Bid Documents

5/16/2013

Contract Number: 201310046

Bid Forms

Date: May 20, 2013

DENVER
THE MILE HIGH CITY

Office of Economic Development
Division of Small Business Opportunity
Compliance Unit – DIA
E-MAIL: small.business@flydenver.com
8500 Peña Blvd., AOB, Suite 7810
Denver, CO 80249
Phone: (303) 342-2189 / Fax: (303) 342-2190

LETTER OF INTENT (LOI)

All lines must be completed or marked N/A for Not Applicable.
Submit the attached completed checklist with this letter.

Project No.:	**Project Name:**

A. The Following Section Is To Be Completed by the Bidder/Consultant
This Letter of Intent Must be Signed by the Bidder/Consultant and M/WBE, SBE or DBE

Name of Bidder/Consultant:		Phone:	
Contact Person:	Email:	Fax:	
Address:	City:	State:	Zip:

B. The Following Section is To Be Completed by the M/WBE, SBE or DBE, at any Tier
This Letter of Intent Must be Signed by the M/WBE, SBE or DBE and Bidder/Consultant

Name of Certified Firm:		Phone:	
Contact Person:	Email:	Fax:	
Address:	City:	State:	Zip:

Please check the designation which applies to the certified firm.		**MBE/WBE ( )**		**SBE ( )**		**DBE ( )**	

Indirect Utilization: If this M/WBE, SBE or DBE is not a direct first tier subcontractor/subconsultant, supplier or broker to the Bidder/Consultant, please indicate the name of the subcontractor/subconsultant, supplier or broker which is utilizing the participation of this firm: _____

A Copy of the M/WBE, SBE or DBE Letter of Certification must be Attached

Identify the scope of the work to be performed or supply item that will be provided by the M/WBE/SBE/DBE.
On unit price bids only, identify which bid line items the M/WBE/SBE/DBEs scope of work or supply corresponds to. _____

	Subcontractor/Subconsultant ( )		**Supplier** ( )		**Broker** ( )

Bidder intends to utilize the aforementioned M/WBE, SBE or DBE for the Work/Supply described above. The cost of the work and percentage of the total subcontractor M/WBE, SBE or DBE bid amount is:

$	**%**
Consultant intends to utilize the aforementioned M/WBE, SBE or DBE for the Work/Supply described above. The percentage of the work of the total subconsultant M/WBE, SBE or DBE will perform is:	**%**
If the fee amount of the work to be performed is requested, the fee amount, is:	**$**

Bidder/Consultant's Signature:	Date:
Title:	
M/WBE, SBE or DBE Firm's Signature:	Date:
Title:	

If the above named Bidder/Consultant is not determined to be the successful Bidder/Consultant, this **Letter of Intent** shall be null and void.

COMP-FRM-012 Revised 3/10/2010

Letter of Intent (LOI) Checklist

All lines must be completed or marked N/A for Not Applicable
Submit the attached completed checklist with this letter.

Completed	
☐	Project Number & Project Name
☐	**Section A**: Name of Bidder/Consultant, Contact Person, Address, City, State, Zip, Phone, Email
☐	**Section B**: Name of Certified Firm, Contact Person, Address, City, State, Zip, Phone, Email
☐	Designation checked for MBE/WBE, SBE or DBE
☐	**Indirect Utilization:** Name of subcontractor/subconsultant, supplier or broker is indicated if using the participation of a 2nd tier subcontractor/subconsultant, supplier or broker.
☐	Scope of work performed or item supplied by M/WBE, SBE or DBE
☐	Line items performed, if line-item bid.
☐	Copy of M/WBE, SBE or DBE Letter of Certification Attached
☐	Designation checked for Subcontractor/Subconsultant, Supplier or Broker
☐	**If project is a hard bid…**
☐	Bidder has indicated dollar amount for value of work going to Subcontractor/ Subconsultant, Supplier or Broker
☐	Bidder has indicated percentage for value of work going to Subcontractor/ Subconsultant, Supplier or Broker
☐	**If project is an RFP/RFQ…**
☐	Consultant has indicated percentage for value of work going to Subcontractor/ Subconsultant, Supplier or Broker Name & contact name for MWBE.
☐	Fee amount if fee amount of work to be performed is requested.
☐	Bidder/Consultant's Signature, Title & Date
☐	M/WBE, SBE or DBE Firm's Signature, Title and Date

The complete and accurate information that is required for the Letter of Intent is based on the following sections of the Ordinance: Section 28-63 and Section 28-68. Failure to complete this information on the Letter of Intent (LOI) may automatically deem a bid or proposal non-responsive.

Division of Small Business Opportunity

JOINT VENTURE AFFIDAVIT

"The Undersigned swear that the foregoing statements are correct and include all material information necessary to identify and explain the terms and operation of our joint venture and the intended participation by each joint venturer in the undertaking. Further, the Undersigned covenant and agree to provide the City current, complete, and accurate information regarding actual joint venture work and the payment thereof and any proposed changes in any of the joint venture arrangements and to permit the audit and examination of the books, records, and files of the joint venture, by authorized representatives of the City or Federal funding agency, if applicable. Any material misrepresentation will be grounds for terminating any contract which may be awarded and for initiating action under Federal or State laws concerning false statements."

_____	
Name of Firm	
_____	_____
Signature	Date
_____	_____
Name	Title

(Name) _____appeared to me personally known, who, being first duly sworn, did execute the foregoing affidavit, and subscribe and swear to such affidavit before me, and did state that he or she was properly authorized by (Name of Firm) _____ to execute the affidavit and did so as his or her free act and deed.

Date:_____ Notary Public_____
State of_____ Commission Expires_____
County of_____ (Seal)
On this _____day of _____ ____ before me

_____
Name of Firm

_____ _____
Signature Date

_____ _____
Name Title

(Name)_____appeared to me personally known, who, being duly sworn, did execute the foregoing affidavit, and did state that he or she was properly authorized by (Name of Firm)
_____ to execute the affidavit and did so at his or her free act and deed.

Date: _____ Notary Public_____
State of_____ Commission Expires_____
County of_____ (Seal)
On this _____day of _____ ____ before me

Rev 8/2000

DIVISION OF SMALL BUSINESS OPPORTUNITY

JOINT VENTURE ELIGIBILITY FORM

Joint Venture means an association of two (2) or more business enterprises to constitute a single business enterprise to perform a City construction or professional design and construction services contract for which purpose they combine their property, capital, efforts, skills and knowledge, and in which endeavor each joint venturer is responsible for a distinct, clearly defined portion of the work of the contract, performs a commercially useful function, and whose share in the capital contribution, control, management responsibilities, risks and profits of the joint venture are equal to its ownership interest. Joint ventures must have an agreement in writing specifying the terms and conditions of the relationships between the joint venturers and their relationship and responsibility to the contract. *D.R.M.C.28-54 (29).*

1. Name of Joint Venture_____

2. Address of Joint Venture:_____
Address

_____ _____ _____
City State Zip Code

3. Telephone number of joint venture:(_____)_____

4. Identify the firms which comprise the joint venture

A. Name:_____
Address:_____

B. Name:`_____
Address:_____

C. Name:_____
Address:_____

1) Describe the role of the MBE/WBE in the Joint Venture:

_____

_____

_____
(Attach additional information if necessary)

2) Briefly describe the experience and business qualifications of each non-MBE/WBE Joint Venture.

_____

_____

_____

(Attach additional information if necessary)

5. Name of the Joint Venture's Business:_____

6. Provide a copy of the signed Joint Venture Agreement

7. What is the claimed percentage of MBE/WBE ownership?_____%

8. Ownership of Joint Venture: (This need not be filled in if described in the joint venture agreement provided in question 6.)

   (a) Profit and loss sharing:_____

   _____

   (b) Capital contributions, including equipment:_____

   _____

   Other applicable ownership interests:_____

   _____

   Duration of the joint venture:
   From: _____ To: _____

9. Control of and participation in this contract. Identify which firm and those individuals (and their titles) who are responsible for the day-to-day management and policy decision making, including but not limited to those with prime responsibility for:

(a) Financial Decisions:

Firm:_____

Name:_____

Title:_____

(b) Management Decisions:

(1) Estimating
Firm:_____

Name:_____

Title:_____

(2) Marketing and Sales

Firm:_____

Name:_____

Title:_____

(3) Hiring and firing of management personnel

Firm:_____

Name:_____

Title:_____

(4) Purchasing of major items or supplies

Firm:_____

Name:_____

Title:_____

Note: (1) An MBE/WBE performs a commercially useful function when it is responsible for execution of a distinct element of the work of the contract and carrying out its responsibilities by actually performing, managing, and supervising the work involved. To determine whether an MBE/WBE is performing a commercially useful function, the amount of work subcontracted, industry practices, and other relevant factors shall be evaluated.

(2) An MBE/WBE does not perform a commercially useful function if its role is limited to that of an extra participant in a transaction, contract, or project through which funds are passed in order to obtain the appearance of MBE/WBE participation or the MBE/WBE subcontracts a greater portion of the work of a contract than would be expected on the basis of normal industry practice for the type of work involved.

(3) A joint venture which includes one (1) or more MBE/WBEs is subject to the review and approval by the Director of DSBO and the participation will count toward satisfaction of the MBE/WBE goal upon confirmation of the utilization in the joint venture of joint management

and full integration of work forces by the joint venture partners.

If there are any significant changes in this submittal, the joint venture members must immediately notify the Division of Small Business Opportunity.

CITY AND COUNTY OF DENVER
DEPARTMENT OF AVIATION

NOTICE TO APPARENT LOW BIDDER

Date: [Date]

To: [Bidder name and address]

The Manager of Aviation, having considered the Bids submitted for the construction of Contract No. 201310046, CENTRAL UTILITY PLANT CHILLER ADDITION, Denver International Airport, as set forth in detail in the Contract Documents for the City and County of Denver, Colorado and it appearing that your Bid is fair, equitable and in the best interest of said City and County, the said Bid with a Total Contract Bid Amount of _____ Dollars ($_____) is hereby declared to be acceptable, subject to the approval of the execution of the contract by the City in accordance with the Charter of the City and County of Denver.

In accordance with the terms of the Contract Documents, you are required to execute the formal Contract and furnish the required Performance Bond, Payment Bond and insurance certificates within five (5) consecutive working days from and including the date of this Notice. In addition, you are required to submit the EEO information described in IB-27 before a Notice to Proceed may be issued.

The bid security submitted with your Bid will be returned upon execution of the Contract, the City's receipt of the required Performance and Payment Bonds and insurance certificates, and, if required, City Council approval of the contract. If you should fail to execute the Contract and furnish the Performance and Payment Bonds and insurance certificate within the time limit specified, said bid security will be retained by the City and County of Denver as liquidated damages, and not as a penalty, for the delay and extra work caused thereby.

All construction contracts made and entered into by the City and County of Denver are subject to applicable City and/or Federal Affirmative Action and Equal Employment Opportunity Rules and Regulations, and each contract requiring payment by the City of Five Million Dollars ($5,000,000.00) or more shall first be approved by the City Council acting by Ordinance and in accordance with Section 3.2.6 of the Charter of the City and County of Denver.

Prior to issuance of Notice to Proceed, all Affirmative Action and Equal Employment Opportunity requirements must be completed.

CITY AND COUNTY OF DENVER

By_____
Deputy Manager of Aviation,
Airport Infrastructure Management

By_____
Manager of Aviation

C O N T R A C T

THIS CONTRACT, made and entered into as of the date indicated on the City signature page below, by and between the **CITY AND COUNTY OF DENVER**, a municipal corporation of the State of Colorado, hereinafter referred to as the "CITY", Party of the First Part, and BOSCO CONSTRUCTORS, INC., a corporation organized and existing under and by virtue of the laws of the State of COLORADO, hereinafter referred to as the "CONTRACTOR", Party of the Second Part;

W I T N E S S E T H

WHEREAS, the City, for at least three (3) consecutive days, advertised that sealed bids would be received for furnishing all labor, tools, supplies, equipment, materials and everything necessary and required for the construction and installation of Contract No. 201310046, CENTRAL UTILITY PLANT CHILLER ADDITION, Denver International Airport;

WHEREAS, bids to said advertisement have been received by the Manager of Aviation, who has recommended that a contract for said work be made and entered into with the above named Contractor who was the lowest, responsive, qualified bidder therefor; and

WHEREAS, said Contractor is now willing and able to perform all of said work in accordance with the Contract Documents and its bid;

NOW, **THEREFORE**, for and in consideration of the compensation to be paid the Contractor, the mutual agreements hereinafter contained, and subject to the terms hereinafter stated, it is mutually agreed as follows:

ARTICLE I - CONTRACT DOCUMENTS: It is agreed by the parties hereto that the following list of instruments, drawings and documents which are attached hereto and bound herewith or incorporated herein by reference constitute and shall be referred to either as the Contract Documents or the Contract, and all of said instruments, drawings and documents taken together as a whole constitute the Contract between the parties hereto, and they are as fully a part of this agreement as if they were set out verbatim and in full herein:

Advertisement of Notice of Invitation for Bids
Instructions to Bidders
Addenda (if any)
Bid Forms
- Bid letter
- Schedule of Prices and Quantities
- Bid Data Forms
- Commitment to Minority/Women Business Enterprise Participation

Notice to Apparent Low Bidder
Contract
Performance Bond
Payment Bond

Notice to Proceed
Form of Final Receipt
Construction Contract General Conditions
Special Conditions
Prevailing wage schedules
Insurance certificate(s)
Equal Employment Opportunity Provisions
Technical Specifications
Contract Drawings
Approved Shop Drawings
Change Directives
Change Orders

ARTICLE II - SCOPE OF WORK: The Contractor agrees to and shall furnish all labor and tools, supplies, equipment, superintendence, materials and everything necessary for and required to do, perform and complete all of the work described, drawn, set forth, shown and included in said Contract Documents.

ARTICLE III - TERMS OF PERFORMANCE: The Contractor agrees to begin the performance of the work required under this Contract within ten (10) days after being notified to commence work by the Deputy Manager of Aviation – Airport Infrastructure Management and agrees to fully complete the Work in its entirety within THREE HUNDRED SIXTY-FIVE (365) consecutive calendar days from the date of said Notice to Proceed. This period of performance is also referred to as Contract Time. The Contractor is not authorized to commence work prior to its receipt of the Notice to Proceed.

ARTICLE IV - LIQUIDATED DAMAGES: It is understood and agreed by and between the City and the Contractor that, if the Contractor fails to achieve Substantial Completion of the Work within the Contract Time or fails to substantially complete the Work described in a Milestone Area within the time set forth in the Special Conditions, the City will suffer substantial damages, which damages would be difficult to accurately determine. The parties hereto have considered the possible elements of damages and have agreed that the amount of liquidated damages for the Contractor's failure to substantially complete the work within the Contract Time or to substantially complete the work described in Milestone Areas within the time set forth in the Special Conditions shall be those amounts listed in the Special Conditions. If the Contractor shall fail to pay such liquidated damages promptly upon demand therefor, the Surety on its Performance Bond and Payment Bond shall pay such damages. Also, the City may withhold all, or any part of, such liquidated damages from any payment due the Contractor. Additional provisions relating to liquidated damages are set forth in the Construction Contract General Conditions and Special Conditions.

ARTICLE V - TERMS OF PAYMENT: The City agrees to pay the Contractor for the performance and completion of all of the Work as required by the Contract Documents, and the Contractor agrees to accept as its full and only compensation therefor, a total amount of SIX MILLION TWO HUNDRED EIGHTEEN THOUSAND THREE HUNDRED SEVENTY-EIGHT Dollars and NO Cents ($6,218,378.00).

Payments will be made to the Contractor in accordance with the City's Prompt Payment Ordinance, D.R.M.C., Section 20-107, et. seq., subject to the maximum contract amount stated above. Contractor agrees that interest and late fees shall be payable by the City hereunder only to the extent authorized and provided for in the City's Prompt Payment Ordinance.

Payment hereunder will be in accordance with the provisions of the Contract Documents, including Title 9 of the General Conditions, and will be made solely and exclusively from funds appropriated and otherwise lawfully made available for the purposes of this Contract from the City and County of Denver Airport System, Operations and Maintenance and Capital Improvement funds. The City has no obligation to make payments from any other fund or source or to make additional appropriations or allocations to such fund to satisfy such costs or other obligations.

ARTICLE VI - DISPUTES: It is agreed and understood by the parties hereto that disputes regarding this contract shall be resolved by administrative hearing under procedures described in Revised Municipal Code Section 5-17.

ARTICLE VII - CONTRACT BINDING: It is agreed that this Contract shall be binding on and inure to the benefit of the parties hereto, their heirs, executors, administrators, assigns and successors.

ARTICLE VIII - SEVERABILITY: If any part, portion or provision of this Contract shall be found or declared null, void, or unenforceable for any reason whatsoever by any court of competent jurisdiction or any governmental agency having authority thereover, only such part, portion, or provision shall be affected thereby and all other parts, portions and provisions of this Contract shall remain in full force and effect.

ARTICLE IX - ASSIGNMENT: The Contractor shall not assign the whole or any part of its duties, rights, and interests in this Contract without first obtaining the written consent of the Manager.

ARTICLE X - APPROVALS: In the event this Contract calls for the payment by the City of Five Million Dollars ($5,000,000.00) or more, approval by the Board of Councilmen of the City and County of Denver, acting by Ordinance in accordance with Section 3.2.6 of the Charter of the City and County of Denver, is and shall be an express condition precedent to the lawful and binding execution and performance of this Contract.

ARTICLE XI - JOINT VENTURE: If the Contractor is a Joint Venture, the partners to the Joint Venture shall be jointly and severally liable to the City for the performance of all duties and obligations of the Contractor which are set forth in the Contract.

ARTICLE XII - NO DISCRIMINATION IN EMPLOYMENT: In connection with the performance of work under this Contract, the Contractor agrees not to refuse to hire, discharge, promote or demote, or to discriminate in matters of compensation against any person otherwise qualified, solely because of race, color, religion, national origin, gender, age, military status, sexual

orientation, gender variance, marital status, or physical or mental disability; and the Contractor further agrees to insert the foregoing provision in all subcontracts hereunder.

ARTICLE XIII - WAIVER OF CRS 13-20-801, *et seq.*: Notwithstanding any other provision of this Contract, the Contractor specifically waives all of the provisions of Colorado Revised Statutes §§ 13-20-801 – 80 as they may relate to the Contractor's performance under this Contract.

ARTICLE XIV - COORDINATION OF SERVICES: The Contractor agrees to perform its work under this Contract in accordance with the operational requirements of DIA, and all work and movement of personnel or equipment on areas included within the DIA site shall be subject to the regulations and restrictions established by the City or its authorized agents.

ARTICLE XV - COMPLIANCE WITH ALL LAWS AND REGULATIONS: All of the work performed under this Contract by the Consultant shall comply with all applicable laws, rules, regulations and codes of the United States and the State of Colorado, and with the charter, ordinances and rules and regulations of the City and County of Denver.

ARTICLE XVI – PROMPT PAY: The Contractor is subject to D.R.M.C. Section 20-112 wherein the Contractor is to pay its subcontractors in a timely fashion. A payment is timely if it is mailed to the subcontractor no later than seven days after receipt of any payment from City. Any late payments are subject to a late payment penalty as provided for in the prompt pay ordinance (Section 20-107 through 20-118).

ARTICLE XVII – COLORADO OPEN RECORDS ACT: The Contractor acknowledges that the City is subject to the provisions of the Colorado Open Records Act, Colorado Revised Statutes §24-72-201 et seq., and the Contractor agrees that it will fully cooperate with the City in the event of a request or lawsuit arising under such act for the disclosure of any materials or information which the Contractor asserts is confidential and exempt from disclosure. Any other provision of this Contract notwithstanding, including exhibits, attachments and other documents incorporated into this Contract by reference, all materials, records and information provided by the Contractor to the City shall be considered confidential by the City only to the extent provided in the Open Records Act, and the Contractor agrees that any disclosure of information by the City consistent with the provisions of the Open Records Act shall result in no liability of the City.

ARTICLE XVIII – ELECTRONIC SIGNATURES AND ELECTRONIC RECORDS: Contractor consents to the use of electronic signatures by the City. The Contract, and any other documents requiring a signature hereunder, may be signed electronically by the City in the manner specified by the City. The Parties agree not to deny the legal effect or enforceability of the Contract solely because it is in electronic form or because an electronic record was used in its formation. The Parties agree not to object to the admissibility of the Contract in the form of an electronic record, or a paper copy of an electronic document, or a paper copy of a document bearing an electronic signature, on the ground that it is an electronic record or electronic signature or that it is not in its original form or is not an original.

[END OF PAGE]

Contract Control Number:

IN WITNESS WHEREOF, the parties have set their hands and affixed their seals at Denver, Colorado as of

SEAL

CITY AND COUNTY OF DENVER

ATTEST:

By_____

_____

APPROVED AS TO FORM:

REGISTERED AND COUNTERSIGNED:

By_____

By_____

By_____

Contract Control Number: PLANE-201310046-00

Contractor Name: Bosco Constructors, Inc.

By: _____

Name: JOSEPH BOSCO

(please print)

Title: PRESIDENT

(please print)

ATTEST: (if required)

By: _____

Name: Lisa Bradwell

(please print)

Title: Asst. Secretary

(please print)

PERFORMANCE BOND

Bond No. 58703714

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned BOSCO CONSTRUCTORS, INC., a corporation organized under the laws of the State of COLORADO, hereinafter referred to as the "Contractor" and WESTERN SURETY COMPANY, a corporation organized under the laws of the State of SOUTH DAKOTA and authorized to transact business in the State of Colorado, hereinafter referred to as Surety, are held and firmly bound unto the CITY AND COUNTY OF DENVER, a municipal corporation of the State of Colorado, hereinafter referred to as the "CITY", in the penal sum of SIX MILLION TWO HUNDRED EIGHTEEN THOUSAND THREE HUNDRED SEVENTY-EIGHT Dollars and NO Cents ($6,218,378.00) lawful money of the United States of America, for the payment of which sum the Contractor and Surety bind themselves and their heirs, executors, administrators, successors and assigns, jointly and severally by these presents.

WHEREAS, the above Contractor has entered into a written contract with the City for furnishing all labor, materials, equipment, tools, superintendence, and other facilities and accessories for the construction of Contract No. 201310046, CENTRAL UTILITY PLANT CHILLER ADDITION, Denver International Airport, in accordance with the Technical Specifications, Contract Drawings and all other Contract Documents therefor which are incorporated herein by reference and made a part hereof, and are herein referred to as the Contract.

NOW, THEREFORE, the condition of this performance bond is such that if the Contractor:

1. Promptly and faithfully observes, abides by and performs each and every covenant, condition and part of said Contract, including, but not limited to, its warranty provisions, in the time and manner prescribed in the Contract, and

2. Pays the City all losses, damages (liquidated or actual, including, but not limited to, damages caused by delays in the performance of the Contract), expenses, costs and attorneys' fees, that the City sustains resulting from any breach or default by the Contractor under the Contract, then this bond is void; otherwise, it shall remain in full force and effect.

IN ADDITION, if said Contractor fails to duly pay for any labor, materials, team hire, sustenance, provisions, provender, or any other supplies used or consumed by said Contractor or its subcontractors in its performance of the work contracted to be done or fails to pay any person who supplies rental machinery, tools, or equipment, all amounts due as the result of the use of such machinery, tools, or equipment in the prosecution of the work, the Surety shall pay the same in an amount not exceeding the amount of this obligation, together with interest as provided by law.

PROVIDED FURTHER, that the said Surety, for value received, hereby stipulates and agrees that any and all changes in the Contract or compliance or noncompliance with the formalities in the Contract for making such changes shall not affect the Surety's obligations under this bond and the Surety hereby waives notice of any such changes.

IN WITNESS WHEREOF, said Contractor and said Surety have executed these presents as of this ____ day of _____, _____.

BOSCO CONSTRUCTORS, INC.
CONTRACTOR

By: _____
President

WESTERN SURETY COMPANY
SURETY

By: _____
Attorney-in-Fact Cynthia M. Burnett

(Accompany this bond with Attorney-in-Fact's authority from the Surety to execute bond, certified to include the date of the bond.)

CITY AND COUNTY OF DENVER

By: _____
MAYOR

By: _____
Manager of Aviation

APPROVED AS TO FORM:

DOUGLAS J. FRIEDNASH, Attorney for the City and County of Denver

By: _____
Assistant City Attorney

Western Surety Company

POWER OF ATTORNEY APPOINTING INDIVIDUAL ATTORNEY-IN-FACT

Know All Men By These Presents, That WESTERN SURETY COMPANY, a South Dakota corporation, is a duly organized and existing corporation having its principal office in the City of Sioux Falls, and State of South Dakota, and that it does by virtue of the signature and seal herein affixed hereby make, constitute and appoint

Douglas John Rothey, Cynthia M Burnett, Individually

of Littleton, CO, its true and lawful Attorney(s)-in-Fact with full power and authority hereby conferred to sign, seal and execute for and on its behalf bonds, undertakings and other obligatory instruments of similar nature

- In Unlimited Amounts -

and to bind it thereby as fully and to the same extent as if such instruments were signed by a duly authorized officer of the corporation and all the acts of said Attorney, pursuant to the authority hereby given, are hereby ratified and confirmed.

This Power of Attorney is made and executed pursuant to and by authority of the By-Law printed on the reverse hereof, duly adopted, as indicated, by the shareholders of the corporation.

In Witness Whereof, WESTERN SURETY COMPANY has caused these presents to be signed by its Vice President and its corporate seal to be hereto affixed on this 22nd day of October, 2012.

WESTERN SURETY COMPANY

Paul T. Bruflat, Vice President

State of South Dakota
County of Minnehaha } ss

On this 22nd day of October, 2012, before me personally came Paul T. Bruflat, to me known, who, being by me duly sworn, did depose and say: that he resides in the City of Sioux Falls, State of South Dakota; that he is the Vice President of WESTERN SURETY COMPANY described in and which executed the above instrument; that he knows the seal of said corporation; that the seal affixed to the said instrument is such corporate seal; that it was so affixed pursuant to authority given by the Board of Directors of said corporation and that he signed his name thereto pursuant to like authority, and acknowledges same to be the act and deed of said corporation.

My commission expires
June 23, 2015

J. MOHR
NOTARY PUBLIC
SOUTH DAKOTA

J. Mohr, Notary Public

CERTIFICATE

I, L. Nelson, Assistant Secretary of WESTERN SURETY COMPANY do hereby certify that the Power of Attorney hereinabove set forth is still in force, and further certify that the By-Law of the corporation printed on the reverse hereof is still in force. In testimony whereof I have hereunto subscribed my name and affixed the seal of the said corporation this _____ day of _____, _____.

WESTERN SURETY COMPANY

L. Nelson, Assistant Secretary

Form F4280-7-2012

PAYMENT BOND Bond No. 58703714

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned BOSCO CONSTRUCTORS, INC. a corporation organized under the laws of the State of COLORADO, hereinafter referred to as the "Contractor" and WESTERN SURETY COMPANY, a corporation organized under the laws of the State of SOUTH DAKOTA and authorized to transact business in the State of Colorado, hereinafter referred to as Surety, are held and firmly bound unto the CITY AND COUNTY OF DENVER, a municipal corporation of the State of Colorado, hereinafter referred to as the "CITY", in the penal sum of SIX MILLION TWO HUNDRED EIGHTEEN THOUSAND THREE HUNDRED SEVENTY-EIGHT Dollars and NO Cents ($6,218,378.00) lawful money of the United States of America, for the payment of which sum the Contractor and Surety bind themselves and their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the above Contractor has entered into a written contract with the City for furnishing all labor, materials, tools, superintendence, and other facilities and accessories for the construction of Contract No. 201310046, CENTRAL UTILITY PLANT CHILLER ADDITION, Denver International Airport, in accordance with the Technical Specifications, Contract Drawings and all other Contract Documents therefor which are incorporated herein by reference and made a part hereof, and are herein referred to as the Contract.

NOW, THEREFORE, the condition of this payment bond obligation is such that if the Contractor shall at all times promptly make payments of all amounts lawfully due to all persons supplying or furnishing it or its subcontractors with labor and materials, rental machinery, tools, or equipment, used or performed in the prosecution of work provided for in the above Contract and shall indemnify and save harmless the City to the extent of any and all payments in connection with the carrying out of such Contract which the City may be required to make under the law, then this obligation shall be null and void, otherwise, it shall remain in full force and effect;

PROVIDED FURTHER, that the said Surety, for value received, hereby stipulates and agrees that any and all changes in the Contract, or compliance or noncompliance with the formalities in the Contract for making such changes shall not affect the Surety's obligations under this bond and the Surety hereby waives notice of any such changes.

[END OF PAGE]

IN WITNESS WHEREOF, said Contractor and said Surety have executed these presents as of this ____ day of _____, _____.

BOSCO CONSTRUCTORS, INC.
CONTRACTOR

By: _____
President

WESTERN SURETY COMPANY
SURETY

By: _____
Attorney-in-Fact Cynthia M. Burnett

(Accompany this bond with Attorney-in-Fact's authority from the Surety to execute bond, certified to include the date of the bond.)

CITY AND COUNTY OF DENVER

By: _____
MAYOR

By: _____
Manager of Aviation

APPROVED AS TO FORM:

DOUGLAS J. FRIEDNASH, Attorney for the City and County of Denver

By: _____
Assistant City Attorney

Western Surety Company

POWER OF ATTORNEY APPOINTING INDIVIDUAL ATTORNEY-IN-FACT

Know All Men By These Presents, That WESTERN SURETY COMPANY, a South Dakota corporation, is a duly organized and existing corporation having its principal office in the City of Sioux Falls, and State of South Dakota, and that it does by virtue of the signature and seal herein affixed hereby make, constitute and appoint

Douglas John Rothey, Cynthia M Burnett, Individually

of Littleton, CO, its true and lawful Attorney(s)-in-Fact with full power and authority hereby conferred to sign, seal and execute for and on its behalf bonds, undertakings and other obligatory instruments of similar nature

- In Unlimited Amounts -

and to bind it thereby as fully and to the same extent as if such instruments were signed by a duly authorized officer of the corporation and all the acts of said Attorney, pursuant to the authority hereby given, are hereby ratified and confirmed.

This Power of Attorney is made and executed pursuant to and by authority of the By-Law printed on the reverse hereof, duly adopted, as indicated, by the shareholders of the corporation.

In Witness Whereof, WESTERN SURETY COMPANY has caused these presents to be signed by its Vice President and its corporate seal to be hereto affixed on this 22nd day of October, 2012.

WESTERN SURETY COMPANY

Paul T. Bruflat, Vice President

State of South Dakota
County of Minnehaha } ss

On this 22nd day of October, 2012, before me personally came Paul T. Bruflat, to me known, who, being by me duly sworn, did depose and say: that he resides in the City of Sioux Falls, State of South Dakota; that he is the Vice President of WESTERN SURETY COMPANY described in and which executed the above instrument; that he knows the seal of said corporation; that the seal affixed to the said instrument is such corporate seal; that it was so affixed pursuant to authority given by the Board of Directors of said corporation and that he signed his name thereto pursuant to like authority, and acknowledges same to be the act and deed of said corporation.

My commission expires
June 23, 2015

J. MOHR
NOTARY PUBLIC
SOUTH DAKOTA

J. Mohr, Notary Public

CERTIFICATE

I, L. Nelson, Assistant Secretary of WESTERN SURETY COMPANY do hereby certify that the Power of Attorney hereinabove set forth is still in force, and further certify that the By-Law of the corporation printed on the reverse hereof is still in force. In testimony whereof I have hereunto subscribed my name and affixed the seal of the said corporation this _____ day of _____, _____.

WESTERN SURETY COMPANY

L. Nelson, Assistant Secretary

Form F4280-7-2012

CITY AND COUNTY OF DENVER

DEPARTMENT OF AVIATION

*** * * * * * * * * * * * ***

NOTICE TO PROCEED

Date:

TO: [Bidder name and address]

You are hereby authorized and directed to proceed on this date with the work of constructing Contract No. 201310046, CENTRAL UTILITY PLANT CHILLER ADDITION, Denver International Airport, Denver, Colorado, as set forth in detail in the Contract Documents for the City and County of Denver.

The bid security submitted with your bid is herewith returned to you.

CITY AND COUNTY OF DENVER

By_____
Deputy Manager of Aviation,
Airport Infrastructure Management

By_____
Manager of Aviation

CITY AND COUNTY OF DENVER

DEPARTMENT OF AVIATION

*** * * * * * * * * * * * * ***

FINAL RECEIPT

Denver, Colorado

_____, ____

Received this date of the City and County of Denver, as full and final payment of the cost of the construction of Contract No. 201310046, CENTRAL UTILITY PLANT CHILLER ADDITION, Denver International Airport, Denver, Colorado, provided for in the foregoing Contract, [Payment amount] Dollars and _____ Cents ($_____), in cash, being the remainder of the full amount accruing to the undersigned by virtue of said Contract; said cash also covering and including full payment for the cost of all extra work and material furnished by the undersigned in the construction of said improvements, and all incidentals thereto, and the undersigned hereby releases said City and County from all claims whatsoever growing out of said Contract.

And these presents are to certify that all persons doing work upon or furnishing materials for said improvements under the foregoing Contract have been paid in full.

_____

_____

_____

CITY AND COUNTY OF DENVER

DEPARTMENT OF AVIATION
DEPARTMENT OF PUBLIC WORKS

STANDARD SPECIFICATIONS FOR CONSTRUCTION

CONSTRUCTION CONTRACT GENERAL CONDITIONS
2011 Edition

TABLE OF CONTENTS

The General Contract Conditions are available electronically as described in the Special Conditions

TITLE 1 - DEFINITIONS..... 1
101 CITY 1
102 CONTRACT 1
103 CONTRACT AMOUNT 1
104 CONTRACT DOCUMENTS 1
105 CONTRACT TIME 1
106 CONTRACTOR 2
107 CONTRACTOR PERSONNEL 2
108 DAYS.....2
109 DEPUTY MANAGER.....2
110 DESIGNER.....2
111 FINAL COMPLETION 2
112 MANAGER 3
113 PRODUCT DATA.....3
114 PROJECT.....3
115 PROJECT MANAGER 3
116 SAMPLES.....3
117 SHOP DRAWINGS.....3
118 SUBCONTRACTOR.....3
119 SUBSTANTIAL COMPLETION 3
120 SUPPLIER 4
121 WORK 4

TITLE 2 – CITY ADMINISTRATIVE ORGANIZATIONS; LINE OF AUTHORITY.....5
201 DEPARTMENT OF AVIATION.....5
202 MANAGER OF AVIATION.....5
203 DEPARTMENT OF PUBLIC WORKS.....5
204 MANAGER OF PUBLIC WORKS.....5
205 BUILDING INSPECTION.....5
206 ZONING 5
207 DIVISION OF SMALL BUSINESS OPPORTUNITY 6
208 CITY AUDITOR 6
209 MANAGER OF FINANCE.....6
210 CITY ATTORNEY.....6
211 OFFICE OF RISK MANAGEMENT.....6
212 CITY'S CONTRACT ADMINISTRATION LINE OF AUTHORITY 6
213 CITY’S COMMUNICATIONS WITH THE CONTRACTOR 7

TITLE 3 - CONTRACTOR PERFORMANCE AND SERVICES..... 8
301 CONSIDERATION (CONTRACTOR’S PROMISE OF PERFORMANCE).....8
302 NOTICE TO PROCEED AND COMPLETION OF THE WORK.....8
303 EXACT CONTRACTOR PERFORMANCE 8
304 SUBSTITUTED PERFORMANCE.....8
305 WORK PERFORMED UNDER ADVERSE WEATHER CONDITIONS 9
306 WORKING HOURS AND SCHEDULE 9
307 CONTRACTOR’S SUPERINTENDENT.....10

308 COMMUNICATIONS 10
309 CONTRACTOR SUBMITTALS AND OTHER WRITTEN COMMUNICATIONS TO THE CITY 10
310 COMPENTENCE OF CONTRACTOR'S WORK FORCE 11
311 NO EMPLOYMENT OF ILLEGAL ALIENS TO PERFORM WORK UNDER THE CONTRACT 11
312 CONDUCT OF CONTRACTOR'S PERSONNEL 12
313 SUGGESTIONS TO CONTRACTOR 12
314 WORK FORCE 12
315 CONSTRUCTION MACHINES AND STANBY EQUIPMENT 13
316 CUTTING AND PATCHING THE WORK 13
317 PERMITS AND LICENSES 13
318 CONSTRUCTION SURVEYS 14
319 PRESERVATION OF PERMANENT LAND SURVEY CONTROL MARKERS 14
320 TRADEMARKS, COPYRIGHTS AND PATENTED DEVICES, MATERIALS, AND PROCESSES 15
321 PROJECT SIGNS 15
322 PUBLICITY AND ADVERTISING 16
323 TAXES 16
324 DOCUMENTS AND SAMPLES AT THE SITE 17
325 CLEANUP DURING CONSTRUCTION 17
326 SANITARY FACILITIES 18
327 POWER, LIGHTING, HEATING, VENTILATING, AIR CONDITIONING AND WATER SERVICES 18

TITLE 4 - CONTRACT DOCUMENTS (DRAWINGS AND SPECIFICATIONS) .. 19
401 CONTRACT DOCUMENTS - REVIEW AND INTERPRETATION 19
402 OWNERSHIP OF CONTRACT DRAWINGS AND TECHNICAL SPECIFICATIONS 20
403 CONTRACT DRAWINGS AND TECHNICAL SPECIFICATIONS ISSUED TO THE CONTRACTOR 20
404 REQUESTS FOR INFORMATION OR CLARIFICATION 21
405 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES 21
406 SUBSTITUTION OF MATERIALS AND EQUIPMENT 22

TITLE 5 - SUBCONTRACTS 24
501 SUBCONTRACTS 24
502 SUBCONTRACTOR ACCEPTANCE 24

TITLE 6 - TIME OF COMMENCEMENT AND COMPLETION 27
601 BEGINNING, PROGRESS AND TIME OF COMPLETION 27
602 LIQUIDATED DAMAGES, ADMINISTRATIVE COSTS; ACTUAL DAMAGES 27
603 DELAY DAMAGES 28

TITLE 7 - COOPERATION, COORDINATION AND RATE OF PROGRESS..... 29
701 COOPERATION WITH OTHER WORK FORCES 29

702 COORDINATION OF THE WORK....30
703 COORDINATION OF PUBLIC CONTACT....30
704 RATE OF PROGRESS....30

TITLE 8 - PROTECTION OF PERSONS AND PROPERTY 32
801 SAFETY OF PERSONS....32
802 PROTECTIVE DEVICES AND SAFETY PRECAUTIONS....33
803 PROTECTION OF PROPERTY AND WORK IN PROGRESS....33
804 PROTECTION OF MUNICIPAL, PUBLIC SERVICE OR UTILITY SYSTEMS....34
805 PROTECTION OF STREET AND ROAD SYSTEM....35
806 PROTECTION OF DRAINAGE WAYS....36
807 PROTECTION OF THE ENVIRONMENT....36
808 HAZARDOUS AND EXPLOSIVE MATERIALS OR SUBSTANCES....37
809 ARCHEOLOGICAL AND HISTORICAL DISCOVERIES....37

TITLE 9 - COMPENSATION.... 38
901 CONSIDERATION (CITY'S PROMISE TO PAY)....38
902 PAYMENT PROCEDURE....38
903 SCHEDULE OF VALUES IN LUMP SUM CONTRACTS....39
904 UNIT PRICE CONTRACTS....39
905 PROGRESS PERIOD....39
906 APPLICATIONS FOR PAYMENT....40
907 RELEASES AND CONTRACTORS CERTIFICATION OF PAYMENT....41
908 RETAINAGE....41
909 ADDITIONAL WITHHOLDING OF PROGRESS PAYMENTS....42
910 FINAL ESTIMATE AND PAYMENT....43
911 ACCOUNTING OF COSTS AND AUDIT....43

TITLE 10 - WAGES 45
1001 PREVAILING WAGE ORDINANCE....45
1002 POSTING OF THE APPLICABLE WAGE RATES....45
1003 RATE AND FREQUENCY OF WAGES PAID....45
1004 REPORTING WAGES PAID....45
1005 FAILURE TO PAY PREVAILING WAGES....46

TITLE 11 - CHANGES IN THE WORK, CONTRACT PRICE OR CONTRACT TIME 47
1101 CHANGE ORDER....47
1102 CITY INITIATED CHANGES....47
1103 CONTRACTOR CHANGE REQUEST....48
1104 ADJUSTMENT TO CONTRACT AMOUNT....51
1105 TIME EXTENSIONS....54

TITLE 12 - CONTRACTOR CLAIMS FOR ADJUSTMENT AND DISPUTES 56
1201 NOTICE OF INTENT TO CLAIM....56
1202 SUBMITTAL OF CLAIMS....56
1203 WAIVER OF CLAIMS....58

TITLE 13 - DISPUTES.... 59

1301 DISPUTES 59

TITLE 14 - SITE CONDITIONS 60
1401 DIFFERING SITE CONDITIONS 60
1402 SITE INSPECTIONS AND INVESTIGATIONS 60

TITLE 15 - PERFORMANCE AND PAYMENT BONDS 62
1501 SURETY BONDS 62
1502 PERFORMANCE BOND 62
1503 PAYMENT BOND 62

TITLE 16 - INSURANCE AND INDEMNIFICATION 63
1601 INSURANCE 63
1602 DEFENSE AND INDEMNIFICATION 63

TITLE 17 - INSPECTION AND DEFECTS 64
1701 CONSTRUCTION INSPECTION BY THE CITY 64
1702 AUTHORITY OF INSPECTORS 64
1703 OBSERVABLE DEFECTS 64
1704 DEFECTS - UNCOVERING WORK 64
1705 LATENT DEFECTS 65
1706 REMOVAL OF DEFECTIVE MATERIALS AND WORK 65

TITLE 18 - WARRANTIES, GUARANTEES AND CORRECTIVE WORK 66
1801 CONTRACTOR'S WARRANTIES, GUARANTEES AND CORRECTION OF WORK 66
1802 PERFORMANCE DURING WARRANTY PERIOD 67

TITLE 19 - SUBSTANTIAL COMPLETION OF THE WORK 69
1901 CONTRACTOR’S NOTICE OF SUBSTANTIAL COMPLETION 69
1902 INSPECTION AND PUNCH LIST 69
1903 CERTIFICATE OF SUBSTANTIAL COMPLETION 69
1904 RIGHT OF EARLY OCCUPANCY OR USE 69

TITLE 20 - FINAL COMPLETION AND ACCEPTANCE OF WORK 71
2001 CLEAN-UP UPON COMPLETION 71
2002 FINAL COMPLETION AND ACCEPTANCE OF THE WORK 71
2003 FINAL SETTLEMENT 71

TITLE 21 - SUSPENSION OF WORK 74
2101 SUSPENSION OF WORK 74
2102 SUSPENSION OF THE WORK FOR THE CITY’S CONVENIENCE 74
2103 SUSPENSION BECAUSE OF ORDER OF CITY, STATE OR FEDERAL COURT OR AGENCY 75
2104 SUSPENSION RESULTING FROM CONTRACTOR’S FAILURE TO PERFORM 75

TITLE 22 - CITY'S RIGHT TO TERMINATE THE CONTRACT 76
2201 TERMINATION OF CONTRACT FOR CAUSE 76
2202 TERMINATION OF CONTRACT FOR CONVENIENCE OF THE CITY 77

TITLE 23 - MISCELLANEOUS PROVISIONS 80

2301 PARTIES TO THE CONTRACT....80
2302 FEDERAL AID PROVISIONS....80
2303 NO WAIVER OF RIGHTS....80
2304 NO THIRD PARTY BENEFICIARY....80
2305 GOVERNING LAW; VENUE....80
2306 ABBREVIATIONS....81
2307 STATUTE OF LIMITATIONS IN C.R.S. § 13-80-102(1)(h)....81

INDEX....i-ix

SPECIAL CONDITIONS
Contract No. 201310046

SC-1 CONSTRUCTION CONTRACT GENERAL CONDITIONS

The Construction Contract General Conditions which constitute a part of the Contract Documents are set forth in a separately published document, entitled "City and County of Denver, Department of Aviation and Department of Public Works, Standard Specifications for Construction, General Contract Conditions," 2011 Edition, the Table of Contents to which is bound herein (which may be informally referred to as the Yellow Book). The General Conditions book is available for purchase for $12.00 per copy at the following locations during the business hours stated, Monday through Friday, excluding holidays:

Office of the Cashier
Wellington E. Webb Municipal Office
Building, 2nd Floor
201 West Colfax Avenue
Denver, Colorado, USA 80202
7:30 a.m. to 4:30 p.m.

The General Conditions are also available on the DIA Contract Procurement on the City and County of Denver website at:
http://www.denvergov.org/dpw_contract_admin/ContractAdministration/ContractorReferenceDocuments/tabid/440535/Default.aspx

SC–2 DRAWINGS AND SPECIFICATIONS TO BE FURNISHED BY THE CITY

The City will provide the following Contract Documents to the Contractor in electronic format at no expense to the Contractor:

Document
Volumes I & 2 (See the Master Table of Contents, page TOC-3, for the content of these volumes)
Volume 3
Contract Drawings
Change Orders and Change Directives

Additional copies of the foregoing documents will be furnished to the Contractor at the Contractor's expense. The Contractor will be responsible for supplying all subcontractors with copies of the Contract Documents at its expense.

If Sensitive Security Information ("SSI") is provided to the Contractor, the Contractor shall be required to comply with Department of Aviation, Standard Policies and Procedures No. 6003, "Contractor Protection of Sensitive Security Information," or its successor, and 49 C.F.R. § 1520, or its successor.

The City will not supply any copies of the General Contract Conditions to the Contractor at City expense.

SC-3 REVISIONS TO G.C. 201

The second sentence of General Condition 201 is amended to read: "The unit responsible for this management and control is the Airport Infrastructure Management Office under the supervision of the Deputy Manager of Aviation for Maintenance and Airport Infrastructure Management."

SC-4 CITY LINE OF AUTHORITY AND CONTACTS

In accordance with General Condition 214, the City's line of authority for administration of this Contract is:

Manager of Aviation (the "Manager" under G.C. 112). The Manager of Aviation is Kim Day, Executive Office, 9th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

Deputy Manager of Aviation for Airport Infrastructure Management (the "Deputy Manager" under G.C. 109), who reports to the Manager. The Manager is David LaPorte, Airport Infrastructure Management Office, 7th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

Assistant Manager of Aviation for Airport Infrastructure Management (the "Assistant Manager"), reports to the Deputy Manager. The Project Manager reports to the Assistant Manager. The Assistant Manager is Michael Steffens Airport Infrastructure Management Division, 7th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

Project Manager, the City representative who has day to day administrative responsibility of this Contract, and who reports to the Deputy Manager. All notices, requests, pay applications (pursuant to G.C. 902), and other correspondence from the Contractor shall be sent to the assigned Project Manager unless otherwise provided in this Contract. The Project Manager for this Contract is: PMname, Airport Infrastructure Management Office, 7th Floor, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249, phone 303-342-2200.

The Manager may from time to time substitute a different City official as the designated "Deputy Manager" hereunder, and any such change will be effective upon the issuance of written notice to the Contractor which identifies the successor Deputy Manager. The Deputy Manager may from time to time change the assigned Project Manager, and any such change will be effective upon the issuance of written notice to the Contractor which identifies the successor Project Manager.

SC–5 CONTRACTOR PERFORMANCE; SUBCONTRACTING

With respect to General Condition 501, no more than 80% of the work may be subcontracted.

SC–6 COOPERATION WITH OTHERS

The Technical Specifications describe the constraints on the physical work site areas. These descriptions are not exhaustive and the Contractor is required to coordinate its activities and work as may be required to meet FAA or City requirements while performing work on DIA.

Without limiting the foregoing, the following contracts administered by the City involve or may involve work overlapping or adjoining the Work under this Contract, and may be prosecuted concurrently with the Work performed under this Contract. There may also be other adjoining or overlapping contracts which are not listed.

Contract No.	Description
	South Terminal Redevelopment Project

SC–7 PROSECUTION AND COMPLETION OF THE WORK:

The Work to be performed under the Contract is described in the Technical Specifications and Contract Drawings. The Contractor shall complete the Work within (365) consecutive calendar days from Notice to Proceed.

The Work to be performed under the Contract is divided into the following Milestone Areas which are described in the Technical Specifications or Contract Drawings. The Contractor shall complete the work included within these areas within the number of days set forth below:

Milestone	Date of Completion (or, days from NTP)
N/A	

SC–8 LIQUIDATED DAMAGES

If the Contractor fails to achieve Substantial Completion of the Work within the Contract Time, the Contractor shall be liable to the City for liquidated damages at the rate of $1,000.00 per day until substantial completion is achieved. [Additionally, if the Contractor fails to substantially complete the Work described in a project Milestone within the time specified in SC-7 PROSECUTION AND COMPLETION OF THE WORK, the Contractor shall be liable to the City for liquidated damages at the following rates per day until such substantial completion is achieved:]

Failure to substantially complete the Work described in Milestone:

Amount per day

N/A

Article IV of the Contract and General Condition 602 cover payment and withholding of liquidated damages.

SC–9 FACILITY SECURITY AND PERSONNEL ACCESS

The Contractor shall conduct all its activities at the Airport in compliance with the Airport security system rules and regulations, which are administered by the Airport Operations Division. The Contractor shall obtain the proper access authorizations for its employees, subcontractors and suppliers (i.e., Badges and Permits), and shall be responsible for such persons' compliance with all the Airport rules and regulations. A copy of the Contractors' section of the Airport Security rules and regulations are available for Contractor review at the Airport Access Services Office, Concourse A East Subcore, 4th Level. Persons regularly entering the construction areas must obtain personnel access badges from the Airport Access Services Office and must display badges , at all times, upon entering the construction, restricted and sterile areas of the airport.. Any employee, subcontractor or supplier who violates such rules may be subject to revocation of his access authorization, including authorization for access to the construction site and all other restricted and sterile areas.

The security status of the Airport is subject to change without notice. These contract Special Conditions are applicable to the current security status of the Airport. Should the security status of the Airport change at any time during the term of this Contract, a written notice shall be issued to the Contractor detailing all applicable security modifications from the airport's current security status. The Contractor shall take **immediate steps** to comply with those security modifications as directed in the written notice.

If these security modifications involve any additional project cost, the Contractor shall submit a Contractor Change Request in accordance with the General Conditions for the additional cost. The Contractor Change Request shall outline in specific detail the effects of the security modifications on the Contractor's performance of the Contract, and shall provide a detailed cost breakdown for each item for which the Contractor is requesting reimbursement.

The Contractor shall return to the City, at contract completion or termination, or upon demand by the City, all access keys issued to it by the City to all areas of the Airport. If the Contractor fails to return any such key or keys at contract completion or termination or upon demand by the City, the Contractor shall be liable to the City for all the City's costs, including the City's labor costs for employees, incurred in re-coring doors and any other work which is required to prevent compromise of the Airport security system. In order to collect such costs hereunder, the City may withhold funds in such amount from any amounts due and payable to the Contractor under this Contract.

The construction of all the Project / Task Items that involve the breaching of any airport perimeter security boundary or continued access to restricted access rooms or areas will require the posting of authorized contract security personnel to maintain required security controls. The Contractor's **Guarantee Maximum Price / Total Contract BID Amount / Task Order Proposal** shall include the cost of providing security services to maintain control and supervision of any and all airport perimeter security boundary breaches and for the duration of work activities where access to restricted areas is required and until the airport perimeter security boundaries are reestablished.

When security boundaries are opened for any reason, the Contractor must maintain one hundred percent (100%) control and supervision for the entire time that the openings are present to prevent unauthorized access to the secure / restricted access areas.

THE IMPORTANCE OF THIS SPECIAL CONDITION CANNOT BE OVER-EMPHASIZED. SEVERE FINANCIAL PENALTIES AS WELL AS CONTRACT TERMINATION COULD RESULT IF AIRPORT PERIMETER SECURITY REQUIREMENTS ARE NOT STRICTLY FOLLOWED. THE REQUIREMENT TO PROVIDE ONE HUNDRED PERCENT (100%) CONTROL AND SUPERVISION OF BREACHES IN THE AIRPORT'S PERIMETER SECURITY BOUNDARY IS ABSOLUTE. AT NO TIME, DURING WORK AND NON-WORK HOURS SHALL ANY BREACHES IN THE AIRPORT'S SECURITY PERIMETER BE UNSUPERVISED AND / OR UNSECURED.

For off-hours of construction, the Contractor may choose to erect a temporary wall to close all perimeter openings. The wall construction shall be of sufficient materials and strength to prevent access to the airport's Sterile/Restricted Areas. The Contractor shall submit for review and approval, the details and materials for the temporary closure of security perimeter breaches for review and approval.

The Contractor will provide contract security guard services to maintain supervision of these openings. The security services must provide coverage to allow for lunch breaks, comfort breaks and etc. The security services **must** be obtained from the following contract security guard company:

HSS
900 S. Broadway, Suite 100
Denver, Colorado 80209

DIA Contact: Glenn Spies
(303) 342-4323

All security guards provided for this project must have a Denver Airport SIDA Badge.

The DIA Security Guard Contractor may change between the bidding or proposal phase of this contract from Notice to Proceed to closure of all security perimeter breaches. The Contractor shall maintain a contractual relationship with the Security Guard Contractor holding the most current contract with Denver International Airport.

The Contractor shall continue to provide security of these areas until such time that the breaches in the airport's security perimeter have been permanently secured.

The Contractor shall submit a written security plan for approval to the Director of Airport Security prior to the start of construction on any work where a breach of the perimeter security boundaries is required.

SC-10 CONSTRUCTION ACCESS

The work site(s) is (are) located at Central Utility Plant. The Contractor shall have access to the work site via loading dock road, gates 1, 413, 5 & 7.

The City will not provide parking spaces for the Contractor's employees or subcontractor employees at the Airport. Arrangements for transportation and parking for all of its and its subcontractors employees will be the responsibility of the Contractor. The Total Contract Bid Amount or Contract Amount shall include any and all costs associated with the Contractor's and subcontractors' employee parking. Information about parking facilities and charges is available from the Airport Parking Office. Refundable deposits are required for all parking passes.

Unless specifically required by the Contract Documents, the Contractor shall install no fences or other physical obstructions on or around any project work area without the approval of the City.

SC–11 VEHICLE PERMITTING

Vehicle access on the Airport Operation Area ("AOA") is controlled by and requires permission from the Airport Access Services Office. It is not anticipated that the Contractor will need to operate vehicles on the AOA to perform the Work. Only direct construction support vehicles and/or equipment will be allowed in the contractor's work areas or sites.

SC–12 VENDORS AND SUPPLIERS

The Contractor shall provide the Project Manager's office with a list of its equipment/material vendors and suppliers. Vendors or suppliers shall access the construction work areas via the Contractor's access route, described in SC-10 above. All delivery vehicles are subject to search.

SC–13 COMMUNICATION DEVICES

Any site communications devices, mobile communication devices or internet data devices used at DIA must be approved by DIA Technologies.

SC–14 USE, POSSESSION OR SALE OF ALCOHOL OR DRUGS

The Contractor and its officers, agents, and employees shall cooperate and comply with the provisions of Executive Order No. 94 and Attachment A thereto concerning the use, possession, or sale of alcohol or drugs. Violation of these provisions or refusal to cooperate with implementation of the policy can result in the City's barring the Contractor from City facilities or participating in City operations.

SC-15 ATTORNEY'S FEES

Colorado Revised Statute 38-26-107 requires that in the event any person or company files a verified statement of amounts due and unpaid in connection with a claim for labor and materials supplied on this project, the City shall withhold from payments to the Contractor sufficient funds to insure the payment of any such claims. Should the City and County of Denver be made a party to any lawsuit to enforce such unpaid claims or any lawsuit arising out of or relating to such withheld funds, Contractor agrees to pay to the City its costs and a reasonable attorney's fee. Because the City Attorney Staff does not bill the City for legal services on an hourly basis, Contractor agrees a reasonable fee shall be computed at the rate of one hundred dollars per hour of City Attorney time.

SC–16 INSURANCE TO BE PROVIDED BY THE CONTRACTOR

In accordance with the provisions of Title 16 of the General Conditions, the minimum insurance requirements for this contract are set forth in the Exhibit Q, attached to this Contract. The Contractor specifically agrees to comply with each condition, requirement or specification set forth in the attachment for each required coverage during all periods when the required coverage's are in effect.

City anticipates providing an Owner Controlled Insurance Program (OCIP), which coverage City agrees will be primary over any other insurance provided by an enrolled party. City agrees to allow Contractor to review all proposed c overage forms prior to implementation of the OCIP. Following implementation of the OCIP, Contractor agrees to provide a credit to the City for the cost of insurance coverage being provided by the OCIP. The amount of such credit will be determined based upon a review of actual OCIP coverages. The City shall be named as an additional insured on Contractor's general liability policy in the event that Contractor includes the costs of said coverage in its bid.

Contractor and sub-contractors shall procure and maintain until all of their obligations have been discharged, including any warranty periods under this Contract are satisfied,

required insurance against claims for injury to persons or damage to property which may arise from or in connection with the performance of the work hereunder by the Contractor, his agents, representatives, employees or sub-contractors.

The insurance requirements herein are minimum requirements for this Contract and in no way limit the indemnity covenants contained in this Contract.

The City and County of Denver in no way warrants that the minimum limits contained herein are sufficient to protect the Contractor from liabilities that might arise out of the performance of the work under this Contract by the Contractor, his agents, representatives, employees or sub- contractors. The Contractor shall assess its own risks as it deems appropriate and/or prudent, maintain higher limits and/or broader coverages. The Contractor is not relieved of any liability or other obligations assumed or pursuant to the Contract by reason of its failure to obtain or maintain insurance in sufficient amounts, duration or types.

Contractor shall furnish the City and County of Denver with certificates of insurance (ACORD form or equivalent approved by CCD) as required by this Contract. The certificates for each insurance policy are to be signed by a person authorized by the insurer to bind coverage on its behalf.

All certificates and any required endorsements are to be received and approved by the City before work commences. Each insurance policy required by this Contract must be in effect at or prior to commencement of work under this Contract and remain in effect for the duration of the project. Failure to maintain the insurance policies as required by this Contract or to provide evidence of renewal is a material breach of the Contract. All insurance coverages for sub-contractors shall be subject to the minimum requirements identified in the Exhibit. All sub-contractors certificates and endorsements shall be received and approved by the Contractor before work commences. The City reserves the right to request copies of these certificates at any time.

All certificates required by this Contract shall be sent directly to Denver International Airport, Business Management Services, Airport Office Building, Room 8810, 8500 Pena Boulevard, Denver, Colorado 80249. The City project/Contract number and project description shall be noted on the certificate of insurance. The City reserves the right to require complete, certified copies of all insurance policies required by this Contract at any time.

The parties hereto understand and agree that the City and County of Denver, its officers, officials and employees, are relying on, and do not waive or intend to waive by any provisions of this Contract, the monetary limitations or any other rights, immunities and protections provided by the Colorado Governmental Immunity Act, §§ 24-10-101 - 120, C.R.S., or otherwise available to the City and County of Denver, its officers, officials and employees.

SC–17 SUBCONTRACTOR RELEASES

The release form referred to in General Condition 907 is attached to these Special Conditions. It is entitled "Denver International Airport Partial Release."

SC–18 ADDITIONAL AFFIRMATIVE ACTION REQUIREMENTS, FEDERAL PROVISIONS

This contract is subject and subordinate to the terms, reservations, restrictions, and conditions of any existing or future agreements between the City and the United States, the execution of which has been or may be required as a condition precedent to the transfer of federal rights or property to the City for airport purposes, and the expenditure of federal funds for airport purposes. The "Federal Requirements" section attached hereto is made a part of this Contract.

SC-19 ESTIMATED QUANTITIES OF UNIT PRICED ITEMS

The "total estimated quantity" of each unit price item as stated on the bid schedules shall be the estimated quantity which is used to determine the percentage of change in such item for purposes of G.C. 1104.7

SC-20 REVISIONS TO G.C. 1102

G.C. 1102.2 is amended by replacing the phrase "Change Request" in all its occurrences in such G.C. with the phrase "Change Notice."

G.C. 1102.3 is amended by replacing the phrase "Field Order/Change Directive" in all its occurrences in such G.C. with the phrase "Change Directive."

SC-21 LISTING OF ACCEPTABLE MANUFACTURERS

The Technical Specifications list "Acceptable Manufacturers" for certain products. Such listing identifies manufacturers of certain products which have been determined by a preliminary review to be able to meet the basic product and/or system technical requirements. The listing is not intended to provide a blanket endorsement or acceptance of the manufacturer's specified products or product line. All products from listed manufacturers must meet the detailed requirements of the Technical Specifications. Products that do not meet all detailed Technical Specifications are not acceptable and will be rejected, regardless of whether the manufacturer was listed as "acceptable." The Contractor is responsible for determining the acceptability of all products under the Technical Specifications prior to submission of products for approval.

SC-22 ACCESSIBLE PARKING SPACES, ACCESS AISLES AND ROUTES OF TRAVEL

If any Work is performed in or adjacent to parking facilities at the Airport, the Contractor is responsible for compliance with this SC-30. "Accessible" parking spaces and access aisles as used in this SC-30 mean parking spaces and access aisles which are accessible for, and reserved for use by, persons with disabilities. These parking spaces and access aisles are designed and built to standards established by federal regulations implementing the Americans with Disabilities Act of 1990 ("ADA"), and are marked by signage. "Accessible routes of travel" as used herein means routes through parking facilities which comply with ADA accessibility standards, including degree of slope and absence of obstructions.

Accessible routes of travel and accessible parking spaces and access aisles must be kept free of obstructions and construction debris at all times. No accessible parking spaces or access aisles or accessible routes of travel shall be relocated, blocked or rendered unusable unless the contractor has obtained specific advance approval in writing for such actions from the airport's ADA Compliance Officer.

When prosecution of the Work requires that accessible spaces be temporarily blocked, those accessible spaces and their access aisles shall be temporarily relocated to another location as close as possible to an accessible building entrance. Temporary signage that identifies these parking spaces and access aisles as reserved for the handicapped shall be installed, and the accessible route shall be clearly marked as required.

Before blocking or relocating accessible parking spaces or accessible routes of travel, the contractor must obtain written approval from the DIA ADA Compliance Officer, by submitting a completed request form, which will be provided to the Contractor by the Project Manager at the preconstruction meeting if it is not included as a standard form in Section 01999 of the Technical Specifications. The request shall include the location of alternative spaces and/or routes, and specifications of the temporary signage to be used. Work shall not proceed without this approval.

If a vehicle is parked in any accessible space which is either temporary or approved to be relocated, the contractor will not remove signage or take any other action which would allow the access aisle for such parking space to be blocked. Such actions must be postponed until the parking space is no longer occupied.

SC–23 SUBCONTRACTOR PAYMENTS AND SUBCONTRACTOR RELEASES – REQUIRED USE OF THE B2G CONTRACT MANAGEMENT SYSTEM

The Contractor is required to use the City B2G Contract Management System to report all subcontractor payments and shall adhere to the City's Procedure for Reporting Subcontractor Payments. It is the Contractor's obligation to ensure that complete subcontractor information is entered into the B2G System prior to submission of the first application for payment in order to avoid any delays in payment. The Contractor

shall, prior to the submission of each subsequent invoice, ensure payments to subcontractors have been entered into the B2G System, including subcontractor confirmation of amount of payment received, for services performed during the prior billing period.

SC-24 PROJECT CONTROLS REQUIREMENTS

The Contractor will be required to use Primavera Contract Management (PCM) and Primavera P6 to comply with the requirements of DIA's Project Controls System. The Project Controls System is Airport Infrastructure Management's tool for project and information management, data analysis and document control. Denver International Airport will be responsible for providing the licensing and training for PCM. The Contractor will be responsible for providing Primavera P6. The Contractor will also be responsible for providing and maintaining the computer hardware, software and system environment capable of supporting Project Controls System requirements including as the minimum: internet connection; Microsoft Internet Explorer 8 or better; Microsoft Office 2010; Oracle Java JRE 1.7.0 Update 5 and Adobe Acrobat X Pro. This is the only project management system that will be accepted.

INSURANCE

REQUIREMENTS

The insurance requirements which apply to this contract are contained in the pages immediately following this page which include the following attachments:

1. **City and County of Denver Insurance Certificate with Requirements (NOT APPLICABLE TO THIS CONTRACT)**
2. **Exhibit Q, Owner Controlled Insurance Program (OCIP)**

The following link contains important information to ensure that all costs are captured within your bid proposal.

3. **Safety Manual, Owner-Controlled Insurance Program (OCIP) http://business.flydenver.com/bizops/documents/safetyManualOCIPAttach3.pdf**

EXHIBIT Q
OWNER CONTROLLED INSURANCE PROGRAM (OCIP)

1.0 Definitions

Certificate of Insurance:	Evidence of the insurance coverage afforded under the OCIP. Also, evidence of insurance coverage provided by Enrolled Parties for automobile liability and offsite exposures.
Contract:	The written agreement between the City and Contractor describing the Work, Contract Terms and Conditions, or a portion thereof. Also includes a written agreement between a Contractor and any tier of subcontractor.
Contractor:	Prime Contractor, subcontractors of any tier.
Contractor insurance cost	The Costs of OCIP Coverage is defined as the amount of Contractor's and eligible Subcontractors' of every tier reduction in insurance costs due to the OCIP Program.
City (Sponsor):	City of Denver
Owner Controlled Insurance Program (OCIP):	A coordinated insurance program providing certain coverage, as defined herein, for the City, Contractor and Enrolled Subcontractors, along with their Eligible Employees, performing Work at the Project Site.
Eligible Employees:	Employees of Enrolled Subcontractors who are not excluded from the OCIP under the "Excluded Parties" definition.
Enrolled Parties:	The Contractor and those Subcontractors that have submitted all necessary enrollment information and been accepted into the OCIP as evidenced by the issuance of a Certificate of Insurance.
Excluded Parties:	Parties not covered by the OCIP because of ineligibility. No insurance coverage provided by City under the OCIP shall extend to the activities or products of the following:

(1) Any person or organization that fabricates or manufactures products, materials or supplies away from the Project Site(s);

(2) Hazardous materials remediation, removal, or transportation companies and their consultants;

(3) Any architect, engineer or surveyor and their consultants except when approved by City;

(4) Truckers, haulers, material dealers, vendors, suppliers, and others who merely transport, pick up, deliver or carry materials, personnel, parts or equipment or any other items or persons to or from the Site;

(5) Contractors and their subcontractors and subconsultants and any employee of an Enrolled Party, who does not work at the Project Site;

(6) Any employees of an Enrolled Party who occasionally visits the Project Site to make deliveries, pick-up supplies or personnel, to perform supervisory or progress inspections, or for any other reason;

(7) Persons or entities who are not enrolled parties or included as insureds within the policies;

(8) Any Day Labor Employees (labor service employees whose coverage is provided by their employer); or

(9) Any other person or entity specifically excluded by City, in its sole discretion, from participation as Enrolled Parties.

Insured: (liability policies) — The City, Contractor and Enrolled Parties and their Eligible Employees and any other party named in the insurance policies.

Insurers — Those Insurance Companies providing the OCIP insurance coverage. The Insurers will be identified in the OCIP Manual.

Net Bid: — Contractor bids with insurance costs removed because of the obligation of any Enrolled Party to delete insurance costs for coverage provided by the OCIP from its bid and all change orders. Net bids are subject to verification by the OCIP Administrator through the providing of contractors' rate and declaration pages from their Insurance policies.

OCIP Administrator: — Insurance services firm selected by the City to administer the OCIP and provide insurance brokerage services as required.

OCIP Manual — A reference document provided to contractors of all tiers, which summarizes the terms and provisions of the OCIP and provides information about compliance with OCIP requirements.

Off-Site Work — Work performed away from the Project Site.

Payroll: — For purposes of the OCIP only, refers to Unburdened Straight

Time Payroll per Workers Compensation Class Code.

Project: The Project as defined in the contract documents and as described in the Declarations of the OCIP policies.

Project Site: Those areas designated in writing by The City of Denver in a Contract document for performance of the Work and such additional areas as may be designated in writing by The City of Denver for Contractor's use in performance of the Work. Subject to OCIP Insurers written approval, the term "Project Site" shall also include: (1) field office sites, (2) property used for bonded storage of material for the Project approved by The City of Denver, (3) staging areas dedicated to the Project, and (4) areas where activities incidental to the Project are being performed by Contractor or Subcontractors covered by the worker's compensation policy included in the OCIP, but excluding any permanent locations of Contractor or such covered Subcontractors.

Subcontract: The written agreement between Contractor and Subcontractor, or between Subcontractor and a lower tier Subcontractor, describing the Work, Subcontract Terms and Conditions, or a portion thereof.

Subcontractor: Includes those persons, firms, joint venture entities, corporations, or other parties that enter into a Subcontract with Contractor to perform Work at the Project Site and any of these Subcontractor's lower-tier subcontractors.

Work: Operations, as fully described in the Contract and Subcontract, performed at the Project Site.

2.0 General Information

2.1 **Insurance Provided by City.** City has arranged for this Project to be insured under an OCIP. Coverage shall be provided for Workers' Compensation, Employer's Liability, General Liability, Excess Liability, Builders Risk (if applicable) and Contactors Pollution Liability as outlined herein and as defined by the respective policies for each coverage, for the period from the start of Work through completion and final acceptance by City, except as otherwise provided herein.

2.2 **Enrollment Required**. Parties performing labor or services at the Project site are eligible to enroll in the OCIP, unless they are Excluded Parties (as defined herein). Participation in the OCIP is mandatory but not automatic. Parties eligible for enrollment shall follow the procedures and use the forms provided in the OCIP

manual to enroll in the OCIP. When the Contractor and Subcontractors and lower-tier subcontractors are properly enrolled in the OCIP, the OCIP Administrator will issue or have issued to the Contractor, Subcontractor and lower-tier subcontractors, prior to their commencing Work on the Project Site, a Certificate of Insurance evidencing the coverage arranged by City.

2.4 **Exclusion of Contractor/Subcontractor Insurance Costs from Proposal and Bid Prices**. Contractor shall exclude from Contractor's cost of work, and ensure that each Subcontractor of every tier exclude from their cost of work, normal costs for insurance without an OCIP for those coverages provided under the OCIP. The calculation of these costs will be determined using the forms found in the OCIP Manual. The Costs of OCIP Coverage includes reductions in insurance premiums, all relevant taxes and assessments, markup on insurance premiums, and losses retained through large deductibles or self-insured retentions, or self-funded other programs. Change orders shall also exclude the Cost of OCIP Coverage.

2.5 **Insurance Premiums**. City will pay the insurance premiums for the OCIP coverage. The City is responsible for all adjustments to the premiums and will be the sole beneficiary of all dividends, retroactive adjustments, return premiums, and any other monies due through audits or otherwise. The Contractor assigns to the City the right to receive all such adjustments, and will require that each subcontractor of every tier assign to City all such adjustments. The Contractor and the Subcontractors who are Enrolled Parties shall execute such further documentation as may be required by City to accomplish this assignment.

2.6 **Off Site Operations**. The OCIP will provide certain insurance coverage for the City, Contractor and Enrolled Parties, along with their Eligible Employees performing Work at the Project Site. Off-site operations shall be covered only if designated in writing by the City and when all operations at such site are identified and solely dedicated to the Project. Contractors and Subcontractors are responsible to notify the OCIP Administrator in writing, to request coverage for specified off-site operations. Coverage is not provided at the site unless confirmed in writing by the OCIP Administrator.

2.7 **OCIP Manual.** As soon as practicable, an OCIP Manual will be sent to the Enrolled Party and will become a part of the Contract and Contractor's Subcontract with Subcontractor. The OCIP Manual will contain the administrative and claim reporting procedures. Contractor agrees to and will require that its Subcontractors and their lower-tier subcontractors also cooperate with the OCIP Administrator in providing all information as required in the OCIP Manual.

2.8 **Conflicts**. The descriptions of the OCIP Coverages set forth in this Section are not intended to be complete or meant to alter or amend any provision of the actual OCIP Policies. The OCIP coverages and exclusions are set forth in full in their respective policy forms. In the event of a conflict or omission between the coverages described in the OCIP Policies and the coverages summarized or described in the OCIP Manual,

this Section or elsewhere in the Contract Documents, the coverages and coverage amounts set forth in the actual OCIP Policies issued by the OCIP Insurers shall control. In the event of a conflict between the provisions of this Section and the OCIP Manual that does not involve any conflict with the provisions of the actual OCIP Policies issued by the OCIP Insurers, then the provisions of this Section shall govern.

3.0 Summary of Insurance Coverage

3.1 **Insurance Provided by the City**. Unless otherwise provided herein, prior to commencement of the Work, City, at its sole option and expense, shall secure and maintain at all times during the performance of this Contract the insurance specified below, insuring the City, Contractor, its Subcontractors and such other persons or interests as City may designate with limits not less than those specified below for each coverage.

Workers' Compensation & Employer's Liability:

Coverage: Statutory limits required by the Workers' Compensation Laws of the State of Colorado:

Part One:	Workers' Compensation:	Statutory Limits
Part Two:	Employer's Liability:	
	Bodily Injury by Accident:	$2,000,000 each accident
	Bodily Injury by Disease:	$2,000,000 each employee
	Bodily Injury by Disease:	$2,000,000 policy limit

General Liability (excluding Automobile Liability and Professional Liability)**:**

Coverage: Third party personal injury, bodily injury and property damage liability

Limits of Liability:

Each Occurrence Limit	$ 2,000,000
General Aggregate	$ 4,000,000
Products/Completed Operations Aggregate	$ 4,000,000
Personal/Advertising Injury Aggregate	$ 2,000,000

Above limits are shared for all Roadway Projects/Contracts.

Excess/Umbrella Liability Insurance (limits noted are minimum limits. The City may elect to provide higher limits, based on the size of the Project):

Coverage: Written on a following form basis over the primary policies.

Minimum Limits of Liability:

Each Occurrence	$50,000,000 or more

General Aggregate	$50,000,000 or more
Products/Completed Operations Aggregate	$50,000,000 or more

Products/Completed Operations coverage will extend to the statute of limitations.

Excess Limits above the first $50,000,000 may apply to all Projects placed under the City's OCIP. .

General Liability Insurance Claim Chargeback. A claims charge-back will be assessed for the amount of any loss payable under the OCIP Commercial General Liability Policy. The Enrolled Party primarily responsible for causing any bodily injury or property damage liability loss shall be responsible for payment of the charge-back. The charge-back will be calculated on the following sliding scale:

For each Contract Per Occurrence:
$1,000 for Enrolled Party with contracts up to $100,000
$5,000 for Enrolled Party with contracts between $100,001 and $250,000
$10,000 for Enrolled Party with contracts between $250,001 and $500,000
$25,000 for Enrolled Party with contracts over $500,000

Contractors Pollution Liability Insurance (limits noted are minimum limits. The City may elect to provide higher limits, based on the size of the Project):

Unless other provided, the City shall purchase Contractors Pollution Liability arising from claims for pollution incidents arising from Work or services performed under contract at or from the designed Project Site.

Coverage: Liability or responsibility for unexpected and unintended pollution conditions resulting in bodily injury, property damage or environmental damage from pollution conditions caused by covered operations including completed operations. Coverage includes microbial matter and legionella pneumophila in any structure on land and the atmosphere contained with the structure.

Limits of Liability:

Each Loss:	$10,000,000 or more
Policy Aggregate:	$10,000,000 or more

Products/Completed Operations coverage may extend for a minimum of eight (8) years after final completion of the Project.

Contractors Pollution Insurance Claims Chargeback. A claims charge-back will be assessed for the amount of any loss payable under the Contractors Pollution. Up to the first $5,000 of any loss will be paid by Contractor. This includes all expenses or claim payments incurred by the OCIP Insurer for losses attributable to the Contractor's work, acts or omissions, or the work, acts or omissions of any tier of

subcontractor. Contractor may elect to pass this charge through to any responsible subcontractor but in no event may require total subcontractor reimbursement in excess of $5,000.

Builder's Risk Insurance (if required)

Unless otherwise provided, the City shall purchase and maintain, builder's risk (and/or Installation Floater) in the amount of the initial Contract Sum, plus value of subsequent Contract modifications and cost of materials supplied or installed by others, comprising total value for the entire Project at the site on a replacement cost basis (as defined in the builders' risk policy). Such builders risk insurance shall end when the first of the following occurs: 1) the City's interest in the Work ceases; 2) the policy expires or is cancelled; or 3) the Work is accepted by the City.

Builders' risk insurance shall be on an "all-risk" or equivalent policy form and shall include, without limitation, insurance against the perils of fire (with extended coverage) and physical loss of damage including , theft, vandalism, malicious mischief, terrorism, rigging and hoisting for materials and equipment that are part of the Project, collapse, earthquake, flood, windstorm, falsework, testing and startup (as provided by the policy), temporary buildings and debris removal including demolition occasioned by enforcement of any applicable ordinance laws, and shall cover reasonable compensation for services and expenses required as a result of such insured loss.

This builder's risk insurance shall cover portion of the Work stored off site, and also portions of the Work in transit.

The City and Contractor shall waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents and employees, each of the other, and (2) the Architect, Architect's consultants, separate contractors, if any, and any of their subcontractors, sub-subcontractors, agents and employees, for damages caused by fire or other causes of loss to the extent covered by builders risk insurance obtained pursuant to this section or other property insurance applicable to the Work, except such rights as they have to proceeds of such insurance held by the City as fiduciary. The City or Contractor, as appropriate, shall require of the Architect, Architect's consultants, separate contractors, and they subcontractors, sub-subcontractors, agents and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, and whether or not the person or entity had an insurable interest in the property damaged.

Builder's Risk Insurance Claims Chargeback. A claims charge-back will be assessed for the amount of any loss payable under the Builder's Risk Policy. Up to

the first $5,000 of any loss will be paid by Contractor. This includes all expenses or claim payments incurred by the OCIP Insurer for losses attributable to the Contractor's work, acts or omissions, or the work, acts or omissions of any tier of subcontractor. Contractor may elect to pass this charge through to any responsible subcontractor but in no event may require total subcontractor reimbursement in excess of $5,000.

3.2 **Insurance provided by Enrolled Parties**. At their own expense, the Enrolled Parties of all tiers must carry the following minimum coverage and limits:

Commercial Automobile Liability Insurance for contract work both occurring on-site and off-site with limits of liability not less than:

$2,000,000 Combined Single Limit

This insurance must apply to all owned, leased, non-owned or hired vehicles to be used in the performance of work. Such insurance shall allow contractor to waive subrogation against the City and/or its representatives and all Contractors and Subcontractors prior to loss or shall include a waiver of the insurer's right of subrogation. Contractor hereby waives rights of subrogation against City and/or its representatives and all Contractors and Subcontractors. **If operations include unescorted airside access at DIA, then a $9 million Umbrella Limit is required.**

Off-Site Workers' Compensation Insurance, including Employer's Liability with minimum limits of

$1,000,000 Bodily Injury with Accident – Each Accident
$1,000,000 Bodily Injury with Disease – Policy Limit
$1,000,000 Bodily Injury with Disease – Each Employee

Coverage to protect Contractor/Subcontractor from and against all claims arising from performance of Work outside the Project Site under the Contract. Such insurance (where permissible by law) shall waive subrogation against the City and/or its representatives and all Contractors and Subcontractors

Off-Site Commercial General Liability Insurance for Contract operations not physically occurring within the Project Site with a limit of liability not less than:

Primary Insurance

$1,000,000 Each Occurrence
$1,000,000 Personal Injury and Advertising Injury
$2,000,000 General Aggregate
$2,000,000 Products/Completed Operations Aggregate

Such policy shall include coverage for contractual liability assumed under the Contract, contractors' protective liability, and explosion, collapse and underground property damage hazards. The Policy Form should be CG 00 01 or equivalent. Contractor and Subcontractors of all tiers will be required to provide additional Insured status to the City for general liability policies in the name of:

> CITY AND COUNTY OF DENVER AND THE DEPARTMENT AVIATION, AND MEMBERS OF THE BOARD OF SUPERVISORS OF THE CITY AND COUNTY OF DENVER AND THE DEPARTMENT OF AVIATION, AND THE OFFICERS, AGENTS AND EMPLOYEES OF THE CITY AND COUNTY OF DENVER AND THE DEPARTMENT OF AVIATION, INDIVIDUALLY AND COLLECTIVELY, AS ADDITIONAL INSUREDS

The additional Insured status shall provide coverage for the Premises/Operations and Products/Completed Operations exposures and shall indicate that such coverage is primary to any insurance carried by the City.

3.2.1 **Insurance provided by Enrolled Parties for Special Situations**. The Contractor or Subcontractor of any tier, at its own expense, shall provide and maintain the following insurance of the type and in limits as set forth by City risk management should construction operations warrant such coverage.

Aircraft/Aviation Liability. Should aircraft of any kind be used by the Contractor, or by anyone else on its behalf, the Contractor shall contact City risk management to ensure the appropriate aircraft/aviation liability is in place. All limits, coverages, and endorsements will be set and enforced by City risk management.

3.3 **Insurance Requirements for Excluded Parties.** Contractor and each Subcontractor and its lower-tier subcontractors shall require all Excluded Parties, as defined herein, to provide and maintain insurance of the type and in limits as set forth in the Contractor Subcontract Agreement. The OCIP, OCIP Policies, and OCIP Coverage shall not apply to Excluded Parties, even if erroneously enrolled in the OCIP. Excluded Parties and parties no longer enrolled or covered by the OCIP or erroneously enrolled in the OCIP shall obtain and maintain, and require by contract that each of their lower-tier Subcontractors obtain and maintain at a minimum, the insurance coverage required by Section 3.2 above, and as required by the OCIP Manual.

4.0 Contractor Warranties and Agreements

4.1 **Accuracy of Contractor-provided Information**. Contractor warrants that all information submitted to the City or the OCIP Administrator is accurate and complete to the best of its knowledge. Contractor will notify the City or Administrator immediately in writing of any errors discovered during the performance of the work.

4.2 **Contractor Responsible To Review Coverage**. Contractor acknowledges that all references to OCIP policy terms, conditions, and limits of liability in this document, as well as the OCIP Manual, are for reference only. Contractor and its subcontractors are responsible for conducting their own independent review and analysis of the OCIP coverage in formulating any opinion or belief as to the applicability to such coverage in the event of any loss or potential claim. Any type of insurance or increase of limits not described above which the Contractor requires for its own protection or on account of statute shall be its own responsibility and at its own expense.

4.3 **Audit**. Contractor agrees to make its records available for review and to cooperate with the insurers, the City, the Auditor of the City, and the representatives of the aforesaid parties in the event of an audit. In the event that a City audit of Contractor's records, as permitted in the Contract or other OCIP documents, reveals a discrepancy in the insurance, payroll, safety, or any other information required to be provided to City or OCIP Administrator, or reveals inclusion of costs for OCIP coverage in any payment for the work, City will have the right to deduct from payments due Contractor all such insurance costs as well as all audit costs.

4.4 **Insurance Costs Removed**. Contractor warrants that the Costs for insurance as provided under the OCIP were not included in Contractor's bid or proposal for the Work, the Contract Price/Contract Sum, and will not be included in any change order or any request for payment for the Work or extra work.

5.0 Contractor Obligations

5.1 **OCIP Documents shall be provided to Subcontractors**. Contractor shall furnish each bidding Subcontractor, vendor, supplier, material dealer or other party a copy of this OCIP Exhibit and the OCIP Manual and shall incorporate the terms of this Exhibit in all contracts and agreements entered into for performance of any portion of the Work.

5.2 **Timely Enrollment Required**. Contractor shall enroll in the OCIP within five (5) days request by City or its OCIP Administrator. Contractor shall notify each Subcontractor of the procedure for enrolling in City's OCIP and confirm that enrollment is mandatory but not automatic. Contractor shall assure that Subcontractor and its lower-tier subcontractors shall not commence work until verification of enrollment is confirmed by the OCIP Administrator by the issuance of a Certificate of Insurance.

5.3 **Compliance with Conditions**. Contractor shall not violate any condition of the policies of insurance provided by City under the terms of this OCIP Exhibit or the OCIP Manual. All requirements imposed by the subject policies and to be performed by Contractor shall likewise be imposed on, assumed, and performed by each Subcontractor and their lower-tier subcontractors.

5.4 **Claims Cooperation**. Contractor shall participate in the claim reporting procedures

of City's OCIP. Contractor agrees to assist and cooperate in every manner possible in connection with the adjustment of all claims arising out of operations within the scope of the Work required by the Contract, and to cooperate with the Insurer in all claims and demands which City's Insurer(s) is called upon to adjust or to defend against. Contractor shall take all necessary action to assure that its Subcontractors and their lower-tier subcontractors comply with any such request for assistance and cooperation. This obligation includes, without limitation, providing light or modified duty for injured workers, appearing in mediation, arbitration or court proceedings and/or participating in settlement meetings, as may be required

5.5 **Monthly Payroll Submission**. All Enrolled Parties shall submit monthly payrolls and worker-hour reports to City or OCIP Administrator on the form required in the OCIP manual. This reporting form will be provided to all Contractors at time of enrollment into the OCIP. Failure to submit these reports may result in funds being held or delayed from monthly progress payments. The form must be submitted for each month, including zero (0) payroll, if applicable, until completion of the Work under each Contract and Subcontract. For those Subcontractors and lower-tier subcontractors performing Work under multiple Subcontracts, a separate form is required for each Subcontract under which Work is being performed.

5.6 **Response to Information Requests**. All insurance underwriting, payroll, rating or loss history information requested by City or the OCIP Administrator shall be provided by the Contractor within three (3) business days of the request. Contractor agrees (and will require each Subcontractor to agree) that City, City's insurer or City's representative may audit the Contractor's or Subcontractor's records and the records of lower-tier subcontractors to confirm the accuracy of all insurance information provided, including, without limitation, any such information that may have any effect on insurance resulting from changes in the Work. At all times during performance of the Contract and Subcontracts, the Contractor, Subcontractor and lower-tier subcontractors shall cooperate with City, OCIP Administrator and OCIP insurers.

5.7 **Responsibility for Safety**. Notwithstanding the OCIP, the Contractor shall initiate, maintain and supervise all safety precautions and programs in connection with the Work. Contractor is solely responsible, at no adjustment to the contract sum payable or contract time, for initiating, maintaining, and supervising all safety precautions and programs relating to the conduct of Work, including, without limitation, any safety programs or procedures that are required by any applicable state or federal laws, rules or regulations, or by the terms of the OCIP Manual.

5.8 **Duty of Care**. Nothing herein shall relieve the Enrolled Parties of their respective obligations to exercise due care in the performance of their duties in connection with the Work or to complete the Work in strict compliance with this Contract and subsequent subcontracts.

6.0 Notices, Costs

6.1 **Limitations on City Provided Coverage**. City assumes no obligations to provide insurance other than that evidenced by the policies referred to in Paragraph 3.1 and subparagraphs. City, however, reserves the right to furnish insurance coverage of various types and limits provided that such coverage shall not be less than that specified in Paragraph 3.1 and the costs of such insurance shall be paid by City. The OCIP also does not cover Workers' Compensation claims or Commercial General Liability claims arising from "Off-Site Work."

6.2 **Contractors Responsible for Own Equipment**. Contractors' Equipment insurance for all construction tools and equipment whether owned, leased, rented, borrowed or used on work at the Project Site is the responsibility of the Contractor and/or Subcontractor, and the City shall not be responsible for any loss or damage to tools and equipment. This Contractors' Equipment insurance shall contain a waiver of subrogation against City and/or its representatives and all approved Contractors and Subcontractors. If an individual Enrolled Party does not purchase such insurance, that Enrolled Party will hold harmless City and/or its representatives and other Enrolled Parties for damage to tools and equipment.

6.3 **No Release; No Waiver of Immunity**. The provision of the OCIP shall in no way be interpreted as relieving CM or any Subcontractor of any responsibility or liability under the Contract Documents, the OCIP Policies, or Applicable Laws, including, without limitation, Contractor's and Subcontractor's responsibilities relative to indemnification and their obligation to exercise due care in the performance of the Work and to complete the Work in strict compliance with the Contract Documents. The parties hereto understand and agree that the City, its officers, officials and employees, are relying on, and do not waive or intend to waive by any provisions of this agreement, the monetary limitations or any other rights, immunities and protections provided by the Colorado Governmental Immunity Act, §§ 24-10-101 to 120, C.R.S., or otherwise available to the City, its officers, officials and employees.

6.4 **City Right to Withhold Payments**. In addition to any other rights of withholding that City may have under the Contract Documents, City has the right to withhold any payments otherwise due to Contractor in the event of a failure by Contractor or any Subcontractor to comply with the requirements of this Exhibit or the OCIP Manual. City may withhold from any payment owing to Contractor the Costs of OCIP Coverage if included in a request for payment. Such withholding by City shall not be deemed to be a default under the Construction Contract. City shall withhold from Contractor the Costs of OCIP Coverage attributable to an increase in an Enrolled Party's total payroll for the Work over the amount reported to City and OCIP Administrator at time of enrollment in the OCIP.

6.5 **City Remedies**. Without limitation upon any of City's other rights or remedies, any failure of an Enrolled Party to comply with any provision of this Exhibit or the OCIP Manual shall be deemed a material breach of the Construction Contract, thereby

entitling City, at its option, upon notice to Contractor, to suspend performance by Contractor, without any adjustment to Contract Sum Payable or Contract Time, until there is full compliance, or (2) or terminate this Construction Contract for cause.

6.6 **Off-Site Storage**. Unless otherwise provided in the Contract Documents, the property insurance provided by the City shall not cover portions of the Work stored off the Site without written approval of the City. Contractor shall be responsible for reporting such property or work if ownership has been transferred to the City. If ownership rests with the Contractor, Contractor shall be responsible for obtaining insurance to protect its interests.

6.7 **Partial Occupancy**. Partial occupancy or use shall not commence until the insurance company or companies providing builders risk and/or property insurance have consented to such partial occupancy or use by endorsement or otherwise. The City and the Contractor shall take reasonable steps to obtain consent of the insurance company or companies and shall, without mutual written consent, take no action with respect to partial occupancy or use that would cause cancellation, lapse or reduction of insurance.

6.8 **City Right to Exclude Parties from OCIP**. City reserves the right to exclude any Subcontractor from the OCIP, before or after enrollment by the Subcontractor into the OCIP. If City elects to exclude a Subcontractor from the OCIP, the Contractor will be responsible for ensuring the insurance coverage outlined in the Contractor's Subcontract Agreement are provided to the City or OCIP Administrator before the Subcontractor can begin or resume work on the Project.

6.9 **City's Right to Modify or Discontinue OCIP Coverages**. The City may, for any reason, modify the OCIP Coverages, discontinue the OCIP, not bind the OCIP Coverages, or request that Contractor or any Subcontractor withdraw from the OCIP upon thirty (30) Days' written notice. The Contractor and the Subcontractors shall in such an event secure and maintain such insurance as is required to provide replacement coverage comparable to that provided under the OCIP. Provided that the foregoing is not the result of any failure by the Contractor or any Subcontractor to comply with the requirements of the Contract Documents or OCIP Reference Guide, the costs of such replacement insurance shall be deemed a Cost of Work for which the Contractor shall be entitled to a Contract Adjustment, without any sum added thereto for Allowable Markup. The form, content, limits of liability, cost and the rating of the insurer issuing such replacement insurance shall be subject to the City's prior written approval.

6.10 **City Right to Purchase Other Coverages**. The City reserves the right at its option, and without obligation to do so, to furnish other insurance coverage of various types and limits if such coverage is not less than that specified in the Contract Documents to be provided by the City. Apart from the OCIP Coverages, the City may at its option purchase additional insurance coverages that insure the Project that may not necessarily insure the Contractor or the Subcontractors. Without limitation, examples

of such coverage may include pollution liability, excess professional liability, and excess automobile liability insurance.

DENVER INTERNATIONAL AIRPORT
PARTIAL RELEASE

DEPARTMENT OF AVIATION

FINAL/PARTIAL RELEASE AND CERTIFICATE OF PAYMENT
(SUBCONTRACTOR/SUPPLIER)

201310046, CENTRAL UTILITY PLANT CHILLER ADDITION	Date: , 20 .
(NAME OF CONTRACTOR)	Subcontract #: .
	Subcontract Value: $.
(NAME OF SUBCONTRACTOR/SUPPLIER)	Last Progress Payment: $. Date: .
Check Applicable Box: [ ] DBE [ ] MBE/WBE	Total Paid to Date: $. Date of Last Work: .

The Undersigned hereby certifies that all costs, charges or expenses incurred by the undersigned or on behalf of the undersigned for any work, labor or services performed and for any materials, supplies or equipment provided on the above referenced Project or used in connection with the above referenced Subcontract (the "Work Effort") have been duly paid in full.

The Undersigned further certifies that each of the undersigned's subcontractors and suppliers that incurred or caused to be incurred, on their behalf, costs, charges or expenses in connection with the undersigned's Work Effort on the above referenced Project have been duly paid in full.

In consideration of $_____ representing the Last Progress Payment referenced above and in further consideration of the Total Paid to Date, also referenced above, and other good and valuable consideration received and accepted by the undersigned this _____ day of _____, 20___, the Undersigned hereby releases and discharges the City and County of Denver (the "City"), the above referenced City Project, the City's premises and property and the above referenced Contractor from all claims, liens, rights, liabilities, demands and obligations, whether known or unknown, of every nature arising out of or in connection with the performance of the work effort.

As additional consideration for the payments referenced above, the undersigned agrees to defend, indemnify and hold harmless the City, its officers, employees, agents and assigns and the above-referenced Contractor from and against all costs, losses, damages, causes of action, judgments under the subcontract and expenses arising out of or in connection with any claim or claims against the City or the Contractor which arise out of the Undersigned's performance of the Work Effort and which may be asserted by the Undersigned or any of its suppliers or subcontractors of any tier or any of their representatives, officers, agents, or employees.

It is acknowledged that this release is for the benefit of and may be relied upon by the City and the referenced Contractor.

The foregoing shall not relieve the undersigned of any obligation under the provisions of the Undersigned's subcontract, as the subcontract may have been amended, which by their nature survive completion of the Undersigned's work effort including, without limitation, warranties, guarantees, insurance requirements and indemnities.

STATE OF COLORADO) ss. CITY OF _____)	_____ (Name of Subcontractor)
Signed and sworn before me this day of , 20 .	By:
. Notary Public/Commissioner of Oaths My Commission Expires	Title:

CITY AND COUNTY OF DENVER
RULES AND REGULATIONS AND BID CONDITIONS
OF THE
MANAGER OF PUBLIC WORKS

PERTAINING TO EQUAL EMPLOYMENT OPPORTUNITY
IN THE CITY AND COUNTY OF DENVER

APPROVED FOR LEGALITY	APPROVED AND ADOPTED:
/s/	/s/
Attorney for the City and County of Denver	Manager of Public Works

Adopted and Published Pursuant to Article III, Division 2 of Chapter 28
of the
Revised Municipal Code
of the
City and County of Denver

These Rules and Regulations cancel
and supersede any and all previously
issued Rules and Regulations on the Subject.

Revised November 1, 1990

RULES AND REGULATIONS
REGARDING
EQUAL EMPLOYMENT OPPORTUNITY

Promulgated and adopted by the Manager of Public Works pursuant to and by authority of Article III, Division 2, Chapter 28 of the Revised Municipal Code of the City and County of Denver, and for the purpose of insuring that contractors, subcontractors and suppliers soliciting and receiving compensation for contract work from or through the City and County of Denver provide equal opportunity in employment without regard to race, color, creed, sex, national origin, age religion, material status, political opinion or affiliation or mental or physical handicap and meet certain requirements for the hiring, training, promotion, and treatment during employment of members of ethnic groups subject to differential treatment, including persons of African descent (Black), Spanish-surnamed (Hispanic), Asian-American and American Indian Groups.

RULE I – DEFINITIONS

A. "City" means the City and County of Denver.

B. "Manager" means the Manager of Public Works for the City and County of Denver.

C. "Contract" means a contract entered into with the City and County of Denver, financed in whole or in part by local resources or funds of the City and County of Denver, for the construction of any of any public building or prosecution or completion of any public work.

D. "Contractor" means the original party to a contract with the City and County of Denver, also referred to as the "general" or "prime" contractor.

E. "Director" means the Director of Contract Compliance.

F. "Subcontractor" means any person, company, association, partnership, corporation, or other entity which assumes by subordinate agreement some or all of the obligations of the general or prime contractor.

G. "Bidding Specifications" as used in Article III, Division 2 of Chapter 28 of the Revised Municipal Code shall include BID CONDITIONS, INVITATION To BID, and NOTICE OF PROPOSAL.

H. "Affirmative Action Program" means a set of specific and result-oriented procedures or steps to which a contractor commits himself to apply every good faith effort to employ members of ethnic minority groups, to include persons of African descent (Black), Spanish surnamed (Hispanic), Asian-American, American Indians, and persons with mental or physical handicap.

I. "Office of Contract Compliance" means the City agency established pursuant to Article

III, Division 1 of Chapter 28 of the Denver Revised Municipal Code.

RULE II – NOTICE OF HEARING

When results of conciliation efforts are unsatisfactory to the Manager and he is informed in accordance with Article III, Division 2 of Chapter 28 of the Denver Revised Municipal code that a contractor or subcontractor has apparently failed to meet affirmative action and equal employment opportunity requirements after a reasonable period of notice to correct deficiencies, the Manager will, prior to imposition of any sanctions, afford the general contractor a hearing in order to determine whether the contractor or his subcontractors have failed to comply with the affirmative action and equal employment opportunity requirements of Article III, Division 2 of Chapter 28 of the Denver Revised Municipal Code or of the contract. Written notice of such hearing shall be delivered personally or sent by certified mail, return receipt requested, to the contractor and to any subcontractor involved, at least ten (10) days prior to the date scheduled for the hearing.

RULE III – HEARING

A. Contractors will appear at hearings and may be represented by counsel, and may present testimony orally and other evidence.

B. Hearings shall be conducted by one or more hearing examiners designated as such by the Manager.

C. The Director of Contract Compliance may participate in hearings as a witness.

D. Hearings shall be held at the place specified in the notice of hearing.

E. All oral testimony shall be given under oath or affirmation and a record of such proceedings shall be made.

F. All hearings shall be open to the public.

G. The hearing officer shall make recommendations to the Manager, who shall make a final decision.

REGULATIONS

REGULATION NO. 1 - ORDINANCE

The Rules and Regulations of the Manager shall be inserted in the bidding specifications for every contract for which bidding is required.

REGULATION NO. 2 - EXEMPTIONS

Each contract and subcontract, regardless of the dollar amount, shall be subject to affirmative action requirements unless specifically exempted in writing individually by the Manager. Exemptions apply only to "affirmative action" in equal employment opportunity, and are not to be construed as condonation in any manner of "discrimination" or "discriminatory practices" in employment because of race, color, creed, sex, age, national origin, religion, marital status, political opinion or mental or physical handicap.

REGULATION NO. 3 - DIRECTOR OF CONTRACT COMPLIANCE

The Director of Contract Compliance shall perform the duties assigned to such official by Article III, Division 2 Chapter 28 of the Denver Revised Municipal Code and by the Manager. The Director of Contract Compliance or designated representatives shall inform bidders and contractors of affirmative action procedures, programs, and goals in accordance with the Ordinance at pre-bid and pre-construction conference; (2) make regular on-site inspections; (3) supply contractors and subcontractors with report forms to be completed by them when requested, and furnished to the Director of Contract Compliance; and (4) review payroll records, employment records and practices of general contractors and their subcontractors and suppliers during the performance of any contract. The Director of Contract Compliance shall promptly report apparent affirmative action deficiencies to the Manager.

REGULATION NO. 4 - GOALS AND TIMETABLES

In general, goals and timetables should take into account anticipated vacancies and the availability of skills in the market place from which employees should be drawn. In addition, where discrimination in employment by a general contractor or any of his subcontractors is indicated, a corrective action program will take into account the need by the general contractor and his subcontractors to correct past discriminatory practices and reach goals of minority manpower utilization on a timely basis through such recruiting and advertising efforts as are necessary and appropriate.

REGULATION NO. 5 - AWARD OF CONTRACTS.

It shall be the responsibility of the Director of Contract Compliance to determine the affirmative action capability of bidders, contractors and subcontractors and to recommend to the Manager the award of contracts to those bidders, contractors and subcontractors and suppliers who demonstrate the ability and willingness to comply with the terms of their contract.

REGULATION NO. 6 - PUBLICATION AND DUPLICATION.

Copies of these Rules and Regulations as amended by the Manager from time to time, shall as soon as practicable and after Notice being published will be made a part of all

City Contracts.

REGULATION NO. 7 - NOTICE TO PROCEED.

Prior to issuance of the Notice to Proceed, a sign-off will be required of the Director of Contract Compliance or his designee.

REGULATION NO. 8 - CONTRACTS WITH SUBCONTRACTORS.

To the greatest extent possible, the contractor shall make a good faith effort to contract with minority contractors, subcontractors and suppliers for services and supplies by taking affirmative actions which include but are not limited to the following:

1. Advertise invitations for subcontractor bids in minority community news media.

2. Contact minority contractor organizations for referral of prospective subcontractors.

3. Purchase materials and supplies from minority material suppliers.

REGULATION NO. 9 - AGENCY REFERRALS.

It shall be no excuse that the union with which the contractor or subcontractor has an agreement providing for referral, exclusive or otherwise, failed to refer minority employees.

REGULATION NO. 10 - CLAUSES.

The Manager shall include the appropriate clauses in every contract, and the contractor shall cause to be inserted in every subcontract the appropriate clauses:

1. APPENDIX A: City and County of Denver Equal Opportunity Clause - ALL CONTRACTS funded only with City and County of Denver monies.

2. APPENDIX B: Equal Opportunity Clause (11246) - ALL FEDERAL ASSISTED.

3. APPENDIX C: Section 3 - Assurance of Compliance - HUD ASSISTED PROJECTS.

4. APPENDIX D: Section 3 - Clause - HUD ASSISTED PROJECTS.

REGULATION NO. 11 - SHOW CAUSE NOTICES.

When the Manager has reasonable cause to believe that a contractor has violated

Article III, Division 2 of Chapter 28 of the Denver Revised Municipal Code, he may issue a notice requiring the contractor to show cause within 15 days why enforcement procedures, or other appropriate action to insure compliance, should not be instituted.

REGULATION NO. 12 - BID CONDITIONS - AFFIRMATIVE ACTION REQUIREMENTS - EQUAL EMPLOYMENT OPPORTUNITY.

1. APPENDIX E: The Bid Conditions - Affirmative Action Requirements - Equal Employment Opportunity as amended and published by the U.S. Department of Labor Employment Standards Administration, Office of Federal Contract Compliance, shall be inserted verbatim for bidding specification in every non-exempt contract involving the use of federal funds.

2. APPENDIX F: The Bid Conditions - Affirmative Action Requirements - Equal Employment Opportunity as published by the Department of Public Works, City and County of Denver, shall be inserted verbatim as bidding specifications for every non-exempt contract using City funds.

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
DESIGN AND CONSTRUCTION MANAGEMENT DIVISION

APPENDIX A
CITY AND COUNTY OF DENVER EQUAL OPPORTUNITY CLAUSE
ALL CONTRACTS

1. The Contractor will not discriminate against any employee or applicant for employment because of race, creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

2. The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap.

3. The Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided, advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

4. Each Contractor will comply with all provisions of Article, Division 2 of Chapter 28 of the Denver Revised Municipal Code, and the rules, regulations, and relevant orders of the Manager of Public Works and the Director of the Division of Small Business Opportunity.

5. The Contractor will furnish all information and reports required by Article m, Division 2 of Chapter 28 of the Denver Revised Municipal Code, and by rules, regulations and orders of the Manager and Director or pursuant thereto, and will permit access to the Contractors books, records, and accounts by the Manager, Director, or their designee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

6. In the event of the Contractor's noncompliance with the nondiscrimination clauses of this

contract or with any of the said rules, regulations or orders, this contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further City contracts in accordance with procedures authorized in Article m, Division 2 of Chapter 28 of the Denver Revised Municipal Code, or by rules, regulations, or order of the Manager of Public Works.

7. The Contractor will include Regulation 12, Paragraph 2 and the provisions of paragraphs (1) through (6) in every subcontract of purchase order unless exempted by rules, regulations, or orders of the Manager issued pursuant to Article III, Division 2 of Chapter 28 of the Denver Revised Municipal Code, so that such provisions will take such action with respect to any subcontractor or supplies. The Contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance.

The applicant further agrees to be bound by the above equal opportunity clauses with respect to its own employment practices when it participates in City contracts. The Contractor agrees to assist and cooperate actively with the Manager of Public Works and the Director of Contract Compliance in obtaining compliance of subcontractors and suppliers with the equal opportunity clause and the rules, regulations and relevant orders of the Manager of Public Works, and will furnish the Manager of Public Works and the Director of Contract Compliance such information as they may require for the supervision of compliance, and will otherwise assist the Manager and Director in the discharge of the City's primary responsibility for securing compliance. The Contractor further agrees to refrain from entering into any contract or contract modification subject to Article III, Division 2 of Chapter 28 of the Denver Revised Municipal Code with a contractor debarred from, or who has not demonstrated eligibility for, City contracts.

The Contractor will carry out such sanctions and penalties for violation of the equal opportunity clause as may be imposed upon contractors and subcontractors by the Manager of Public Works and Director of Contract Compliance. In addition, the Contractor agrees that failure or refusal to comply with these undertakings the Manager of Public Works may take any or all of the following actions:

A. Cancellation, termination, or suspension in whole or in part of this contract.

B. Refrain from extending any further assistance to the applicant under the program with respect to which the failure occurred until satisfactory assurance of future compliance has been received from such applicant.

C. Refer the case to the City Attorney for appropriate legal proceedings.

SUBCONTRACTS - Each prime Contractor or Subcontractor shall include the equal opportunity clause in each of its subcontracts.

APPENDIX F:
AFFIRMATIVE ACTION REQUIREMENTS
EQUAL EMPLOYMENT OPPORTUNITY

For all Non-Exempt Construction Contracts to be awarded by the City and County of Denver, Department of Public Works

NOTICE

EACH BIDDER, CONTRACTOR OR SUBCONTRACTOR (HEREINAFTER THE CONTRACTOR) MUST FULLY COMPLY WITH THE REQUIREMENTS OF THESE BID CONDITIONS AS TO EACH CONSTRUCTION TRADE IT INTENDS TO USE ON THIS CONSTRUCTION CONTRACT, AND ALL OTHER CONSTRUCTION WORK (BOTH CITY AND NON-CITY) IN THE DENVER AREA DURING THE PERFORMANCE OF THIS CONTRACT OR SUBCONTRACT. THE CONTRACTOR COMMITS ITSELF TO THE GOALS FOR MINORITY MANPOWER UTILIZATION, AS APPLICABLE, AND ALL OTHER REQUIREMENTS, TERMS AND CONDITION OF THESE BID CONDITIONS BY SUBMITTING A PROPERLY SIGNED BID. THE CONTRACTOR SHALL APPOINT A COMPANY EXECUTIVE TO ASSUME THE RESPONSIBILITY FOR THE IMPLEMENTATION OF THE REQUIREMENTS, TERMS AND CONDITIONS OF THESE BID CONDITIONS.

Manager of Public Works
City and County of Denver

A. REQUIREMENTS - AN AFFIRMATIVE ACTION PLAN:

Contractors shall be subject to the provisions and requirements of these bid conditions including the goals and timetables for minority* and female utilization, and specific affirmative action steps set forth by the Division of Small Business Opportunity. The contractor's commitment to the goals for minority, and female utilization as required constitutes a commitment that it will make every good faith effort to meet such goals.

1. GOALS AND TIMETABLES:

The goals and timetables for minority and female participation, expressed in percentage terms for the contractor's aggregate workforce in each trade are as follows:

GOALS FOR MINORITY PARTICIPATION FOR EACH TRADE	GOALS FOR FEMALE PARTICIPATION FOR EACH TRADE
From January 1, 1982 to Until Further Notice	From January 1, 1982 to Until Further Notice
21.7% - 23.5%	6.9%

The goals for minority and female utilization above are expressed in terms of hours of training and employment as a proportion of the total number of hours to be worked by the contractor's aggregate workforce, which includes all supervisory personnel, in each trade, on all projects for the City and County of Denver during the performance of its contract (i.e., The period beginning with the first day of work on the City and County of Denver funded construction contract and ending with the last day of work).

The hours of minority and female employment and training must be substantially uniform throughout the length of the contract in each trade and minorities and females must be employed evenly on each of a contractor's projects. Therefore, the transfer of minority or female employees from contractor to contractor or from project to project for the purpose of meeting the contractor's goals shall be a violation of these Bid Conditions.

If the Contractor counts the nonworking hours of apprentices they must be employed by the Contractor during the training period; the Contractor must have made a commitment to employ apprentices at the completion of their training subject to the availability of employment opportunities; and the apprentices must be trained pursuant to training programs approved by the Bureau of Apprenticeship and Training.

* “Minority” is defined as including, Blacks, Spanish Surname Americans, Asian Americans, and American Indians, and includes both minority men and women.

2. SPECIFIC AFFIRMATIVE ACTION STEPS:

If contractor shall be found to be in noncompliance solely on account of its failure to meet its goals, but will be given an opportunity to demonstrate that the contractor has instituted all the specific affirmative action steps specified and has made every good faith effort to make these steps work toward the attainment of its goals within the timetables, all to the purpose of expanding minority and female utilization in its aggregate workforce A contractor, who fails to comply with its obligation under the Equal Opportunity Clause of its contract and fails to achieve its commitments to the goals for minority and female utilization has the burden of proving that it has engaged in an Affirmative Action Program directed at increasing minority and female utilization and that such efforts were at least as extensive and as specific as the following:

a. The Contractor should have notified minority and female organizations when employment opportunities were available and should have maintained records of the organization's response.

b. The Contractor should have maintained a file of the names and addresses of each minority and female referred to it by any individual or organization and what action was taken with respect to each such referred individual, and if the individual was not employed by the Contractor, the reasons. If such individual was sent to the union hiring hall for referral and not referred back by the union or if referred, not employed by the Contractor, the file should have documented this and their reasons.

c. The Contractor should have promptly notified the Department of Public Works, and the Division of Small Business Opportunity when the union or unions with which the Contractor has collective bargaining agreements did not refer to the contractor a minority or female sent by the contractor, or when the Contractor has other information that the union referral process has impeded efforts to meet its goals.

d. The Contractor should have disseminated its EEO policy within its organization by including it in any employee handbook or policy manual; by publicizing it in company newspapers and annual reports and by advertising such policy as reasonable intervals in union publications. The EEO policy should be further disseminated by conducting staff meetings to explain and discuss the policy; by posting of the policy; and by review of the policy with minority and female employees.

e. The Contractor should have disseminated its EEO policy externally by informing and discussing it with all recruitment sources; by advertising in news media, specifically including minority and female news media; and by notifying and discussing it with all subcontractors.

f. The Contractor should have made both specific and reasonably recurrent written and oral recruitment efforts. Such efforts should have been directed at minority and female organizations, schools with substantial minority and female enrollment, and minority and female recruitment and training organizations within the Contractor's recruitment area.

g. The Contractor should have evidence available for inspection that all tests and other

selection techniques used to select from among candidates for hire, transfer, promotion, training, or retention are being used in a manner that does not violate the OFCCP Testing Guidelines in 41 CFR Part 60-3.

h. The Contractor should have made sure that seniority practices and job classifications do not have a discriminatory effect.

i. The Contractor should have made certain that all facilities are not segregated by race.

j. The Contractor should have continually monitored all personnel activities to ensure that its EEO policy was being carried out including the evaluation of minority and female employees for promotional opportunities on a quarterly basis and the encouragement of such employees to seek those opportunities.

k. The Contractor should have solicited bids for subcontracts from available minority and female subcontractors engaged in the trades covered by these Bid Conditions, including circulation of minority and female contractor associations. NOTE: The Director and the Division of Small Business Opportunity will provide technical assistance on questions pertaining to minority and female recruitment sources, minority and female community organizations, and minority and female news media upon receipt of a request for assistance from a contractor.

3. NONDISCRIMINATION:

In no event may a contractor utilize the goals and affirmative action steps required in such a manner as to cause or result in discrimination against any person on account of race, color, religion, sex, marital status, national origin, age, mental or physical handicap, political opinion or affiliation.

4. COMPLIANCE AND ENFORCEMENT:

In all cases, the compliance of a contractor will be determined in accordance with its obligations under the terms of these Bid Conditions. All contractors performing or to perform work on projects subject to these Bid Conditions hereby agree to inform their subcontractors in writing of their respective obligations under the terms and requirements of these Bid Conditions, including the provisions relating to goals of minority and female
employment and training.

A. CONTRACTORS SUBJECT TO THESE BID CONDITIONS:

In regard to these Bid Conditions, if the Contractor meets the goals set forth therein or can demonstrate that it has made every good faith effort to meet these goals, the Contractor shall be presumed to be in compliance with Article m, Division 2 of Chapter 28 of the Denver Revised Municipal Code, the implementing regulations and its obligations under these Bid Conditions. In the event, no formal sanctions or proceedings leading toward sanctions shall be instituted unless the contracting or administering agency otherwise determines that the contractor is violating the

Equal Opportunity Clause.

1. Where the Division of Small Business Opportunity finds that a contractor failed to comply with the requirements of Article III, Division 2 of Chapter 28 of the Denver Revised Municipal Code or the implementing regulations and the obligations under these Bid Conditions, and so informs the Manager, the Manager shall take such action and impose such sanctions, which include suspension, termination, cancellation, and debarment, as may be appropriate under the Ordinance and its regulations. When the Manager proceeds with such formal action it has the burden of proving that the Contractor has not met the goals contained in these Bid Conditions. The Contractor's failure to meet its goals shall shift to it the requirement to come forward with evidence to show that it has met the good faith requirements of these Bid Conditions.

2. The pendency of such proceedings shall be taken into consideration by the Department of Public Works in determining whether such contractor can comply with the requirements of Article III, Division 2 of Chapter 28 of the Denver Revised Municipal Code, and is therefore a "responsible prospective contractor".

3. The Division of Small Business Opportunity shall review the Contractor's employment practices during the performance of the contract, If the Division of Small Business Opportunity determines that the Contractor's Affirmative Action Plan is no longer an acceptable program, the Director shall notify the Manager.

B. OBLIGATIONS APPLICABLE TO CONTRACTORS:

It shall be no excuse that the union with which the Contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority or female employees, Discrimination in referral for employment, even if pursuant to provisions of a collective bargaining agreement, is prohibited by the National Labor Relations Act, as amended, Title VI of the Civil Rights Act of 1964, as amended, and Article Division 2 of Chapter 28 of the Denver Revised Municipal Code. It is the policy of the Department of Public Works that contractors have a responsibility to provide equal employment opportunity, if they wish to participate in City and County of Denver contracts. To the extent they have delegated the responsibility for some of their employment practices to a labor organization and, as a result, are prevented from meeting their obligations pursuant to Article m, Division 2 of Chapter 28 of the Denver Revised Municipal Code, such Contractors cannot be considered to be in compliance with Article m, Division 2 of Chapter 28 of the Denver Revised Municipal Code, or its implementing rules and regulations.

C. GENERAL REQUIREMENTS:

Contractors are responsible for informing their subcontractors in writing regardless of tier, as to their respective obligations. Whenever a Contractor subcontracts a portion of work in any trade covered by these Bid Conditions, it shall include these Bid Conditions in such subcontractors and each subcontractor shall be bound by these Bid Conditions to the full extent as if it were the prime contractor. The Contractor shall not, however, be held accountable for the failure of its

subcontractors to fulfill their obligations under these Bid Conditions. However, the prime contractor shall give notice to the Director of any refusal or failure of any subcontractor to fulfill the obligations under these Bid Conditions. A subcontractor's failure to comply will be treated in the same manner as such failure by a prime contractor.

1. Contractors hereby agree to refrain from entering into any contractor contract modification subject to Article III, Division 2 of Chapter 28 of the Denver Revised Municipal Code with a contractor debarred from, or who is determined not to be a "responsive" bidder for the City and County of Denver contracts pursuant to the Ordinance.

2. The Contractor shall carry out such sanctions and penalties for violation of these Bid Conditions and the Equal Opportunity Clause including suspension, termination and cancellation of existing subcontracts and debarment from future contracts as may be ordered by the Manager pursuant to Article III, Division 2 of Chapter 28 of the Denver Revised Municipal Code and its implementing regulations.

3. Nothing herein is intended to relieve any contractor during the term of its contract from compliance with Article M, Division 2 of Chapter 28 of the Denver Revised Municipal Code, and the Equal Opportunity Clause of its contract with respect to matters not covered in these Bid Conditions.

4. Contractors must keep such records and file such reports relating to provisions of these Bid Conditions as shall be required by the Division of Small Business Opportunity.

5. Requests for exemptions from these Bid Conditions must be made in writing, with justification, to the Manager of Public Works, City and County Building, Room 379, Denver, Colorado 80202, and shall be forwarded through and with the endorsement of the Director of the Division of Small Business Opportunity.

EXHIBIT A

STANDARD FEDERAL ASSURANCES
ATTACHMENT 1

NOTE: As used below the term "contractor" shall mean and include the "Party of the Second Part," and the term "sponsor" shall mean the "City".

During the term of this contract, the contractor, for itself, its assignees and successors in interest (hereinafter referred to as the "contractor") agrees as follows:

1. Compliance with Regulations. The contractor shall comply with the Regulations relative to nondiscrimination in federally assisted programs of the Department of Transportation (hereinafter "DOT") Title 49, Code of Federal Regulations, Part 21, as they may be amended from time to time (hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this contract.

2. Nondiscrimination. The contractor, with regard to the work performed by it during the contract, shall not discriminate on the grounds of race, color, sex, creed or national origin in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The contractor shall not participate either directly or indirectly in the discrimination prohibited by section 21.5 of the Regulations, including employment practices when the contract covers a program set forth in Appendix B of the Regulations.

3. Solicitations for Subcontractors, Including Procurements of Materials and Equipment. In all solicitations either by competitive bidding or negotiations made by the contractor for work to be performed under a subcontract, including procurements or materials or leases of equipment, each potential subcontractor or supplier shall be notified by the contractor of the contractor's obligations under this contract and the Regulations relative to nondiscrimination on the grounds of race, color, or national origin.

4. Information and Reports. The contractor shall provide all information and reports required by the Regulations or directives issued pursuant thereto and shall permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the sponsor or the Federal Aviation Administration (FAA) to be pertinent to ascertain compliance with such Regulations, orders, and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish this information, the contractor shall so certify to the sponsor of the FAA, as appropriate, and shall set forth what efforts it has made to obtain the information.

5. Sanctions for Noncompliance. In the event of the contractor's noncompliance with the nondiscrimination provisions of this contract, the sponsor shall impose such contract sanctions as it or the FAA may determine to be appropriate, including, but not limited to:

a. Withholding of payments to the contractor under the contract until the contractor

complies, and/or

b. Cancellation, termination, or suspension of the contract, in whole or in part.

6. Incorporation of Provisions. The contractor shall include the provisions of paragraphs 1 through 5 in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Regulations or directives issued pursuant thereto. The contractor shall take such action with respect to any subcontract or procurement as the sponsor or the FAA may direct as a means of enforcing such provisions including sanctions for noncompliance. Provided, however, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the contractor may request the sponsor to enter into such litigation to protect the interests of the sponsor and, in addition, the contractor may request the United States to enter into such litigation to protect the interests of the United States.

EXHIBIT B

NONDISCRIMINATION IN AIRPORT EMPLOYMENT OPPORTUNITIES

The Party of the Second Part assures that it will comply with pertinent statutes, Executive Orders and such rules as are promulgated to assure that no person shall, on the grounds of race, creed, color, national origin, sex, age, or handicap be excluded from participating in any activity conducted with or benefiting from Federal assistance. This Provision obligates the Party of the Second Part or its transferee for the period during which Federal assistance is extended to the airport program, except where Federal assistance is to provide, or is in the form of personal property or real property or an interest therein or structures or improvements thereon. In these cases, this Provision obligates the Party of the Second Part or any transferee for the longer of the following periods: (a) the period during which the property is used by the sponsor or any transferee for a purpose for which Federal assistance is extended, or for another purpose involving the provision of similar services or benefits; or (b) the period during which the airport sponsor or any transferee retains ownership or possession of the property. In the case of contractors, this Provision binds the contractors from the bid solicitation period through the completion of the contract.

It is unlawful for airport operators and their lessees, tenants, concessionaires and contractors to discriminate against any person because of race, color, national origin, sex, creed, or handicap in public services and employment opportunities.

EXHIBIT C:
Certification for Contracts, Grants, Loans and Cooperative Agreements

The Contractor certifies by execution of this Agreement to the best of its knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the Contractor to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any federal contract, grant loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the Contractor shall complete and submit Standard Form-LLL, "Disclosure of Lobby Activities," in accordance with its instructions.

(3) The Contractor shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this transaction is a prerequisite for making or entering to this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Contract Encumbrance Number:

_____

PROJECT MANUAL

DENVER INTERNATIONAL AIRPORT

CENTRAL UTILITY PLANT CHILLER ADDITION

CONTRACT NUMBER: 201310046-00

VOLUME 1

ISSUED FOR CONSTRUCTION

CITY AND COUNTY OF DENVER
DEPARTMENT OF AVIATION

KIM DAY
MANAGER OF AVIATION

CENTRAL PLANT CHILLER ADDITION

INDEX AND CERTIFICATION PAGE

Division No.	Division Title	No. of Pages
1	GENERAL REQUIREMENTS	169
3	CONCRETE	5
4	MASONRY	11
5	METALS	28
7	THERMAL AND MOISTURE PROTECTION	33
8	DOORS AND WINDOWS	25
9	FINISHES	68
15	MECHANICAL	217
16	ELECTRICAL	135

CERTIFICATION(S)

CENTRAL PLANT CHILLER ADDITION

TECHNICAL SPECIFICATIONS

DIVISION 01 - GENERAL REQUIREMENTS

01010 - Summary Of Work
01014 - Work Sequence And Constraints
01015 – SECURITY REQUIREMENTS non SSI.Doc
01016 - Vehicle And Equipment Permitting
01020 - Utilities Interface
01025 - Measurement For Payment
01050 - Layout Of Work And Surveys
01051 - Project Coordination
01060 - Regulatory Requirements
01070 - Abbreviations And Symbols
01091 - Reference Standards
01095 - Definitions And Conventions
01110 - Construction Safety
01111 - Construction Safety - Airside
01200 - Project Meetings
01300 - Submittals
01310 - Schedule (LP)
01340 - Shop And Working Drawings, Product Data And Samples
01370 - Schedule Of Values
01380 – Construction Photographs
01400 - Contractor Quality Control
01401 - Independent Testing Agency
01402 - DIA Quality Assurance
01410 - Cutting And Patching
01411 - Selective Demolition
01500 - Temporary Facilities
01505 - Mobilization
01566 - Environmental Controls
01576 - Traffic Control
01580 - Temporary Signs
01620 - Storage And Protection
01630 - Substitutions
01650 - System Startup, Testing And Training
01700 - Contract Closeout
01710 - Cleaning
01720 - Contract Record Documents
01730 - Operation And Maintenance Data
01740 - Warranties And Bonds
01999 - Standard Forms

DIVISION 02 - SITE CONSTRUCTION (NOT USED)

DIVISION 03 – CONCRETE

03300 - Cast-In-Place Concrete

DIVISION 04 – MASONRY

04200 - Unit Masonry

DIVISION 05 – METALS

05120 - Structural Steel
05500 - Metal Fabrications
05999 - Welding

DIVISION 06 - WOOD AND PLASTICS (NOT USED)

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07250 - Sprayed-On Fireproofing
07270 - Firestopping
07841 - Through-Penetration Firestop Systems
07900 - Joint Sealers

DIVISION 08 - DOORS AND WINDOWS

08110 - HM Doors and Frames
08305 - Access Doors
08710 - Hardware

DIVISION 09 – FINISHES

09255 - Gypsum Board Assemblies
09911 - Painting (Consumer Line Products)
09960 - High-Performance Coatings
09975 - High-Temperature-Resistant Coatings

DIVISION 10 – SPECIALTIES (NOT USED)

DIVISION 11 – EQUIPMENT (NOT USED)

DIVISION 12 – FURNISHINGS (NOT USED)

DIVISION 13 - SPECIAL CONSTRUCTION (NOT USED)

DIVISION 14 – CONVEYING SYSTEMS (NOT USED)

DIVISION 15 – MECHANICAL

15010 - Basic Mechanical Requirements
15050 - Basic Mechanical Materials and Methods
15072 – Mechanical Removals and Demolition
15135 - Gauges and Meters
15140 - Supports and Anchors
15190 - Mechanical Identification
15245 - Vibration Isolation
15260 - Piping Insulation
15280 - Equipment Insulation
15330 - Wet Pipe Systems
15410 - Plumbing Piping
15510 - Hydronic Piping
15515 - Hydronic Specialties
15535 - Refrigerant Piping and Specialties

15540 - HVAC Pumps
15545 - Chemical Water Treatment
15684 - Centrifugal Water Chillers
15855 - Air Handling Units
15890 - Ductwork
15910 - Ductwork Accessories
15940 - Air Outlets and Inlets
15952 - Controls and Instrumentation
15985 - Sequence of Operation
15990 - Testing, Adjusting, and Balancing
15995 - Mechanical System Commissioning
15996 - Commissioning Agent Requirements

DIVISION 16 – ELECTRICAL

16010 - Basic Electrical Requirements
16015 - Electrical Demolition
16065 - Testing Acceptances And Certification
16110 - Raceways And Fittings
16120 - Wires And Cables
16135 - Electrical Boxes And Box Fittings
16142 - Electrical Connections For Equipment
16143 - Wiring Devices
16160 - Cabinets And Enclosures
16170 - Circuit And Motor Disconnects
16190 - Supporting Devices And Seals
16195 - Electrical Identification
16270 - Medium Voltage Variable Frequency Drive
16354 - Medium Voltage Motor Controls And Centers
16452 - Grounding
16460 - Transformers
16470 - Panelboards
16477 - Fuses
16480 - Motor Controllers
16486 - Electric Motors
16515 - Interior Lighting Fixtures
16535 - Emergency Lighting
16721 - Intelligent Life Safety Fire Management System
16770 - Voice Paging System

DIVISION 1 – GENERAL REQUIREMENTS

SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. General

1. The Work specified in this contract consists of furnishing all management, supervision, labor, materials, tools, equipment, services, testing and incidentals for the construction of the Work indicated in the contract documents including lump sum items and unit price items.

2. The Work in this Contract may impact operations of Denver International Airport. The Contractor shall bid, plan and execute the Work so as to minimize disruption of operations and inconvenience to the public.

B. The project consists of but is not limited to the following project elements, all within the Central Plant:

1. Provide two new, 2,500 ton, dual-compressor, VFD Trane Chillers in Bay 4 of the Chiller Room.

2. Provide new 4,160 kV equipment for the new chillers

3. Modify the plant control systems as required to integrate all new equipment into the plant control system (Johnson Controls, Inc.).

4. Relocate existing Refrigerant Transfer Units within the plant

5. Disconnect electrical equipment that serves Chiller C-4 and associated Condenser Water Pump P-34.

6. Provide new horizontal split case, VFD condenser water pump

7. Provide new horizontal split case, VFD chilled water pump.

8. Add Variable Frequency Drives (VFD) to existing vertical turbine pumps P-23 & P-24.

9. Add new Electrical Room for new electrical equipment and drives in Bay 6 of the Boiler Room.

10. Reduce size of existing Break Room and Tool Room in Pump Room to allow for installation of new chilled water pump.

11. .

1.02 WORK BY OTHERS

A. The Contractor is hereby notified that there may be other construction activities now and in the future within the project areas and adjacent to the worksites throughout the duration of this contract. The Contractor is responsible for keeping apprised of other projects and worksites and how they may affect the work.

B. The Contractor shall maintain contact with the City and with other contractors to schedule work to minimize the effect of such construction activities on other site activities. The Contractor shall also maintain, at the direction of the Project Manager, contact with tenants to ensure minimal disruption to tenant operations.

1.03 FUTURE WORK

A. A. The Contractor is hereby notified that there may be other future construction activities within the project and adjacent to the worksites that are scheduled after completion of this contract. It is the Contractor's responsibility to keep apprised of such projects and how they may affect the Work.

1.04 SITE CONDITIONS

A. The Contractor acknowledges satisfaction as to the nature and location of the Work, all of the general and local conditions, particularly those bearing upon availability of transportation, access to the site, disposal, handling and storage of materials, availability of labor, water, power, roads, and uncertainties of weather, or similar physical conditions at the site, the conformation and conditions of the ground, the character of equipment and facilities needed preliminary to and during work, and all other matters that can in any way affect the work or the cost thereof under this contract.

B. The Contractor further acknowledges, by submission of a bid and on each Work Request bid, satisfaction as to the character, quality and quantity of all surface and subsurface materials and all features on top of the surface or at worksites that would be encountered from his inspection of the site and from reviewing available records of exploratory work furnished by the City. Failure by the Contractor to become acquainted with the physical conditions of the sites and all the available information will not relieve the Contractor from responsibility for properly estimating the difficulty or cost of performing the Work.

C. The Contractor warrants that as a result of examination and investigation of all the aforesaid data and the site, that the Contractor can perform the Work in a good and workmanlike manner and to the satisfaction of the City. The City assumes no responsibility for any representations made by any of its officers or agents during or prior to the execution of this contract unless such representation is expressly stated in the contract.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 CONTRACTOR'S DUTIES

A. Except as otherwise specified, furnish the following to the full extent required by the contract:

1. Labor, superintendence, supervision and products.
2. Construction equipment, tools, machinery and materials.
3. Utilities required for construction and related activities.
4. Other facilities and services necessary to properly execute and complete the Work, including security for worksite, testing and storage and protection of all materials awaiting incorporation into the Work, providing a safe working environment for workers, City and County of Denver representatives, and the public in accordance with all local,

state and federal requirements.

B. Prosecute the Work as specified and in a timely manner. Submit a schedule of Work that will be performed at times other than during the eight-hour working day of Monday through Friday, daylight hours. Submit this schedule five working days prior to the beginning of Work to the Project Manager for review and acceptance. Approval to work at night may be obtained after Contractor presents a written program outlining special precautions to be taken to control the extraordinary hazards presented by night work. That program shall include, but not limited to, supplementary lighting of work areas, availability of medical facilities, security precautions and noise limitations.

3.02 COORDINATION

A. Coordinate prosecution of the Work with those public utilities, governmental bodies, private utilities and other contractors performing work on and adjacent to the worksites. Eliminate or minimize delays in the Work and conflicts with those utilities, bodies and contractors. Schedule governmental, private utility and public utility work that relies upon survey points, lines and grades established by the Contractor to occur immediately after those points, lines and grades have been established. Confirm coordination measures for each individual case with the City in writing.

B. In the coordination effort of work by others, the Contractor shall obtain and refer to equipment locations and other layouts, as available, to avoid interface problems.

C. The City reserves the right to permit access to the site of the Work for the performance of work by other contractors and persons at such times that the City deems proper. The exercise of such reserved right shall in no way or to any extent relieve the Contractor from liability for loss and damage to the work due to or resulting from its operations or from responsibility for complete execution of the Contract. The Contractor shall cooperate with other contractors and persons in all matters requiring common effort.

3.03 CONTRACTOR USE OF WORKSITE

A. Confine worksite operations to areas permitted by law, ordinances, permits and the contract.

B. Consider the safety of the Work and that of the people and property on and adjacent to the worksite when determining amount, location, movement and use of materials and equipment on worksite.

C. Do not load worksite with equipment and products that would interfere with the Work. Only equipment, tools or materials required for this Work may be stored at the worksite.

D. Protect products, equipment and materials stored on worksite.

E. Relocate stored products, equipment and materials which interfere with operations of City, government bodies, public and private utilities, and other contractors.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this section including any and all necessary relocations requested by the City. The cost of the work described in this section shall be included in the applicable multiplier or bid items contract price.

END OF SECTION 01010

SECTION 01014

WORK SEQUENCE AND CONSTRAINTS

PART 1 - GENERAL

1.01 OTHER WORK

A. Other concurrent construction contracts with which the Contractor must interface are described elsewhere in the Contract Documents. Refer to Technical Specifications Section 01310 and the Special Conditions for specific work constraints and milestones.

1.02 WORK SEQUENCE

A. General

1. The work sequence shall be in compliance with Phasing, Sequencing and Milestones as indicated in the Contract Documents and in accordance with the approved Construction Schedule developed by the Contractor. The schedule shall be in compliance with requirements indicated in the Special Conditions and Technical Specifications Section 01014 Work Sequence and Constraints. The Construction Schedule is described in Technical Specifications Section 01310 Schedule.

B. Project Specific Issues Affecting Work Sequences

1. No systems may be taken out of service until major equipment has arrived and been approved by DIA PM and construction manager.
2. Coordinate with DIA central plant operations and the utility company for power outages necessary to complete the electrical work.

1.03 WORK CONSTRAINTS

A. Site Constraints

1. Access to the project shall be generally as indicated in the Contract Documents. Access shall be organized and planned by the Contractor to ensure no disruption of airline or DIA operations.
2. Access to work sites will be strictly monitored and must comply with DIA Airport Operations and FAA Regulations. The Contractor shall provide monitoring and escorts as required by DIA Operations in the area of the work.
3. The Contractor's staging area will be as indicated in the Construction Documents.
4. Contractor employee parking will not be allowed within the existing revenue control system. To access the Terminal building, Contractor employees may use the DIA Landside Employee Parking Lot located on 78th Avenue at a cost of $30.00 per month per employee. A free DIA shuttle to the Terminal is available from this Lot. Material for work in the Terminal may be brought in through the Terminal Loading Dock accessed via Gate 1. Employee and material access to the Concourses will be via Gate 5.
5. The Contractor shall use the haul routes specified in the plans.
6. If required, the Contractor shall provide a bus and driver to transport the Contractor’s employees between the designated employee parking area and the work sites. No

separate payment will be made for this bus and driver. The cost shall be included in the bid item "Mobilization". The bus driver shall be provided at all times when Contractor employees are working on the project.

B. System Interruptions

1. The Contractor shall submit on approved forms through the Project Manager to DIA Maintenance Control any written requests for system interruptions such as fire alarm, HVAC, electrical, water systems or other systems. System interruptions shall not be considered if the interruptions interfere with airport operations or tenant operations. Interruptions or system shut down shall be limited to between the hours of 11:00 p.m. and 5:30 a.m. Baggage system shutdown shall be limited to between the hours of 10:00 p.m. and 4:00 a.m. and in accordance with Technical Specifications Section 01014, paragraph 1.03.F. Roadway shutdown times are to be coordinated with Airport Operations and the DIA Project Manager prior to submitting a request for approval to shutdown a roadway.

2. The request forms shall be submitted only during the normal work week (Monday through Friday) between 8:00 a.m. and 4:00 p.m.

3. Upon approval of a system shutdown, the Contractor representatives and the individuals performing the work shall remain at the worksite and shall remain in contact with Maintenance Control until such time as the system is restored to working condition. The requesting party shall assume liability for the system until the system is restored to proper working order.

4. Fire Systems, HVAC, and Plumbing: Submit requests five working days prior to the time of requested interruption.

5. Electrical System Interruptions: Submit requests five working days prior to the time of requested interruption.

C. Airfield Operations at Denver International Airport

1. Full airport and aircraft operations are underway adjacent to this project. Contractors are required to obtain a Contractor Participant Manual from the Security Manager and must follow the guidelines in the manual. Copies of the Contractor section of the manual are available for review at the Denver International Airport Access Services Office.

   a. If any Work contains requirements for Work activities or access through or in the restricted area, reference Technical Specifications Section 01015 and 01016 for requirements.

   b. If not in a restricted area, the Contractor personnel still must be badged; reference Technical Specifications Section 01015.

D. CONDUCT OF PERSONS USING THE DENVER MUNICIPAL AIRPORT SYSTEM

1. Contractor activities shall comply with Airport Operations and Regulation 130 TRAFFIC and 20 CONDUCT OF PERSONS USING THE DENVER MUNICIPAL AIRPORT SYSTEM shall be followed. These regulations are available from Airport Operations at Denver International Airport.

E. OPERATIONAL SAFETY ON AIRPORTS DURING CONSTRUCTION

1. All work shall be accomplished in accordance with FAA Advisory Circular AC150/5370-2C, "Operational Safety on Airports During Construction", FAR Part 139 and FAR Part 107 except as herein modified.

F. Welding Equipment, Procedures and Constraints

1. Natural gas-powered portable welders or “Powcon Inverter” welders are the only acceptable welding equipment to be used inside of building basement or tunnel areas. Acceptability of equipment other than the equipment noted above shall be at the sole discretion of the Project Manager. If the Contractor proposes other types of inverter welding equipment, testing of equipment for harmonics by the Contractor must be completed prior to the request by the Contractor for use of the equipment.

2. Welding activities inside buildings require submittal of a System Interruption Request (See paragraph 1.03.B of this Specifications Section). Prior to welding in any area, the Contractor shall locate smoke detectors and shall request interruption of the fire alarm system. Subsequent to the interruption of the fire alarm system and prior to welding activities, the Contractor shall cover and protect smoke detectors until work is complete. Prior to expiration of each interruption of the system, the Contractor shall uncover the smoke detectors.

3. Electrical Service: The Contractor shall be responsible for verifying with the DIA Project Manager or representatives locations acceptable for accessing electrical power for welders and other electrical equipment feeders. The Contractor shall be responsible for all work and equipment required to install temporary or permanent electrical modifications for construction power and lighting.

   a. Temporary Hook-up: Pigtails wired into electrical panels - temporary only: Permanent installation shall require conduit, labeling, and all requirements of Division 16 Technical Specifications. Comply with the following:
      1) Provide 20 amp, 3 pole plugs.
      2) Wire shall be (4) #10 copper
      3) 480V, 3 phase, 3 pole, 4 wire twist lock ground line
      4) NEMA L16-20 or ANSI C73.87

   b. The Contractor may not begin operation of the equipment prior to request for inspection by DIA representatives and acceptance of the installation.

4. Welding Practices: All standard safe welding practices must be followed, including but not limited to the following:
      1) Flash protection for surrounding areas
      2) Contractor fire extinguisher in area
      3) One person in each welding area solely designated as fire watch for each welder
      4) Protect all equipment, cable trays and contents, etc. in area
      5) Use fire blankets and other appropriate materials to confine sparks and molten metal from the welding, cutting, and/or grinding activities.
      6) All welders shall have been qualified through welding tests in accordance with applicable welding code, such as but not limited to AWS, ASME, API, within one year prior to welding taking place. Evidence of qualification shall be through Welding Performance Qualification Records (WPQR).
      7) All welder qualifications test shall be or shall have been administered and witnessed by an Independent Testing Agency (ITA), AWS Certified Welding Inspector (CWI).
      8) If re-certification of welders is required, delay costs and retesting costs shall be borne by the Contractor.

5. Grounding: Review with DIA representative’s area of work prior to beginning work to ensure ground procedures do not induce undesirable charges in steel building system or other systems. This review should take place subsequent to the pre-work meeting. Do not ground to adjacent building systems, baggage system, hangers, or devices that support mechanical or electrical equipment.

G. Cleaning Equipment and Spoils

1. Discharge of water, liquids, or chemicals into the building waste, drain systems or storm drainage systems is prohibited. The Contractor shall comply with all Federal, State, and Local requirements for disposal of chemicals. The Contractor shall maintain and service in work areas containers for discharge of water from cleaning of any construction equipment or removal of water from excavations.

H. Vehicle Permitting for Tunnel and Basement Use

1. Electric carts require permitting. The Contractor shall provide at least one electric cart for Contractor use during the work in the tunnel and basements of the buildings. Only CNG powered trucks are allowed in the tunnel and basements of the buildings. CNG/gasoline trucks may be used and shall not be parked overnight or for long terms within the tunnel or basements. All vehicles require permitting. Permits may be acquired at the DIA Airport Security Office for a fee of $5.00 each (non refundable) with a $100.00 deposit (refundable at project completion).

I. Radio and Cell Phone Use

1. The Contractor shall have in place prior to initiation of work in the tunnel or basements communications equipment either by use of cell phone and or radio. Cell phone use is limited to “line of sight” communication. Radio equipment shall be submitted to DIA for approval of use at least 14 days prior to intended use. Radio equipment frequencies shall be submitted. Frequencies shall be subject to DIA approval.

J. Keys

1. The Contractor shall be required to contact DIA Maintenance Control to procure keys for access to all rooms having locks in order to gain access. Keys may be checked out at the beginning of each work shift by the Contractor and shall be returned to DIA Maintenance Control at the end of each work shift.

1.04 COORDINATION

A. The Contractor will designate a contact person for coordination with the Project Manager and airline tenants. The contact person shall have the authority to make decisions for the Contractor firm and shall have binding signatory power for changes in work. The contact person shall be on site at all times during work activity.

B. No additional costs shall be considered for coordination activities throughout this project. The Contractor shall include in his bid costs for coordination of all activities.

1.05 LATE COMPLETION

A. The Contractor will notify the City as soon as possible, but in no case not less than four weeks in advance, of the inability to meet any of the constraints or milestones. Notification shall be consistent with the requirements of Article 5, General Conditions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 DUST/PROTECTION BARRIERS

A. Prior to any demolition the Contractor shall construct area containment doors and dust barriers at five feet outside the limits of demolition of the wall and as directed by the DIA Project Manager. Dust barrier at wall demolition shall be constructed of metal studs with ½" painted gyp board from floor to ceiling. At a minimum, any space containing electrical or telecommunications equipment will require dust barriers for the entire space during demolition and construction. Contractor shall install all required modifications to exit/egress signage until temporary barriers are removed. Contractor shall coordinate location of partition with Fire Sprinkler Contractor to ensure adequate sprinkler coverage during construction. Temporary barriers shall be removed only after completion of the work scope within the areas including final punch list activities. Areas between ceilings and structure above shall be contained to prevent migration of any dust into adjacent areas.

B. HVAC system containment. The Contractor shall submit to DIA Maintenance HVAC and Fire Alarm shut down requests prior to modifications to the area of work for dust containment. The HVAC system shall be interrupted, re-routed, or blocked off to prevent dust from entering return or supply ducts.

C. Debris and Protection Barriers: The Contractor shall construct code-approved and DIA-approved dust and debris barriers on both sides of walls and doors that are to be modified. Barriers shall be constructed to allow emergency ingress and egress to and from equipment and spaces. Barriers shall be constructed to allow continual uninterrupted function of building equipment and spaces.

1. Return all removed door hardware to DIA. Label each hardware set correlating the door number of the original hardware set. Coordinate with the DIA Project Manager representatives for storage and return of hardware.

3.02 EQUIPMENT

A. Equipment: CNG-powered equipment is allowed within the buildings. No other fossil fuel equipment may be used within the buildings unless the equipment is directly vented to the building exterior.

B. Electric: Electric powered equipment is acceptable in the Work area.

PART 4 -

PART 5 - MEASUREMENT

5.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 6 - PAYMENT

6.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01014

SECTION 01015

SECURITY REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Badges and Permits: DIA requires personnel badging and vehicle permitting administered by the Denver International Airport Security Office. The Contractor shall be required to obtain the proper access authorizations for badges and permits, and the Contractor shall immediately report the presence of unauthorized (unbadged) persons or unauthorized (no permit) vehicles on site to the DIA Project Manager.

B. Fences: If required, the Contractor shall establish and maintain a secure (fenced) perimeter at its primary operations area to include its field offices, staging and storage areas, and maintenance facilities. The responsibility for security within its operations area shall rest solely with the Contractor. Entrance gates to operations areas shall be equipped with a combination of locks to include a lock provided by the City for its use in accessing emergency equipment, should that need arise. The location, size and other physical characteristics of the Contractor's operations area must be approved by the City prior to its installation.

1. Unless specifically required by the Contract Documents and with the exception of the fenced operations area described above, the Contractor shall install no fences or other physical obstructions on or around the project work area without the written approval of the City.

C. Trash Dumpsters: To provide maximum security will all construction projects in public areas, all trash dumpsters must have the ability to be covered and locked when not in use.

1.02 VENDORS AND SUPPLIERS

A. The Contractor shall escort ON A FULL TIME BASIS all unbadged vendors and suppliers requiring access to the restricted areas. Only those vendors and suppliers providing materials and/or supplies shall be allowed on site.

1.03 AIRPORT SECURITY PARTICIPANT MANUAL

A. Contractors are required to obtain an Airport Security Participant Manual from the Airport Security Office and must follow the guidelines in the manual. The Airport Security Participant Manual will be issued after the company has attended a Participant meeting with Airport Security. The Contractor shall comply with the Denver Municipal Airport System Rules and Regulations and TSA regulations.

1. Denver Municipal Airport System Rules and Regulations **Part** 130 Movement of Vehicles in the Restricted Area and **Part 20** Security must be adhered to. The Denver Municipal Airport System Rules and Regulations can be found on the flydenver.com website.

2. All work shall be accomplished in accordance with FAA Advisory Circular AC150/5370-2E, "Operational Safety on Airports During Construction", 49 CFR Part 1542 and 14 CFR Part 139 except as modified herein.

3. The following paragraphs supplement, modify, change, delete from or add to FAA AC150/5370-2E. Where any paragraph, subparagraph or clause of the Advisory Circular is modified or deleted by these supplements, the unaltered provisions of that paragraph, subparagraph or clause shall remain in effect.

4. The Transportation Security Administration requires has the authority to issue civil penalties for failure to adhere to their regulations.

5. It is the responsibility of the Airport to ensure all fences and gates are secure. If a Contractor's operations necessitate the frequent use of a particular gate, the Contractor shall place two contract security guards at the gate that shall have been trained and certified by the Operations, Public Safety and Security Division to facilitate access to its work. The Contractor assumes full responsibility for maintaining security once this is done. If the perimeter gate will be used as a haul route, the contractor must also place Haul Route Monitors as dictated by the TSA approved Temporary Amendment. Any fines levied against the Airport as a result of the failure by the Contractor to provide adequate security shall be passed on to the Contractor.

6. Contractors will be required at all times to have a supervisor or foreman at each work location in both restricted and non-restricted areas.

B. Access to Restricted Area via Vehicles

1. The Contractor shall obtain access to the restricted area via a vehicle only when the vehicle displays a valid Vehicle Permit issued by Airport Security (refer to Technical Specifications Section 01016) and the driver has an Airport ID badge with driver authorization.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SUBMITTAL FOR BADGES

A. Airport Id badges and vehicle permits shall not be issued prior to Notice to Proceed. The Contractor may at his own risk submit the required information to DIA Maintenance and Engineering Division and to DIA Airport Security prior to Notice to Proceed in order to expedite the badging and permitting process.

B. By submitting information for the individual requesting or requiring an Airport Id badge that would permit unescorted access to the Sterile and/or Restricted Areas must be fingerprinted and pass a Criminal History Records Check (CHRC) and Security Threat Assessment. Passing a CHRC means the employee shall not have been convicted, given a deferred sentence, found not guilty by reason of insanity or have been arrested and are awaiting judicial proceedings of any felony charge during the ten (10) years before the date of the individual's application for unescorted access authority. For an individual to obtain driver authorization to drive within the Restricted Area, the individual must have a valid driver license that allows them to drive their contractor vehicle.

C. An employee requesting an Airport ID Badge must resolve all pending or valid violations before being allowed to proceed in the badging process. If the employee no longer works for the company and is attempting to be employed by a different company, a management representative from the "new" company must attend the Violation Notice Hearing along with the employee.

D. Airport ID Badges are obtained as follows:

1. The Contractor shall designate an Authorizing Agent who must attend an annual class with Airport Security. The Authorizing Agent must be an employee of the Contractor, have a valid Denver International Airport ID badge. The Authorizing Agent will be authorized to sign for the Contractor on the Fingerprinting and Badge Application Form and will be the primary designation contact for Airport Security related business.

2. The Contractor shall meet with the DIA Project Manager to review the procedures and required access points at DIA. The Contractor and the Project Manager shall visit the site to verify the access points. Access points shall be listed and submitted by the Contractor to the Project Manager for review and comment prior to Contractor's application for badging.

3. The Contractor's Authorizing Agent shall schedule a Participant Meeting with the DIA Airport Security Office to review DIA security procedures. A second meeting will be scheduled for the Authorizing Agent to learn how to successfully complete the required forms for employee badges and vehicle permits.

4. A CHRC and Security Threat Assessment (STA) are required for each employee requesting unescorted access to the restricted areas. The employee will complete the Fingerprinting and Badge Application (two-sided form) and schedule an appointment with the Airport Security Office to have the form reviewed and to be fingerprinted. The Federal Bureau of Investigation will conduct the CHRC and will return the results to the Airport Security Office. For the fee for the Fingerprinting please see the flydenver.com website. The Transportation Security Administration will process the STA and will return the results to the Airport Security Office.

5. When the Authorizing Agent is notified by Airport Security that the CHRC and STA has cleared, the individual shall call the Airport Security Office, to schedule an appointment to come to the Airport Security Office to receive regulated security and driver training. The appointment will take approximately one hour for security training and approximately two hours for security and driver training.

6. All applicants will must watch and pass all concepts of a computer based security training module for a SIDA Airport ID badge. All individuals requesting driver authorization in the non movement area must also view an interactive computer based driver training module and complete a test by passing all concepts. In addition the individual must receive non movement driver orientation training by the Contractor's driver representative before being allowed to drive on the airfield. Non Movement Orientation training should be conducted annually.

7. **ALL EMPLOYEES ARE REQUIRED TO HAVE AN AIRPORT ID BADGE**. The Contractor is advised that there is a $10 dollar processing fee for every issued Airport ID badge. Rebadging fee is $10.00.

8. The Airport ID badges must be returned to the Airport Security Office prior to final payment. All Airport ID badges are issued with an annual expiration date. The expiration date is determined by either the end of the estimated project date or the expiration of the vehicle insurance, whichever ever date is closer. Contractors shall notify the Project Manager as soon as possible but in no case less than four weeks in advance of any requirement to extend the duration of badge validations.

9. Total fees for startup:
   $ 40 Criminal History Records Check (per employee) for Unescorted access.
   $ 10.00 Badge (per employee)

3.02 DUMPSTERS

A. Security Requirements: The following procedures must be followed to provide maximum security with all construction projects in public areas:

1. Roll-off dumpsters must have the ability to be covered (hard side) and locked when not in use.

2. When unlocked and in use, the Contractor shall provide an employee, or a subcontractor's employee, to stand by the dumpster to prevent unauthorized placement of prohibited items.

3. If the Contractor is not able to have a roll-off dumpster with the ability to be locked, the dumpster shall be removed from the public area when the construction site is inactive.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01015

SECTION 01016

VEHICLE AND EQUIPMENT PERMITTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall comply with the Airport Security Program. Vehicle permits are required for all vehicles operating in the Restricted Area. Two types of permits are required. The DIA vehicle permit is required for vehicles operating in the Restricted Area but limited to above grade, outdoor activity. Vehicles or machinery operating within buildings shall be required to acquire a DIA emissions permit as well as a DIA vehicle permit.

B. Contractors performing work in or through Restricted Areas are required to become Participants in the Airport Security Program. Contractors shall comply with all Denver Municipal Airport System Rules and Regulations.

1. Denver Municipal Airport System Rules and Regulations Part **130 Movement of Vehicles in the Restricted Area** and Part **20 Security** shall be followed. These regulations are available through the flydenver.com website.

2. All work shall be accomplished in accordance with FAA Advisory Circular AC150/5370-2E, "Operational Safety on Airports During Construction", 49 CFR Part 1542 and 14 CFR Part 139, except as herein modified.

3. The following paragraphs supplement, modify, change, delete from or add to FAA AC150/5370-2E. Where any paragraph, subparagraph or clause of the AC is modified or deleted by these supplements, the unaltered provisions of that paragraph, subparagraph or clause shall remain in effect.

4. Special care shall be exercised by the Contractor when operating within clear zones, under approach and departure zones of runways and in the apron area. The clearance zones shall be considered as extending to a distance of 750 feet laterally from the centerline of runways and to a distance of 193 feet laterally from the centerline of taxiways. Where these zones overlap, the greater distance shall apply. Vertical clearance in the approach and departure zones shall be considered as starting at grade 200 feet beyond the ends of runways and rising at the rate of 50 feet horizontal to one foot vertical.

5. Access to the runways, taxiways and aprons shall be gained by the Contractor after establishing radio communications with Airport Operations. No personnel or equipment will be allowed on the runways until radio contact has been made with Airport Operations and permission given.

6. Access to airport operations areas will be limited in order to allow the maximum efficient movement of aircraft. As part of this limitation the Contractor may be required to only use these areas late at night when there is less aircraft traffic.

7. Once admitted into the Restricted Area, the Contractor shall proceed directly to the Work location by way of a route assigned by Airport Security. At no time shall a Contractor or any of its personnel enter onto a taxiway, runway or ramp without proper clearance from the Aviation Operations Manager or Assistant Aviation Operations Manager. Contractors or individuals violating these requirements for driving in the Restricted Area may be subject to fines, suspension or permanent revocation of the

Airport ID badge and driver authorization.

8. The Transportation Security Administration requires that all operating airports be secured from the general public and has the authority to issue citations for violations of these requirements. It is the responsibility of the Airport to ensure all fences and gates are secure. If a Contractor's operations necessitate the frequent use of a particular gate, the Contractor shall place two guards at the gate, which shall be trained and certified by the Airport Operations, to facilitate access to its work. If a Temporary Amendment is required, then the Contractor mush also adhere to all requirements within the TSA approved Temporary Amendment and ensure Haul Route Monitors are trained. The Contractor assumes full responsibility for maintaining security once this is done. Any fines levied against the Airport as a result of the failure by the Contractor to provide adequate security shall be passed on to the Contractor.

9. Cranes and Construction Equipment: The Contractor shall provide the necessary drawings and specifications to indicate all information needed by the FAA and the City including but not limited to location of construction activities and height of objects including cranes, construction equipment and vehicles. Drawings shall be scaleable site plans indicating northing and eastings of proposed equipment locations, air space northing and eastings of activity and elevations of equipment based on DIA datum. Specifications shall include standard sheets on equipment specifications and any non-standard modifications to the equipment.

10. The above information shall be submitted to the Project Manager for approval five days prior to mobilization. Changes to information submitted shall be re-submitted for approval at least five days prior to mobilization of any change.

11. If required by DIA, standard DIA-approved warning lights and flagging will be required on any temporary equipment or structures.

12. Lighting of the work area is subject to approval by DIA Operations and DIA Planning and Development. The Contractor shall include in item (9) above information on any site lighting proposed by the Contractor. The locations, heights and types of luminaries shall be submitted. The Contractor shall conduct his activities, especially lighting, so as not to interfere with Airport and FAA operations.

C. General safety regulations when in aircraft operations areas may include the following:

1. At all times, the Contractor shall coordinate its work with the requirements of the Airport site and operations. All work, movement of men, materials, supplies and equipment in areas used by aircraft shall be subject to regulations and restrictions established by the City. The Contractor shall take special precautions and be fully responsible for the prevention of damage to materials and equipment in the areas affected by the jet blast of taxiing aircraft. No work shall proceed until necessary protective devices are placed as required to protect the public, airport operations, property and personnel from the hazards of the Work. The Contractor shall proceed with his work, including temporary work and storage of tools, machinery and materials, to cause no interference with or hazards to the operation of the Airport.

2. Landings, takeoffs and taxiing shall take precedence over all Contractor's operations. In the event that the Contractor is notified that an emergency landing or a takeoff is imminent, the Contractor shall stop all operations immediately, regardless of the sequence of events in progress and shall immediately evacuate his personnel and equipment from the runway and taxiway areas as directed.

3. The Contractor shall remove its personnel and equipment to the distance specified below for the prevailing conditions:

a. For emergencies the Contractor shall move all personnel and equipment as directed by Airport Operations or the Project Manager.

b. At the end of a work day in areas where aircraft are operating, all equipment shall be moved to a location that is not less than 750 lineal feet measured from the near edge of the runway, taxiway or ramp area or to the location designated by the City.

4. If the Contractor is asked to leave part of its worksite to allow aircraft operation, the Contractor shall clean the area to allow safe aircraft movement. Cleaning may include sweeping the area to prevent damage to aircraft.

D. Vehicle Permitting

1. Vehicle permits are limited to those vehicles and or equipment required for completion of the work. Employee vehicles will not be issued permits. Employee parking is addressed in Technical Specification Section 01014 or as indicated in the Contract Documents. No Contractor employee parking will be acceptable in the Restricted Area.

2. The Contractor shall obtain access to the Restricted Area only when the vehicle displays a vehicle permit, has the vehicle permit application in the vehicle and the driver has an Airport ID badge with a driver authorization. Vehicle permits may be obtained as follows:

a. Vehicle permits must be renewed annually and cost $5.00 dollars. Vehicle permits must be surrendered to Airport Security before final payment will be made for work accomplished. A Vehicle Permit Application must be filled out and approved by the Project Manager prior to the issuance of the permit. The Contractor's Authorizing Agent must file a sponsorship form with the Airport Security Office and accompany any subcontractor requesting a vehicle permit. The approved vehicle application must be presented at Airport Security to obtain the vehicle permit.

b. All vehicles that are not permitted by Airport Operations to drive in the Restricted Area are required to be escorted. All vehicles that are escorted must have a minimum of $1,000,000.00 combined single limit coverage with a 30 day notice of cancellation to Airport Security. All unescorted vehicles must have $10,000,000.00 combined single limit coverage with a 30-day notice of cancellation to Airport Security prior to any permits being issued.

c. Vehicle permits are issued with the expiration date of the project on the permit. A $5 fee will be charged for a new permit that requires an extension of time.

d. The Contractor must have a four-inch letter company logo on each side of the vehicle. All vehicles operating in the Restricted Area must display the logo at all times.

e. The Contractor shall obtain a driver authorization for all operators of vehicles in the Restricted Area. Reference Technical Specifications Section 01015.

f. Contractors will be required to have a supervisor or foreman at each work location at all times.

E. Equipment Permitting

1. Fossil fuel powered equipment to be used in the interior of buildings and/or in basement/tunnel areas shall require inspection by DIA Maintenance and the Denver Fire Department. **Only CNG fossil fuel powered equipment may be used; gasoline powered, propane powered, or diesel powered equipment will not be acceptable unless identified and operated per Specifications Section 01014.**

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 PERMITS

A. Vehicle permits shall not be issued prior to Notice to Proceed. The Contractor may, at his own risk, submit required information prior to Notice to Proceed to the following:

1. Vehicle permit: DIA Engineering Group or DIA Airport Security

2. Equipment and vehicle emissions permit: DIA Engineering or DIA Maintenance Group.

3.02 SCHEDULE

A. The Contractor shall allow in his schedule five days for DIA review of submittals for permits. Testing of equipment and review by the Denver Fire Department shall be scheduled by the Contractor. By submitting information for permits, the Contractor certifies that equipment and vehicles comply with all city, state and federal regulations including but not limited to emissions, licensing and safety requirements.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item. All permits shall be returned to the City prior to the Contractor submittal for Final Settlement, Termination, and/or upon written request from the Project Manager.

END OF SECTION 01016

SECTION 01020

UTILITIES INTERFACE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Various utilities are located within the limits of work in the project area. The owners of these utilities hereinafter noted may require that the Contractor is to work around their existing facilities until such alterations, relocation or abandonment have been completed. All known existing utilities are shown; however, the Contractor shall verify and satisfy himself that there are no other existing utilities that may not be shown.

B. The owners of known utilities within the project area and corresponding representatives are:

Qwest Telephone	Susan Jensen	303-391-8373
DIA Telephone	Pat McFadden	303-342-2200
Xcel Energy Natural Gas	Joanna Gomez	303-375-3509
Xcel Energy Electrical Services	Joanna Gomez	303-375-3509
DIA Storm Water	Donald Smith	303-342-2200
DIA Sanitary Sewer	Donald Smith	303-342-2200
Denver Water Department	John Bambei	303-628-6669
Inland Technologies	Brian Stierman	303-342-6811
Fuel System (ASII)	Gil Patron	303-342-3552
Premise Wiring System	Kelan Pape	303-342-2200
FAA Duct Bank	Rick Silva	303-342-1405
Oil/Gas Wells	Julie Brant	303-513-6169
DIA Electrical Department	Pat Kelly/Tai Lai	303-342-2800
Fire Alarm System	Pat Kelly/Tai Lai	303-342-2800
Paging System	Pat Kelly/Tai Lai	303-342-2800

C. The location and establishment of each construction vehicle crossing shall be at sites mutually agreed upon in writing by the Contractor and the owner of the utility.

D. At the locations where the Contractor needs to establish a construction vehicle crossing over any of the operating pipelines, the furnishing and placing of a crossing shall be by the Contractor. The crossing shall allow the normal operation of the pipeline at all times. Each crossing shall be adequately marked and signed for safe passage of vehicles over the crossing. Construction vehicles shall not be allowed to cross over operating pipelines at any place other than an established crossing. The maximum size of any vehicle crossing operating pipelines at any location in the project area shall be limited to no larger than a Caterpillar D6 bulldozer unless noted otherwise.

E. Coordinates for known utilities located within the project area may be available at the Denver International Airport Office. These utilities locations are based upon information provided by the utility companies or previous construction contractors that were the basis for determining utility coordinates. The City does not warrant their accuracy.

F. The Contractor shall control his operations in order to avoid creating any obstacles for the utility owner's access for maintaining or operating their equipment.

1.02 REGULATORY REQUIREMENTS

A. The Contractor shall obtain and pay for all utility company permits, fees, and licenses necessary for the execution of this work. The Contractor shall give all notices and shall comply with all laws, ordinances, rules and regulations of all authorities having jurisdiction.

1.03 QUALITY CONTROL

A. When the Contractor performs any operations that will impact a utility owner, the Contractor will give timely notice to the utility owner and the DIA Project Manager so that the Contractor's operations may be observed by the utility owner's representative at the discretion of the utility owner's representative and the Project Manager's representative.

1.04 WORK INCLUDED

A. The work of this section includes furnishing all materials, equipment and labor necessary to provide utility crossings as required and as specified herein and subject to approval by the associated utility owner.

B. North American Resources requires a minimum of 12 feet of total cover over their pipelines at each crossing. This required cover is to extend a minimum distance of five feet perpendicular on both sides of the pipeline, then slope away from the pipeline at a slope determined by the Contractor as sufficient for his vehicles. The top 12 inches of the cover overall shall be Colorado Department of Highways Class 6 road base.

C. FAA Underground Duct lines: The FAA has duct lines passing under the site. The Contractor shall contact the FAA prior to beginning earthwork operations to ascertain any special requirements or conditions required to maintain this service during construction activities.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Suitable cover material shall be in accordance with Colorado Department of Highways Standard Specifications. Wet, soft or frozen material, asphalt chunks, or other deleterious substances shall not be used for cover.

B. Aggregate for road base material shall consist of clean, sound and durable particles of crushed stone, crushed gravel or crushed slag, shall be free from coatings of clay, silt and organic matter, and shall contain no clay balls. Material shall conform to the State of Colorado Standard Specifications for Road and Bridge Construction Class 6 aggregate base.

C. The materials for the load distribution system on top of the cover shall conform to the specification of the American Institute of Steel Construction, the American Institute of Timber Construction, or the American Concrete Institute, as applicable, depending upon the system agreed upon between the Contractor and utility owner.

D. Materials for the sleeving of the pipelines shall be purchased by the utility owner at the Contractor’s expense.

PART 3 - EXECUTION

3.01 NOTIFICATION OF UTILITIES FOR LOCATING AND POTHOLING

A. The Contractor shall verify the location of all utilities prior to any operations including physically uncovering the utility to verify location as required by the utility owner or the DIA Project Manager and shall be solely responsible for protection of the utilities during construction. Only manual labor shall be used within five feet of the suspected location of a utility to uncover it. The Contractor shall obtain written permission from each utility owner before constructing crossings or crossing pipelines in service, and provide the Project Manager with a copy of the permission 48 hours prior to commencement of crossing work.

B. A minimum of three days notice by the Contractor shall be given to the utilities for locating and potholing their lines as needed.

C. The Contractor shall notify the Utility Notification Center of Colorado (303) 534-6700 as a minimum for location of utilities.

D. In the event that the Contractor needs to conduct Contractor's operations which will affect an operating utility, the Contractor shall be required to sign a "hold-harmless" agreement with the owner of the utility prior to the Contractor conducting any operations affecting the utility.

E. Denver International Airport has embarked on a robust program to collect sub-surface utility engineering surveys for all airport construction projects. All construction projects that expose the location of sub-surface utilities needs to accurately capture the location and provide the data to the Planning & Design Division. Construction plans should indicate when sub-surface utilities are to be uncovered and/or new utilities installed and coordinate with the DIA Survey Department for the collection of all utility data prior to being covered. The DIA Survey Department will be responsible for the collection of utility data including Denver Water and Excel Energy utilities, but notification to the DIA Project Manager and Airport Survey Office is required by contractor three business days before items are uncovered. Refer to Design Manual 12 Chapter 5 Existing Subsurface Utilities Data Standard for more information.

3.02 TRENCHING AND SLEEVING

A. All trenching, excavation, sleeving and shoring needed to cross over or under a utility shall be performed in the manner required by the party owning the utility and in such a manner as to ensure no dislocation of the existing utility. The method used to cross under the utility shall ensure it is fully supported at all times. The Contractor shall accurately locate and record the position of a utility being crossed as soon as it is uncovered and again prior to covering it and report to the Project Manager any change in location greater than 0.5 inch. The crossing shall be protected so that water or construction equipment will not dislocate or undermine unsupported sections of the utilities.

3.03 COVER AND COMPACTION

A. Backfilling of trenches or adding additional cover shall be conducted at all times in a manner that will prevent damage to the pipe. If the excavated material is not suitable for backfill and cover, as determined by the DIA Project Manager, unsuitable material shall be hauled away and disposed of properly. The owner of the utility will observe at all times the installation of the backfill and cover. Backfill and cover shall be the placement of suitable materials in horizontal, uniform layers and brought up uniformly on the sides and over the pipelines.

B. The thickness of each layer of backfill shall not exceed eight inches before being compacted to 95 percent relative compaction per ASTM D-698 or to the density required by the utility owner and tested for density by the Contractor.

3.04 ROADBASE COMPACTION

A. If the required compacted depth of the road base exceeds eight inches, it shall be constructed in two or more layers of approximately equal thickness. The maximum compacted thickness of any layer shall not exceed eight inches before being compacted to 95 percent relative compaction per ASTM D-698 or to the density required by the utility owner.

3.05 REMOVAL

A. All temporary crossings shall be removed after completion of the work.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable multiplier work request bid item.

END OF SECTION 01020

SECTION 01025

MEASUREMENT FOR PAYMENT

PART 1 - GENERAL

1.01 SCOPE

A. This Section covers the requirements for measurement of quantities for payment as they apply to this contract.

B. Measurement methods specified in the individual sections of these specifications shall govern if they differ from methods specified in this Section.

C. The Contractor will compute all final quantities subject to review and acceptance by the Project Manager. Where necessary, such computations will be based upon surveys performed by the Contractor as specified in Technical Specifications Section 01050.

1.02 MEASUREMENT OF QUANTITIES

A. Measurement Standards

1. All work to be paid for at a contract price per unit of measurement will be measured by the Contractor in accordance with United States Standard Measures.

2. Measurements are subject to check and review by the Project Manager: if errors are found the Contractor shall correct them. If, in the opinion of the Project Manager, the errors are significant or frequent enough, the Project Manager may make the measurements with his own forces at the Contractor's expense. No payment will be made on that portion of an item containing measurement or calculation errors until the errors are corrected to the satisfaction of the Project Manager.

B. Measurement by Weight

1. Items to be paid for by weight shall be measured by scale or by handbook weights for the type and quantity of material actually furnished and used. One ton shall consist of 2,000 pounds. Handbook weights will only be allowed if there is one-half of one percent or less difference between the handbook weight and the allowable deviation per manufacturer's specification of a material's finish weight.

2. Material to be measured and paid for by weight shall be weighed on accurate, approved scales, furnished by and at the expense of the Contractor. Platform scales of sufficient size and capacity shall be used to permit the entire vehicle or combination of vehicles to rest on the scale platform while being weighed. Combination vehicles may be weighed as separate units provided they are disconnected while being weighed. All scales shall be inspected and certified as often as the Project Manager may deem necessary to ascertain accuracy. Costs incurred as a result of regulating, adjusting, testing, inspecting and certifying scales shall be borne by the Contractor.

   a. Scales for weighing materials which are required to be proportioned or measured and paid for by weight shall be furnished, erected and maintained by the Contractor or be certified, permanently installed commercial scales.

   b. Scales shall be accurate to within one-half of one percent of the correct weight throughout the range of use. The Contractor shall have the scales checked under

the observation of the Project Manager before beginning work and at such other times as requested. The intervals shall be uniform in spacing throughout the graduated or marked length of the beam or dial and shall not exceed one-tenth of one percent of the nominal rated capacity of the scale, but not less than one pound. The use of spring balances will not be permitted.

c. Beams, dials, platforms and other scale equipment shall be so arranged that the operator and the City's inspector can safely and conveniently view them.

d. Scale installations shall have suitable weights or devices available for testing the weighing equipment.

e. Scales must be tested for accuracy and serviced before use at a new site. Platform scales shall be installed and maintained with the platform level.

f. Scales "overweighing" (indicating more than correct weight) will not be permitted to operate and all materials received subsequent to the last previous correct weighing-accuracy test will be reduced by the percentage of error in excess of one-half of one percent.

g. In the event inspection reveals the scales have been "underweighing" (indicating less than correct weight), they shall be adjusted and no additional payment to the Contractor will be allowed for materials previously weighed and recorded.

3. The Project Manager may be present to witness the weighing and to check and compile the daily record of such scale weights; however, in any case, the Project Manager will require that the Contractor furnish weigh slips and daily summary weigh sheets. In such cases, a duplicate weigh slip or load slip for each vehicle weighed shall be furnished to the Project Manager at the point of delivery of the material.

   a. As a minimum, the weigh slips shall contain the following information:
      1) Contractor's name and contract number
      2) Supplier's name and location of material source
      3) Type of material
      4) Haul unit's unique identification number
      5) Empty weight (this should be checked three times per day)
      6) Full weight
      7) Weight of material hauled
      8) Scale operator’s signature stating the weights are correct to within one percent of standard weights.

   b. The loads shall be weighed prior to water being added.

4. If the material is shipped by rail, the certified car weights will be accepted provided that only actual weight of material will be paid for and not minimum car weight used for assessing freight tariff. Car weights will not be acceptable for material to be passed through mixing plants or material off loaded from rail cars and hauled to the jobsite by trucks from rail cars located off the worksite.

5. Trucks used to haul material being paid for by weight shall be weighed empty daily and at such additional times as the Project Manager may require. Each truck shall bear a plainly legible identification mark. The Project Manager may require the weight of the material verified by weighing empty and loaded trucks on such other scales as the he may designate.

6. When requested by the Contractor and approved by the Project Manager in writing, material specified to be measured by the cubic yard may be weighed and such weights will be converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Project Manager and shall be agreed to by the Contractor before such method of measurement of pay quantities is used.

7. The Contractor shall comply with all legal load restrictions in the hauling of equipment or materials on public roads beyond the limits of the project. A special permit will not relieve the Contractor of liability for damage resulting from the moving of equipment or material.
   a. The operation of equipment or hauling loads that cause damage to structures, the roadway or any other construction will not be permitted. Hauling of materials over the base course or surface course under construction shall be limited by the Contractor to methods and equipment that will prevent damage to the pavement structure before the expiration of the curing periods. The Contractor shall be responsible for the repair of all damage and related expenses resulting from hauling equipment and construction operations.
   b. If a vehicle's gross weight exceeds the legal limit, and the material transported by the vehicle is delivered to the project, the material and the scale ticket (certificate of correct weight) will not be accepted, except a 500 pounds tolerance will be allowed for overweight loads.
   c. If a scale ticket from an overweight vehicle is inadvertently accepted and the material incorporated into the project, the Project Manager will adjust the price for the overweight load as follows:
      1) The pay item quantity represented by the amount of material in excess of the legal weight plus 500 pounds tolerance will not be paid for.
      2) A price reduction will be assessed for the overweight portion of the load based on the following schedule:

Overweight (pounds)	Price Reduction (dollars)
0 - 500	0
501 - 3,000	20
3,001 - 4,000	40
4,001 - 5,000	82
5,001 - 6,000	130
6,001 - 7,000	226
7,001 - 8,000	376
8,001 - 9,000	582
9,001 - 10,000	842
Over 10,000	870 plus $164 for each 1,000 lbs.,or fraction thereof, or 10,000 lbs.

8. Bituminous materials will be measured by the gallon or ton. Unless noted otherwise volume will be measured at 60 degrees Fahrenheit or will be corrected to the volume at 60 degrees Fahrenheit using ASTM D 1250 for asphalt or ASTM D 633 for tars. Net certified scale weights or weights based on certified volumes in the case of rail shipments will be used as a basis of measurement, subject to correction when bituminous material has been lost from the car or the distributor, wasted, or otherwise not incorporated in the work. When bituminous materials are shipped by truck or transport, net certified weights or volume subject to correction for loss or foaming will be used for computing quantities.

C. Measurement by Volumes

1. Measurement by in-place volume will be by the cubic dimension listed or indicated in the Schedule of Prices and Quantities. Volume measurements will be neat line as shown on contract documents, or if actual field measurements show that the volume is less than neat line, the actual volume will be used. Method of volume measurement shall be

by average end area method, with end areas taken at no greater than 100 feet apart or every major change in the cross section area, which ever occurs first, unless noted otherwise. The Contractor may request alternate methods subject to the approval of the Project Manager.

2. Material indicated to be measured by volume in the hauling vehicle shall be hauled in approved vehicles and measured therein at the point of delivery. Vehicles for this purpose may be of any size or type acceptable to the Project Manager provided that the body is of such shape that the actual contents may be readily and accurately determined and is water tight so that the volume can be measured by filling with water. All vehicles shall be loaded to at least their water level capacity, and all loads shall be leveled when the vehicles arrive at the point of delivery.

D. Measurement of Areas

1. Measurement of areas will be by the square dimension listed or indicated in the Schedule of Prices and Quantities and or Unit Price Items. Area measurements will be neat line as shown on contract documents or, if actual field measurements show that the area is less than neat line, the actual area will be used. All longitudinal measurements shall be horizontal unless noted otherwise. Method of square measurement will be as determined by the Project Manager.

E. Measurement of Linear Items

1. Linear measurement will be by the linear dimension listed or indicated in the Schedule of Prices and Quantities and/or Unit Price Items. Linear measurements will be neat line as shown on contract documents, or if actual field measurements show that the linear measurement is less than neat line, the actual linear measurement will be used. Method of linear measurement will be as determined by the Project Manager. Generally, items, components or work to be measured will be measured at the centerline of the item in place.

1.03 FIELD MEASUREMENT FOR PAYMENT

A. The Contractor will compute all quantities of Work performed by the Contractor, including quantities of materials and equipment delivered to the site, for final payment purposes. Computed quantities are subject to check and review by the Project Manager. If errors are found, the Contractor shall correct them. If, in the opinion of the Project Manager, the errors are significant or frequent enough, the Project Manager may make the calculations with his own forces at the Contractor's expense. No payment will be made on that portion of an item containing calculation errors until the errors are corrected to the satisfaction of the Project Manager.

1. The Contractor will show the actual measurements that are used to compute the quantities along with the formulas used. As requested by the Project Manager, the Contractor shall supply the Project Manager with computations and sketches indicating where measurements were taken and their relationship to the finished product.

B. The Contractor will supply the Project Manager with an electronic copy and instruction manual of any computer programs used to calculate quantities. Any computer program used shall be executable on an IBM compatible computer with a 286, 386, 486 or Pentium processor. The Contractor shall also provide an electronic copy of the data files used to determine quantities.

C. The Contractor shall take all measurements for payment purpose in the presence of the Project Manager in accordance with the provisions for measurement specified herein and in

Technical Specifications Section 01050.

1.04 REJECTED MATERIALS

A. Quantities of material wasted or disposed of in a manner not called for under the contract, rejected loads of material including material rejected after it has been placed by reasons of the failure of the Contractor to conform to the provisions of the contract, material not unloaded from the transporting vehicles, material placed outside the lines indicated on the contract drawings or established by the Project Manager, or material remaining on hand after completion of the Work will not be paid for and such quantities shall not be included in the final total quantities. No compensation will be permitted for loading, hauling and disposing of rejected material.

1.05 PAYMENT CONSIDERATIONS

A. Payment will be full compensation for furnishing all labor, materials, tools, equipment, transportation, services and incidentals as specified in the General Conditions, technical specifications, and contract drawings, and for performing all work necessary for completing the item or work classification including all incidental work.

B. Full compensation for all expenses involved in conforming to the requirements for measuring materials shall be considered as included in the unit or lump sum prices paid for the materials being measured and no additional compensation will be permitted.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01025

SECTION 01050

LAYOUT OF WORK AND SURVEYS

PART 1 - GENERAL

1.01 SCOPE

A. This Section covers the procedures and accuracy requirements for survey services for layout of work, as-built surveys, and field measurement of work quantities to be determined by surveys.

B. Before commencing any layout of work and surveys the Contractor shall give the Project Manager 48 hours written advance notice so that the Project Manager may witness such work. Contact the Airport Survey Office: Dennis Hamlin, PLS DIA Land Surveyor Supervisor (Airport Survey Manager), DIA Airport Survey Office, 303-342-4428 or email: Dennis.Hamlin@flydenver.com. Contractors are responsible for obtaining DIA related survey guidance, survey points, calibration files and training materials from the Airport Survey Office prior to beginning survey work.

C. Reference Contract General Conditions, GC 317 and GC 318.

D. All construction as-built surveys shall comply with Federal Aviation Administration Advisory Circulars:

1. AC 150/5300-13 “Airport Design”
2. AC 150/5300-16A “General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey.”
3. AC 150/5300-17C “General Guidance and Specifications for Aeronautical Surveys: Airport Imagery Acquisition and Submission to the National Geodetic Survey.”
4. AC 150/5300-18B “General Guidance and Specifications for Aeronautical Surveys: Airport Survey Data Collection and Geographic Information System Standards.”

E. All construction as-built surveys shall comply with requirements of the following DIA Modeling Standards:

1. DIA Design Standards Manual 12: Chapter 2 – CADD Template.
2. DIA Design Standards Manual 12: Chapter 3 – GIS Data Standards.
3. DIA Design Standards Manual 12: Chapter 5 – Existing Subsurface Utilities Data Standards
4. DIA Design Standards Manual 12: Chapter 6 – Metadata Standards
5. DIA Design Standards Manual 12: Chapter 7 – GIS/CADD Data Submittal Requirements

F. Survey Project Checklist:

Step	Yes	No	N/A	Project Kickoff Phase
1	☐	☐	☐	Did Consultant/Contractor meet with DIA PM obtain the data standards and general requirements for data gathering?

2	☐	☐	☐	Did Consultant/Contractor meet with Airport Survey Office to obtain airport survey control points, GPS calibration files, and airport survey training materials?
3	☐	☐	☐	Did Consultant/Contractor provide Survey Statement of Work to DIA PM?
4	☐	☐	☐	Did Consultant/Contractor provide Geodetic Control Plan to DIA PM (only required if modifying/establishing PACS/SACS)?
5	☐	☐	☐	Did Consultant/Contractor provide Survey and Quality Control Plan to DIA PM?
6	☐	☐	☐	Did Consultant/Contractor provide Imagery Plan to DIA PM? (only required if collecting aerial imagery)?
7	☐	☐	☐	Did the FAA accept survey plans?
Step	**Yes**	**No**	**N/A**	**Construction Phase (As-Builts)**
8	☐	☐	☐	Did Consultant/Contractor perform field survey of project site to collect accurate as-built data?
9	☐	☐	☐	Did the Consultant/Contractor provide DIA PM with subsurface utility data?
10	☐	☐	☐	Each week, did the Consultant/Contractor provide DIA PM with Project Status Reports?
11	☐	☐	☐	Did the Consultant/Contractor provide DIA PM with 30% as-built data in both CADD and GIS formats including all attribute information and metadata?
12a	☐	☐	☐	Did DIA PM report 30% QA findings via email to Consultant/Contractor?
12b	☐	☐	☐	If required, did the Consultant/Contractor provide DIA PM with 60% as-built data in both CADD and GIS formats including all attribute information and metadata?
12c	☐	☐	☐	If applicable, did DIA PM report 60% QA findings via email to Consultant/Contractor?
12d	☐	☐	☐	If required, did the Consultant/Contractor provide the DIA PM with 90% as-built data in both CADD and GIS formats including all attribute information and metadata?
12e	☐	☐	☐	If applicable, did DIA PM report 90% QA findings via email to Consultant/Contractor?
13	☐	☐	☐	Did the Consultant/Contractor provide DIA PM with 100% as-built data in both CADD and GIS formats including all attribute information and metadata?
14	☐	☐	☐	Did Consultant/Contractor provide DIA PM with a completed Final Survey Report?
15	☐	☐	☐	Did DIA PM report QA findings via email to Consultant/Contractor?

1.02 SUBMITTALS

A. Refer to Technical Specifications Sections 01300 and 01340 for the submittal process.

1. Copies of original pages of field notes.
2. Original field notebooks when filled and at end of contract.

B. Consultant shall submit drawing data at each submittal to the City in both CADD and GIS

formats including all attribute information. GIS/CADD drawing submittals shall adhere to the standards set forth in document DSM 12 Chapter 7 CADD-GIS Data Submittal Requirements.

C. Geodetic Control Plan (only required if modifying or establishing PACS/SACS)

D. Survey Statement of Work (SOW)

E. Survey and Quality Control Plan (SQCP)

F. Imagery Plan –(only required if new aerial imagery is to be collected)

G. Weekly Project Status Updates

H. 30% as-built data in both CADD and GIS formats including all attribute information and metadata

I. 60% as-built data in both CADD and GIS formats including all attribute information and metadata (if required by DIA PM)

J. 90% as-built data in both CADD and GIS formats including all attribute information and metadata (if required by DIA PM)

K. Final as-built data in both CADD and GIS formats including all attribute information and metadata

L. Final Survey Report

PART 2 - PRODUCTS (NOT USED)

PART 3 - SURVEY CONTROL

3.01 GEODETIC CONTROL

A. All airport construction project surveys must tie to DIA LDP using methodologies established in the 12/10/2010 Woolpert, Inc Report: A Low Distortion Projection for Denver International Airport (DEN). The report provides Geodetic Control for establishing DIA Airport Survey Control points in DIA LDP. Denver International Airport utilized a coordinate system called DIA Grid coordinate system prior to August 1, 2011. Drawings may be found in the legacy coordinate system; however, these drawings can be used for reference purposes only unless specifically stated otherwise by the Denver International Airport Project Manager. Surveys must not utilize DIA Grid coordinate system for placing construction stakes or for collecting construction as-built information. All construction survey as-built data must be collected in DIA LDP regardless of special circumstances which allowed design, and construction stake surveys to be conducted in another airport approved coordinate system. All of DIA Airport Control Points are cataloged at www.ngs.noaa.gov website. The Airport Survey Office can provide coordinates of the Airport Control points in DIA LDP based upon project site location. DIA coordinate values are based on a DIA LDP (Low Distortion Projection) that was developed by Woolpert Inc. If there are any problems working with the local coordinates based on this system, contact Kevin Hoffman of Woolpert, Inc at Kevin.Hofman@woolpert.com.

B. Report damaged or destroyed airport control points, bench marks, and section corner monuments to the Project Manager.

1. If section corner monuments are damaged or destroyed during construction activities, such points shall be re-established pursuant to “Laws of the State of Colorado Regulating the Practice of Land Surveying” by a Professional Land Surveyor registered in the State of Colorado.

2. If airport control points or bench marks are damaged, moved, altered or destroyed by the Contractor, the City's cost of reestablishing such points shall be borne by the Contractor.

3. The City will not be responsible for any increased costs or delays to the Contractor relating to reference points, airport control points, or bench marks which are damaged, moved, altered or destroyed by the Contractor or its subcontractors, suppliers, agents or employees or other Contractors working on the site.

C. Report alleged errors in reference points, airport control points, or bench marks promptly to the Project Manager.

1. Discontinue use of reference points, airport control points, or bench marks alleged to be in error until the accuracy of points can be verified or as directed.

2. Claims for extra compensation for alteration or reconstruction allegedly due to errors in reference points, airport control points, or benchmarks will not be allowed unless original reference points, airport points and benchmarks still exist or substantiating evidence proving error is furnished by the Contractor, and unless the Contractor has reported such errors to the Project Manager as specified herein.

D. The following are limitations and additional information on reference points, airport control points and benchmarks:

1. The use of control monuments and GPS calibration files for construction surveying other than those shown on the contract drawings or furnished by or approved by the Airport Survey Office is strictly prohibited. Use of other monuments is at the Contractor's sole risk.

2. The DIA Airport Control Points include NAVD 88 elevations and LDP coordinate data. These values as listed on the contract drawings or listed in the specifications are the only approved coordinate points and elevations for construction surveying.

3. The use of control monuments for construction surveying other than those shown on the contract drawings or furnished by the Airport Survey Office is prohibited. Use of other monuments is at the Contractor's sole risk.

4. Elevations are based upon mean sea level datum from several NGS Class 2 benchmarks, which were accessed from areas outside of DIA to establish a NAVD88 Vertical Datum at DIA., in Jan. 2007 (1st order Class 2 elevations) by Woolpert, Inc.

5. The X, Y, Z data listed on the contract drawings or in the specifications is the only approved data to be used for construction surveying. This data will only be available on Airport Control Points. It is recommended that contractor contact Airport Survey Office to verify that horizontal and vertical data on contract drawings is correct, before beginning any work.

6. The coordinate (X, Y) data published on Airport Control Points is based on the DIA LDP coordinates developed for DIA by Woolpert, Inc.

7. The Airport Survey Office will provide the contractor with information on implementing the DIA LDP coordinate system. It is up to the Contractor to use the correct methodology in performing any survey task.

3.02 TEMPORARY CONTROL

A. When a contractor establishes temporary control stations for airport construction work they must follow FAA guidelines. All project temporary control stations must be tied to the National Spatial Reference System (NSRS) through the use of the a) National Geodetic Survey (NGS) Online User Positioning System (OPUS) or b) to DIA Survey Control Points provided by the Airport Survey Office. The only two acceptable means to establish temporary geodetic control for airport construction are as follows:

1. Temporary Control must be established under close cooperation with the Airport Survey Office following the procedures outlined in AC150/5300-16 General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to National Geodetic Survey only in the following cases:
    a. Large Airport Airfield Construction Project that significantly changes the airport geometry and would trigger the need to acquire new Digital Stereo Imagery following AC 150/5300-17 General Guidance and Specification for Aeronautical Survey Airport Imagery Acquisition and Submission to the National Geodetic Survey. Examples include a new Runway and Taxiway Complex, significant modification of existing Runway or Taxiway system, development of new outboard deice pad complex or establishment of new mid airfield concourse and terminal complex. The size and complexity of the project will dictate the need to acquire new Digital Stereo Imagery for significant construction.
    b. Construction that establishes a new ILS CAT II/III Operations
    c. New Instrument Development Procedure
    d. New Airport Layout Plan Survey Update
    e. New Airport Obstruction Chart Update
    f. New Airport Mapping Database
2. On Airport construction projects, the contractor, excluding large airport airfield construction projects referenced in 302.A.1, may use temporary control stations on their project site. These temporary stations must be tied to the nearest airport survey control points provided by the Airport Survey Office. All surveyors must obtain permission to establish temporary control points from the Airport Survey Office prior to beginning field work. The temporary points will have DIA LDP coordinate values only, along with NAVD88 elevations.
3. Contractors must protect and preserve all Airport Control Points and section corner monuments with their associated reference points. Coordinates shown on the drawings are based on DIA LDP coordinate system.
4. Contact Airport Survey Office for any additional coordinates that may exist in the area of the specific project. Establishing permanent reference points, control points and benchmarks are prohibited except by authorized personnel.
5. Report damaged or destroyed Airport Control Points, benchmarks and section corners to the Project Manager and the Airport Survey Manager.
    a. If any section corner monuments are damaged or destroyed during construction activities, such points shall be re-established pursuant to “Laws of the State of Colorado Regulating the Practice of Land Surveying” by a Professional Land Surveyor registered in the State of Colorado. Work to be done under supervision of Airport Survey Manager.
    b. If Airport Control Points are damaged, moved, altered or destroyed by the Contractor, the City's cost of reestablishing such points shall be borne by the Contractor.
    c. The City will not be responsible for any increased costs or delays to the Contractor relating to reference points, Airport Control Points which are damaged, moved, altered or destroyed by the Contractor or its subcontractors, suppliers, agents or

employees or other Contractors working on the site.

6. Report alleged errors in reference points, Airport Control Points, promptly to the Project Manager and to the Airport Survey Manager.
   a. Discontinue using any Airport Control Points, alleged to be in error until the accuracy of points can be verified or as directed.
   b. Claims for extra compensation for alteration or reconstruction allegedly due to errors in Airport Control Points, will not be allowed unless original still exist or substantiating evidence proving error is furnished by the Contractor, and unless the Contractor has reported such errors to the Project Manager and to the Airport Survey Manager as specified herein.
7. The following are limitations and additional information on Airport Control Points and benchmarks.
   a. The use of control monuments and GPS calibration files for construction surveying other than those shown on the contract drawings or furnished by or approved by the Airport Survey Office is strictly prohibited. Use of other monuments is at the Contractor's sole risk.
   b. The DIA Airport Control Points include NAVD 88 elevations and LDP coordinate data. These values as listed on the contract drawings or listed in the specifications are the only approved coordinate points and elevations for construction surveying.
   c. The use of control monuments for construction surveying other than those shown on the contract drawings or furnished by the Airport Survey Office is prohibited. Use of other monuments is at the Contractor's sole risk.
   d. Elevations are based upon mean sea level datum from several NGS Class 2 benchmarks, which were accessed from areas outside of DIA to establish a NAVD88 Vertical Datum at DIA., in Jan. 2007 (1st order Class 2 elevations) by Woolpert, Inc.
   e. The X, Y, Z data listed on the contract drawings or in the specifications is the only approved data to be used for construction surveying. This data will only be available on Airport Control Points. It is recommended that contractor contact Airport Survey Office to verify that horizontal and vertical data on contract drawings is correct, before beginning any work.
   f. The coordinate (X, Y) data published on Airport Control Points is based on the DIA LDP coordinates developed for DIA by Woolpert, Inc.
   g. The Airport Survey Office will provide the contractor with information on implementing the DIA LDP coordinate system. It is up to the Contractor to use the correct methodology in performing any survey task.

PART 4 - FAA REPORTING REQUIREMENTS

4.01 DESCRIPTION

A. Work specified in this Section includes FAA required reporting requirements for projects created during actual airport construction which must be provided by the Contractor.

B. Thorough reporting to the FAA is required for all Airport Construction Projects at DIA. Prior to beginning any fieldwork, a Contractor must submit the following items to the DIA Project Manager:

C. A Geodetic Control Plan (GCP) - only “required” when establishing PACS/SACS

D. Statement of Work (SOW)

E. Survey and Quality Control Plan (SQCP)

F. Imagery Plan – only "required" if new aerial imagery is to be collected

G. During the construction project as-built survey collection period, Weekly Status Reports are required to be submitted to the DIA Project Manager for DIA submittal to the FAA. Upon project completion, the Contractor must provide to the DIA Project Manager a final project survey report.

H. All reporting requirements are mandatory requirements set forth by the FAA and not the airport. The airport is responsible for meeting FAA reporting requirements under Airport Improvement Program Grant Obligation #34.

I. At a minimum, the Contractor:

J. "….must provide all labor, equipment, supplies, materials, and transportation to produce and deliver data and related products as required…"

K. "…must submit in writing requests for modifications to or deviations from…specifications to the contractor issuing authority, NGS, and FAA points of contact (POCs) as soon as a need for them is identified."

L. "…must notify the contract issuing authority of any unusual circumstances occurring during the performance of the tasks identified…that affect the deliverables or their quality…"

M. "…must submit a weekly project status report, a Quality Control Plan…, a Project Survey Plan…, and a Final Project Report…to the contract issuing authority."

N. Must retain "…observation logs and other original records generated during (the completion of a) project…and must be retained for data accountability by the Airport Authority."

4.02 GEODETIC CONTROL PLAN

A. Denver International Airport (DEN) is a NPIAS or National Plan of Integrated Airport Systems Part 139 airport and has existing Primary Airport Control Stations (PACS) and Secondary Airport Control Stations (SACS). The survey monuments established in the airport vicinity must meet all accuracy requirements and other criteria specified in AC 150/5300-16, General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey. These monuments and their accurate connection to the NSRS assure accurate relativity between all surveyed points on an airport and the NAS, including navigation satellites.

B. A Geodetic Control Plan is required only if establishing PACS/SACS at DIA. Contact DIA Airport Survey Office to coordinate this plan if required. Refer to 01050a, Appendix X for a Geodetic Control Plan Template.

4.03 STATEMENT OF WORK

A. The Contractor must use AC 150/5300-18 Table 2-1, "Survey Requirements Matrix," to develop a complete Statement of Work (SOW) that can then be uploaded into the FAA Airports GIS website. The SOW is the consultant's written description of their methodology for surveying/consulting services that are going to be provided as part of the project (including specific features that will be surveyed, action items, timelines, necessary airport resources and general information). The SOW must be reviewed and accepted by the FAA. Refer to 01050a, Appendix X for a SOW Template.

4.04 SURVEY AND QUALITY CONTROL PLAN

A. The Contractor must develop and submit a survey and quality control plan to the DIA Project Manager. The FAA Airport Surveying–GIS Program manager or designated representative will review and approve the survey work and quality control plans. In these plans, detail the methodologies for data collection, data safeguarding and quality assurance. Provide insight into how you will completely check all data to ensure it is complete, reliable, and accurate. Identify data safeguards used to protect this sensitive and safety critical data. Utilize a checklist based quality control process with definable and repeatable standards for each element ensuring consistency of work between different personnel within an organization. Refer to 01050a, Appendix X for a Survey Quality Control Plan Template.

B. The Survey and Quality Control Plan must include the quality control (including error analysis) procedures and practices followed during data collection and provide traceability and adherence to the requirements of this guidance. At a minimum, the plan will include the following:

1. Summarize what methods you will use to ensure high-quality data.
2. Describe the quality control measures used to ensure all data is checked, complete, reliable, and meets the accuracy requirements of AC 150/5300-18.
3. Provide evidence of the methods used to collect the various types of features to meet the desired accuracies.
4. Describe the data backup and archive procedures and methods used to ensure the integrity of the original data.
5. Explain the methods used to check all file formats and provide a summary of the file-naming convention for all electronic files.

4.05 IMAGERY PLAN

A. An Imagery Plan is required only if collecting aerial imagery for a project.

4.06 WEEKLY PROJECT STATUS REPORTS

A. The Contractor shall submit a project status report to the Project Manager weekly, from the date of the task order until the work is completed. Include in the reports the percentage complete for each of the major portions of the work with the estimated completion date or completion date. Provide the status of ongoing work (with expected completion dates) and any unusual circumstances and/or deviations from this guidance. Refer to 01050a, Exhibit X for a Weekly Project Status Report Template.

4.07 FINAL PROJECT SURVEY REPORT

A. The Contractor shall submit a Final Project Survey Report. The Final Survey Report is a compilation of documentation supporting the survey project providing a standardized delivery of field notes, raw survey data and project summary to facilitate the independent verification, validation, and quality assurance of the safety critical data. Refer to 01050a, Exhibit X for a Final Project Survey Report Template.

PART 5 - EXECUTION

5.01 CONSTRUCTION LINES AND GRADES

A. The Contractor shall make surveys and layouts as necessary to delineate the work. The

Contractor shall make the surveys for the proper performance of the Work. As a part of such surveys, the Contractor shall furnish, establish and maintain in good order survey control points that may be required for the completion of the Work subject to the approval of the Project Manager as to their location, sufficiency and adequacy. However, such approval by the Project Manager shall not relieve the Contractor of his responsibility for the accuracy of his survey work.

B. The Project Manager shall have the right to check surveys and layouts made by the Contractor prior to approving any of the Work. The Contractor shall give advance notice of not less than 48 hours to the Project Manager to enable such checking prior to placing any Work. The Contractor shall furnish assistance as may be required for checking purposes when so requested by the Project Manager.

C. The Contractor shall furnish skilled labor, instrument platforms, ladders and such other temporary structures as may be necessary for making and maintaining points and lines in connection with the surveys required.

D. The City may draw the Contractor's attention to errors or omissions in lines or grades, but the failure to point out such errors or omissions shall not give the Contractor any right or claim nor shall in any way relieve the Contractor of his obligations according to the terms of this contract.

E. The Contractor's instruments and other survey equipment shall be accurate, suitable for the surveys required in accordance with recognized professional standards and in proper condition and adjustment at all times. Surveys shall be performed under the direct supervision of a Colorado licensed surveyor.

F. Field Notes:

1. The Contractor shall record surveys in field notebooks or as electronic field notes, whichever is more appropriate to the type of survey work. Copies of the original pages of field notebooks shall be furnished to Project Manager and the Airport Survey Manager at intervals required by the Project Manager. Each field notebook shall be furnished to the Project Manager when filled or completed. Field notes shall be kept in the form and style shown in the book Surveying with Construction Applications" by Barry F. Kavanagh Fourth Edition. No erasures are allowed on the data entered in the field book. Cross out errors, and write correct entries above. The person that makes correction in the field book should initial above corrections made. An explanatory note shall be made for all corrections to original figures. All editing of computer records shall be done on a copy of the original with all changes initialed. Electronic data from data collectors shall be provided in formats in accordance with Design Standards Manual Volume 12 and Construction Plan Manual Technical Specifications Division 1. These will be used to supplement field books and shall be supplied to the Project Manager and Airport Survey Manager on Compact Disk (CD).

2. If the Project Manager or Airport Survey Manager finds errors in the field notes he will return them to the Contractor for correction and resubmission. This review does not relieve the Contractor from the responsibility of maintaining accurate survey data. Whichever method of note-taking the Contractor starts with, he must use the same method throughout the contract duration. If the Project Manager finds errors in the field notes he will return them to the Contractor for correction and resubmission. This review does not relieve the Contractor from the responsibility of maintaining accurate survey data.

G. The Project Manager may at any time use line and grade points and markers established by

the Contractor. The Contractor's surveys are a part of the Work and may be checked by the Project Manager or his representatives at any time. The Contractor shall be responsible for any lines, grades or measurements that do not comply with specified or proper tolerances or which are otherwise defective and for any resultant defects in the Work. The Contractor will be required to conduct re surveys or check surveys to correct errors indicated by review of the field notebooks.

5.02 AS-BUILT SURVEYS

A. Denver International Airport contractually requires record drawings of all construction projects that occur on airport property. Layout or stake-out surveys are the translation of construction plans into physical points on the ground used as a basis for the actual construction. The airport requires the collection of layout (stake-out surveys) for the placement of sub surface utilities to capture the location of sub-surface utilities before they are covered. All As-Built (Airport Record Drawing) construction surveys require data collection that is compliant with Design Standards Manual Volume 12. FAA requirements for construction as-builts are contained in AC150/5300-18B Chapter 5. Denver International Airport desires standard accuracy requirements at engineering quality for all features collected in as-built airport record drawings. These requirements are for 0.25 ft horizontal accuracy and 0.25 ft vertical accuracy. Denver International Airport positional accuracy requirements often exceed FAA mandated accuracy requirements for features contained in AC150/5300-18B Chapter 5. If the contractor is unable to meet Denver International Airport engineering survey accuracy of 0.25ft, the contractor must meet minimum FAA mandated accuracy requirements contained in AC150/5300-18B Chapter 5. The contractor must notify the Project Manager of any deviations in accuracy standards that depart from 0.25 ft vertical/horizontal. Please reference the feature(s) involved, and explain why you must deviate from the accuracy requirement and what accuracy the feature(s) were collected in both vertical and horizontal planes.

1. Collect all manmade objects on airport property and if outside airport property all objects that have a height equal or greater than 200 ft AGL.
2. The identification of the boundary lines of the project tract using the features in the Man Made Structures group.
3. Show lines of original lot boundaries using features from the Cadastral group.
4. The collection of all existing roads, alleys and easements with their widths and platted using the features in the Surface Transportation group.
5. The collection of sufficient spot elevations defining the surface drainage on the project site and within 50 feet outside the boundary using the features of the Geotechnical group.
6. Identification of control Benchmark(s) through use of Geotechnical group features.
7. Locate and classify all visible evidence of utilities and storm water drainage features on or within 50 feet of the project boundary to include water lines, valves, backflow devices, meters and fire hydrants. This information uses features from the Utilities group.
8. Sanitary sewer, manholes with invert and top elevation, pipe sizes through manholes with direction of flow indicated. Irrigation lines, catch basins, storm sewer pipes, junction boxes with inverts, type of inlet, pipe sizes, pipe types and direction of flow. Swales, curbs, gutters with spot elevations and direction of flow can all be modeled with features from the Utilities group.
9. Sidewalk, street parking, loading areas, driveway width(s) along with the edge(s) of existing paved areas using the Surface Transportation feature group.
10. Power poles, guy wires, overhead power lines are classified using the Utilities features

group.

11. Trees, tree groupings and shrubs using the Environmental feature.

12. Model existing building structures, fences or walls on site and within 50 feet of the property line using features within the Man Made Structures group.

13. Show existing contours on 0.50 foot intervals if existing site elevations vary by greater than 1.5 feet using features from the Geotechnical group.

14. Existing natural features such as high points, water courses, depressions, ponds, marshes, swamps, wooded areas and flood elevations (if available) are modeled using the features in the Environmental group.

15. Location of any protected species habitat or environmentally sensitive lands or vegetation, as well as any known historical or archaeological resources using the Environmental and Man Made Structures feature groups.

16. Identify any objects under construction as “Building Under Construction”.

17. Determine the elevation of the object at time of survey. If a construction crane extends above a feature under construction, it is necessary to determine the elevation and position of the crane. Identify, classify and report using the Construction Area feature and associated accuracies and collection requirements.

B. Exceptions to survey collection requirements include: Annual weeds, corn, millet, alfalfa etc. Construction equipment and debris, including dirt piles and batch plants which are:

1. Temporary in nature

2. Under the control of the airport

3. Located on Airport Property

C. As-built measurement for items that will be hidden or visible including all civil, mechanical, electrical, control work and all utilities that are placed in concrete, earth or behind walls shall be made by and under the direction of a Colorado licensed surveyor while the work is exposed and the measurements submitted to the Project Manager. Unless noted otherwise the measurements shall show the final location within 0.1ft of their actual horizontal and vertical location based upon DIA LDP coordinates and NAVD88 vertical datum. Items located within or five feet beyond a building shall be referenced to building column lines and finish floor elevations. Special attention shall be paid to items requiring service, sensors, and items with moving parts, access points and locations of junctions, elevation changes and directional changes. If a construction project alters any natural (including topography) or man-made feature that was not specifically addressed in the project scope of work, the Contractor is responsible for collecting the change in the feature(s) affected by the project and supplying those affected features in the final as-built survey.

D. Survey notes shall be supplied to the Project Manager prior to covering up the work. Survey notes shall also be supplied to the DIA Survey Manager in an electronic format that can be read in AutoCAD 2010 or earlier version.

E. Should the submitted as-built drawing or model fail a quality control check, the Contractor is responsible for correcting the as-built survey to comply with airport standards.

F. The Airport Survey Office has the right to enter any construction site, at any time, and request from the contractor any:

1. Survey Field Notes

2. All FAA Weekly Project Status Reports

3. Geo-tagged Photographs (if required by FAA depending on project location)
4. Airport Survey Control Points used
5. Survey measurement files used in data collection
6. Inspect Survey Equipment Used by Contractor

G. The Airport Survey Office may also check site survey work with their own survey instruments to ensure survey work is within tolerance requirements. Any problems found by the Airport Survey Office during site inspections are to be reported to the Project Manager.

5.03 SUBSURFACE UTILITIES ENGINEERING (SUE)

A. Refer to Technical Specifications Sections 01020 for information related to underground utilities.

5.04 NAVAID SURVEY

A. If an Airport construction project installs new aeronautical navigational equipment or changes any aspect of existing Airport Navigational Aids, compliance with FAA criteria is necessary. The Navaid may be owned or operated by either by the FAA, City of Denver, or County of Denver. Prior coordination with the Planning Department and Airport Survey Office is required to obtain specific technical survey requirements.

B. A list of common Airport Navigational Aids is provided below:

1. Air Route Surveillance Radar (ARSR)
2. Airport Surface Detection Equipment (ASDE)
3. Airport Surveillance Radar (ASR)
4. Distance Measuring Equipment (DME)
5. Fan Marker (FM)
6. Localizer (LOC)
7. Glide Slope (GS)
8. End Fire Types (GS)
9. Inner Marker (IM)
10. Middle Marker (MM)
11. Outer Marker (OM)
12. Back Course Marker (BCM)
13. Localizer Type Directional Aid (LDA)
14. MLS Azimuth Antenna (MLSAZ)
15. MLS Elevation Antenna (MLSEL)
16. Non-Directional Beacon (NDB)
17. Simplified Directional Facility (SDF)
18. Tactical Air Navigation (TACAN)
19. VHF Omni Directional Range (VOR)

20. VOR/TACAN (VORTAC)
21. Airport Beacon (APBN)
22. Visual Glide Slope Indicators (VGSI)
23. Runway end Identifier Lights (REIL)
24. Approach Light System (ALS)

5.05 CONSTRUCTION ALTERING/REHABILITATING AIRPORT RUNWAYS (ALL RUNWAYS AT DIA)

A. Significant application of special survey criteria for collecting as-built conditions after any construction or alteration of a runway is most critical to the FAA and hence requires construction is complete as well as utility collection when subsurface utilities are being placed in the ground. Any construction which will take place in areas defined below needs prior coordination with the DIA Planning Department to create a survey plan that meets specific FAA criteria. No surveying should take place prior to the Airport Project Manager coordinating with the DIA Planning Department and Airport Survey Office.

1. Construction on paved Runway Surface
2. Construction on Runway Shoulders
3. Construction in Runway Safety Area
4. Construction in Runway Protection Zone
5. Construction on Runway Blast Pad

5.06 CONSTRUCTION TOPOGRAPHIC SURVEYS/DESIGN SURVEYS

A. Topographic/Design surveys determine the shape and slope of the construction project area allowing the user to visualize the rise and fall of the land. Typically, airport topographic surveys provide landform data for planning studies, engineering designs, navigational aid installation or to support a new instrument flight procedure.

Contour Interval	Vertical Positional Accuracy (in feet)	Horizontal Positional Accuracy (in feet)
1 foot	±0.50	±1.0
2 feet	±1.30	±2.0
4 feet	±2.60	±4.0
5 feet	±3.20	±4.0
10 feet	±6.50	±8.0
Spot ground elevations	±0.20	±2.0
Spot paving elevations	±0.05	±1.0
Well defined planimetric features	±0.10	±1.0

1. Document the location of permanent structures including bridges, piers, culverts and docks using the Bridge feature in the Surface Transportation feature group.
2. Document the location of street or road paving entrance drives, openings, and sidewalks using features from the Surface Transportation feature group.
3. Classify the elevations on the top of curbs, gutters and sidewalks using features from the Surface Transportation feature group.
4. Provide spot elevations covering the entire survey limits showing high points, low

points, and grade changes. This should be done at sufficient intervals to represent the general character of the terrain using the Airport Control Point feature in the Geospatial feature group.

5. Location and elevation of lakes, rivers, streams or drainage courses on or near the airport or design area using the Shoreline feature in the Environmental feature group.

6. Location, diameter, and species of all trees over a 6-inch diameter using features from the Environmental feature group.

7. Outline the perimeter outline of thickly wooded areas unless otherwise directed using features from the Environmental feature group.

8. Electric utilities – the location of power poles, guy wires, anchors, vaults, etc. using features from the Utilities feature group.

B. As with other aspects of airport surveys, the positional accuracy of the topographic survey ensures the data collected meets the needs of the FAA. The following relative positional accuracies are provided as a general guide for topographic surveys and are specified at the 95% confidence level. Collect and provide the location and elevation of water and gas components extending more than 3 inches above the surface. These components include items such as water or gas valves, standpipes, meters, regulators, fire hydrants, etc. Locate, classify, and determine the elevation (MSL) of other utility components such as telephone or light poles, manholes, boxes, etc., visible on the airport. Classify these features using the appropriate feature types in the Utility feature group in DSM12 - Chapter 2 CADD Procedures Manual.

5.07 PROPERTY BOUNDARY SURVEYING/LAND-USE

A. All property surveys on airport property need to comply with the requirements for the State of Colorado and be conducted by a licensed surveyor in the state. For more details please see the following links.

Colorado State Constitution

Article XX – Home Rule

http://www.michie.com/colorado/

Colorado Revised Statutes Regarding Land Surveying

http://www.dora.state.co.us/aes/Statute-PLS.pdf

State Board Rules and Regulations

http://www.dora.state.co.us/aes/AES2008_Rules_Bylaws_II.pdf

State Board Policies

http://www.dora.state.co.us/aes/Policies-PEPLS.pdf

City and County of Denver Municipal Code

Chapter 49 – Article III Layout of Streets

Chapter 50 Subdivision of Land

http://www.municode.com/Resources/gateway.asp?pid=10257&sid=6

B. When necessary, the surveyor will set boundary monuments in accordance with the accepted surveying practice and legal requirements so that, upon completion of the survey, each

corner of the property and each referenced control stations will be physically monumented. When it is impossible or impracticable to set a boundary monument on a corner, the surveyor will set a reference monument, similar in character to the boundary monument and preferably along one of the property lines intersecting at the corner. When a reference monument is used, clearly identify it as a reference monument on the plat of the property and in any new deed description, written for the property. Every boundary monument and/or reference monument set by the surveyor will, when practicable:

1. Be composed of a durable material.
2. Have a minimum length of thirty inches with a 2 inch minimum diameter durable metallic cap
3. Have a minimum cross-section area of material of 0.2 square inches.
4. Be identified with a durable marker bearing the surveyor's registration
5. Number of (PLS) with company name and date, should be stamped on the cap
6. Be detectable with conventional instruments for finding ferrous or magnetic objects.

C. When a case arises due to physical obstructions where a boundary or reference monument cannot be conveniently or practically set, then alternative monumentation will be established for the particular situation. This alternative monumentation must be durable and identifiable (e.g. chiseled "X" in concrete, drillhole, etc.).
   1. Reference Contract General Conditions, GC 31 and GC 318.

5.08 SPECIAL SURVEYS

A. Under the contract City may require a special type of data collection – HDS or images with geotag. Contractor shall follow the Standards for HDS scanning and provide deliverables with accordance to Design Standards Manual Volume 12 and Project Plan Technical Specifications Division 1. Denver International Airport currently utilizes the Leica HDS C10 Scanner to collect data and Leica Cyclone 7 to process point clouds and export deliverables for CAD/BIM/GIS.

B. All contractors must use proper and compatible HDS instruments and post processing software to assure that the final deliverables will fit in the following requirements:
   1. Acceptable file formats:
   2. DWG and DXF
   3. GIS SHP files
   4. RVT-BIM Rivet File
   5. TXT, CSV, XYZ format for points with coordinates and elevation
   6. Content in acceptable file formats
   7. Solids
   8. Shapes
   9. Break lines
   10. Point, Polyline, Line, Polygon, Multipatch
   11. TIN,

12. Image –geotaged JPG, TIFF

C. Data must comply with Design Standards Manual: Volume 12 and Construction Plan Manual Technical Specifications Division 1.

5.09 SURVEYS FOR MEASUREMENT FOR PAYMENT

A. When the specifications or the Project Manager require items in the Schedule of Prices and Quantities to be measured by surveying methods, the Contractor shall perform the surveys. All such surveys, including control surveys run for establishing the measurement reference lines, shall be performed in the presence of the Project Manager or his representative who will witness the surveying operation and who will sign the field notes or keep duplicate field notes, at the Project Manager's option. The Contractor will reduce the field notes and calculate final quantities for payment purposes. The note reductions and calculations will be given to the Project Manager upon request.

5.10 SURVEYING ACCURACY AND TOLERANCES IN SETTING SURVEY, LAYOUT AND QUANTITY CALCULATION STAKES

A. Control traverse field surveys and computations shall be performed to an accuracy and precision of at least 1:40,000.

B. The tolerances generally applicable in setting survey stakes shall be as set forth below. Such tolerances shall not supersede stricter tolerances required by the Drawings or Specifications, and shall not otherwise relieve the Contractor of responsibility for measurements in compliance therewith. Tolerances in setting survey stakes shall be as follows:

1. Tolerance on Error in Line, Kind of Survey Stake or Mark Distance Tangent, Markers on hubs and monuments, curves, on centerline and offset centerlines: 1:20,000, 0.01 ft, 10 sec.
2. Intermediate stakes or marks on centerline and offset centerlines: 1:5,000, 0.05 ft, 1 min.
3. Grade Stakes or Marks for: Excavation and backfill; slope stakes +/-0.10 ft
4. Steel reinforcement and formed concrete ACI and AISC specified tolerance. If none described then the tolerance is +/- 0.02 ft.

PART 6 - MEASUREMENT

6.01 METHOD OF MEASUREMENT

A. Construction as-built surveying shall be measured per lump sum for all work described herein, including preparation of survey plan documents, field surveying, data reduction and attribution, data deliverables, and final survey report.

PART 7 - PAYMENT

7.01 METHOD OF PAYMENT

A. Payment shall be made at the contract unit price per lump sum.

B. Payment shall be made under:

1. Item 01050a As-Built Surveying and FAA AGIS-compliant Data Deliverables.....….per lump sum

END OF SECTION 01050

SECTION 01051

PROJECT COORDINATION

PART 1 - GENERAL

A. Work specified in this Section includes coordination efforts which must be provided by the Contractor to ensure that work by others in the contract designated work area and adjacent areas does not negatively impact the Work and overall project.

B. The construction schedule as specified in Technical Specifications Section 01310 shall reflect all interfaces and coordination efforts as specified in General Condition 701, Special Condition SC-6, Technical Specification Sections 01010, 01014, 01051, and 01650, and other related contracts and procurement documents.

C. The Contractor will establish regular working relations with all contractors, tenants and the Airport Maintenance Department working in the same area and areas adjacent to the construction site. The Contractor will attend construction progress meetings as described in Technical Specification Section 01200 and will coordinate work as described therein.

D. The Contractor will assign a member of his staff to act as a coordinator, who will work to coordinate the Contractor's work with other parties doing work at the Denver International Airport site.

1.02 WORK INCLUDED

1.03 CONTRACTOR'S RESPONSIBILITIES

1.04 COORDINATION WITH OTHER PROJECTS

1.05 METHOD OF MEASUREMENT

1.06 METHOD OF PAYMENT

A. Minimum cooperation requirements with other contractors include the following:

1. Regular meeting (weekly or more often)
2. Construction schedule coordination
3. Staging area and access planning (to include employee shuttle routes)
4. Deliveries
5. Traffic control.

B. When and where required, the Contractor shall develop appropriate coordination drawings for use by interfacing adjacent parties using the Denver International Airport site.

C. The following is a list that includes, but is not limited to all of the contractors that will be working in the area of the project limits: dia project manager needs to complete list below.

1. (insert name of contractor)
2. (insert name of contractor)

3. (insert name of contractor)

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01051

SECTION 01060

REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section identifies primary compliance with the State, City and County of Denver's regulatory requirements including:

1. The Department of Aviation
2. Colorado Department of Transportation
3. Department of Public Works (including The Division of Wastewater Management)
4. The standards which govern design and construction projects at Denver International Airport.

B. Construction shall be based on the latest edition of the referenced codes including additions and revisions thereto that are in effect at the time of project bidding.

1.02 RELATED SECTIONS

A. 01566 – Environmental Controls: for environmental and related permitting requirements.

1.03 BUILDING CODE

A. All design and construction work shall be governed by the Building Code for the City and County of Denver, latest edition. This is based upon the International Building Code of the International Code Council with Denver Amendments to this code. Appendix N of the amendments addresses Airport Buildings and Structures.

1.04 DENVER BUILDING DEPARTMENT

A. For review and approval of all construction documents for compliance to the Denver building code:

City and County of Denver
Community Planning and Development
Building Inspection Division
201 West Colfax Avenue, Dept 205
Denver, Colorado 80202
Telephone 720-865-2720
Fax 720-865-2880

1.05 DENVER FIRE DEPARTMENT

A. For review and approval of plans for compliance with the Denver Fire Department's requirements as they apply to the Denver International Airport:

Denver Fire Department
745 W. Colfax Ave.
Denver, Colorado 80204
Telephone 720-865-2833

B. The Contractor is advised that the Denver Fire Department – Fire Prevention Bureau requires permitting for the following activities as they apply to the scope of work. The Contractor is responsible for obtaining the appropriate permits necessary to complete the work. All costs associated with this permitting and policy compliance shall be the responsibility of the Contractor. The policies all reference the International Fire Code (IFC).

1. "Hot work", which is defined as the operation of any equipment or tool that creates sparks, hot slag, or radiant or convective heat as a result of the work. This includes, but is not limited to, welding, cutting, brazing, or soldering.

2. Use and storage of compressed gas for both temporary storage and permanent facility installation. This includes, but is not limited to, flammable gas (excluding propane-LPG), oxidizer (including oxygen), and inert and/or simple asphyxiates.

3. Tank installation, which includes above-ground storage tanks (AST) and underground storage tanks (UST) for both temporary tanks and permanent facility installations.

C. In addition to the above permits, the Denver Fire Department may require other permits that are associated with the specific work in the Contract Documents. Policies provided by the Denver Fire Department are meant to provide basic information for the most common conditions and situations. In any given occupancy, many other Uniform Fire Code requirements may be enforced. These should be addressed with the Denver Fire Department before construction begins and during construction with premise inspection(s). Any questions can be addressed to the Fire Prevention Bureau between 6:30 AM and 9:00 AM Monday-Friday at 720-913-8242 or -8237.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 PERMITS AND CERTIFICATIONS

A. The Contractor shall maintain records on site of all permits acquired by federal, state, and local agencies. Posting of permits shall conform to requirements of the respective agencies.

B. At the completion of any inspection by other agencies, the Contractor shall forward copies of the status of the inspection and copies of any approved or "signed-off" inspections by the respective agencies to the Project Manager.

C. At the time of request for Substantial Completion, the Contractor shall forward to the Project Manager all permits approved by the respective agencies.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work

described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01060

SECTION 01070

ABBREVIATIONS AND SYMBOLS

PART 1 - GENERAL

1.01 REFERENCE LIST

A. Documents published by the following agencies may be referenced within these Contract Documents to define the quality of materials, equipment, workmanship and other features of work. Unless otherwise stated, the reference documents shall be of the latest edition as of the date of the Advertisement for Bids.

B. Wherever used in the Contract Documents, the following abbreviations will have the meanings listed:

AALA	American Association of Laboratory Accreditation
AAN	American Association of Nurserymen
AAO	Affirmative Action Officer
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFI	Air Filter Institute
AGTS	Automated Ground Transportation System
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute, Inc.
APA	American Plywood Association
APEN	Air Pollution Emission Notes
APWA	American Public Works Association
ARI	Air Conditioning and Refrigeration Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers

ASME	American Society of Mechanical Engineers
ASNT	American Society for Non-Destructive Testing
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
AWPA	American Wood Preserver's Association
AWS	American Welding Society
AWWA	American Water Works Association
BID	Building Inspection Division, Department of Public Works
CAR	Corrective Action Report
CCD	City and County of Denver
CCR	Contractor Change Request
CCRL	Cement Concrete Reference Laboratory
CD	Change Directive
CDOH	Colorado Department of Highways or Colorado Department of Health
CDOT	Colorado Department of Transportation
CMEC	Concrete Materials Engineering Council
CN	Change Notice
CO	Change Order
COE	Corps of Engineers
CPM	Critical Path Method
CR	Change Request
CRSI	Concrete Reinforcing Steel Institute
CSI	Construction Specifications Institute
DFD	Denver Fire Department
DIA	Denver International Airport
DOT	United States Department of Transportation

DOR	Designer of Record
DWB	Denver Water Board
EEO	Equal Employment Officer or Equal Employment Opportunity
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
FM	Factory Mutual Association
FS	Federal Specifications (U.S. General Services Administration)
GCC	General Contract Conditions
IAPMO	International Association of Plumbing and Mechanical Officials
IBR	Institute of Boiler and Radiator Manufacturer's
ICBO	International Conference of Building Officials
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
ISA	Instrument Society of America
ITA	Independent Testing Agency
MIL	Military Specifications (Naval Publications and Forms Center)
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NAAB	National Association of Air Balance
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards (now called National Institute of Standards and Technology)
NCR	Nonconformance Report
NEC	National Electric Code (NFPA 70)

NECA	National Electric Contractors Association
NEMA	National Electrical Manufacturer's Association
NESC	National Electrical Safety Code
NFC	National Fire Code (as published by NFPA)
NFPA	National Fire Protection Association
NICET	National Institute for the Certification of Engineering Technologies
NIST	National Institute of Standards and Technology
NGS	National Geological Survey
NLMA	National Lumber Manufacturers Association
NOAA	National Oceanic and Atmospheric Administration
NRMCA	National Ready Mix Concrete Association
NTP	Notice to Proceed
NVLAP	National Voluntary Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PDM	Precedent Diagram Method
PS	Product Standard of NIST (U.S. Department of Commerce)
PM	Project Manager (DIA)
QA	Quality Assurance
QC	Quality Control
RAR	Remedial Action Request
RFI	Request for Information
SC	Special Contract Condition
SDI	Steel Door Institute
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
SSPWC	Standard Specifications for Public Works Construction

TCP	Traffic Control Plan
TSA	Transportation Security Administration
UBC	Uniform Building Code (published by ICBO)
UL	Underwriters Laboratories, Inc.
UMC	Uniform Mechanical Code (published by ICBO)
UPC	Uniform Plumbing Code (published by ICBO)
USC	United States Code
WBS	Work Breakdown Structure

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01070

SECTION 01091

REFERENCE STANDARDS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. This Section contains a summary of industry-accepted and recognized standards published by trade associations, government and institutional organizations which are referred to in the various Sections of these specifications or elsewhere in the contract documents.

B. Standards listed herein are included in the contract documents by this reference and become a part of the contract documents to the same extent as though included in their entirety unless specific limitations are noted in the individual Specifications sections.

C. Listings of reference standards include name and address of the organization publishing the standard, plus the full name and designator of each of the standards referenced herein.

D. If a publication date or edition number is listed with the reference standard, that publication date or edition number shall apply; otherwise, the publication date or edition number in effect at the contract date shall apply.

E. Inclusion of reference standards herein does not make the Project Manager an agent of the publishing agency, nor does it obligate the Project Manager to perform inspections required by or to enforce rules or regulations contained in the reference standards.

1.02 REFERENCES

A. RELATED DOCUMENTS: General Conditions, Special Conditions, and applicable provisions of Division 1 sections apply to this Section.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SCHEDULE OF REFERENCE STANDARDS

A. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO), 444 North Capitol Street, NW, Suite 249, Washington, DC 20090

AASHTO M 36	Corrugated Metal Pipe
AASHTO M216	Standard Specification for Lime for Soil Stabilization
AASHTO T26	Standard Method of Test for Water to be Used in Concrete
AASHTO T84	Specific Gravity and Absorption of Fine Aggregate
AASHTO T85	Specific Gravity and Absorption of Coarse Aggregate

AASHTO T103	Freeze-Thaw
AASHTO T219	Standard Methods of Testing Lime for Chemical Constituents and Particle Sizes

B. AMERICAN CONCRETE INSTITUTE (ACI) P.O. Box 19150, Redford Station, Detroit, MI 48219, (313) 372-9800

ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 211.2	Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 301	Specifications for Structural Concrete for Buildings
ACI 304	Recommended Practices for Measuring, Mixing, Transporting and Placing Concrete
ACI 304.2R	Placing Concrete by Pumping Methods
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Codes Requirements for Reinforced Concrete
(NOTE:	Reference to ACI 318 may be limited to more stringent requirements of local building code)

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) 1916 Race Street, Philadelphia, PA 19103, (215) 299-5585

ASTM A 27	Mild to Medium Strength Carbon - Steel Casting for General Application
ASTM A 36	Structural Steel
ASTM A 47	Malleable Iron Castings
ASTM A 82	Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 123	Hot-dip Galvanizing
ASTMA 184	Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	Specifications for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
ASTM A 283	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars

ASTM A 615	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 706	Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement
ASTM C 25	Method for Chemical Analysis of Limestone, Quicklime and Hydrated Lime
ASTM K 29	Unit Weight of Aggregate
ASTM C 31	Methods of Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Specification for Concrete Aggregates
ASTM C 39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42	Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 76	Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
ASTM C 88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 94	Specification for Ready Mixed Concrete
ASTM C 109	Mortar Bar Test for Cement
ASTM C 110	Methods for Physical Testing of Quicklime, Hydrated Lime and Limestone
ASTM C 117	Materials Finer than 75 mm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	Resistance of Abrasions of Small Size Coarse Aggregate by Use of the Los Angeles Machine
ASTM C 136	Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 138	Unit Weight, Yield and Air Content of Concrete
ASTM C 143	Test Method for Slump of Portland Cement Concrete
ASTM C 150	Specification for Portland Cement
ASTM C 171	Specification for Sheet Materials for Curing Concrete
ASTM C 172	Method of Sampling Fresh Concrete
ASTM C 173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C 231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	Specification for Air Entraining Admixtures for Concrete
ASTM C 309	Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe Using Rubber Gaskets
ASTM C 494	Specification for Chemical Admixtures for Concrete
ASTM C 595	Blend Hydraulic Cements
ASTM C 618	Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 655	Reinforced Concrete D Load Culvert, Storm Drain and Sewer Pipe
ASTM C 789	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers
ASTM C 803	Test Method for Penetration Resistance of Hardened Concrete
ASTM C 805	Test Method for Rebound Number of Hardened Concrete
ASTM C 977	Specification for Quicklime and Hydrated Lime for Soil Stabilization
ASTM D 75	Sampling Aggregate
ASTM D 422	Test Method for Particle Size Analysis of Soils
ASTM D 516-88	Standard Test Method for Sulfate Ions in Water
ASTM D 693	Crushed Stone, Crushed Slag and Crushed Gravel for Dryer Water-Bound Macadam Base Courses and Bituminous Macadam Base and Surface Courses of Pavements
ASTM D 698	Test Method for Moisture Density Relations of Soils and Soil- Aggregate Mixtures Using 5.5-lb. Hammer and 12-Inch Drop
ASTM D 751	Burst Strength
ASTM D 1556	Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	Test Method for Moisture Density Relations of Soils and Soil- Aggregate Mixtures Using 10-lb. Hammer and 18-Inch Drop
ASTM D 1682	Ultraviolet Resistance Grab Tensile Strength Grab Tensile Elongation Toughness
ASTM D 1751	Specification for Preformed Expansion Joint Fillers for Concrete Paving

and Structural Construction

ASTM D 1752 Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM D 2167 Test Method for Density of Soil in Place by the Rubber-Balloon Method

ASTM D 2216 Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil Aggregate Mixtures

ASTM D 2363-78 Trapezoid Tear Strength

ASTM D 2419 Sand Equivalent Value of Soils and Fine Aggregate

ASTM D 2487 Test Method for Classification of Soils for Engineering Purposes

ASTM D 2922 Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Method

ASTM D 3017 Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

ASTM D 3665 Random Sampling of Paving Materials

ASTM D 4253 Test Method for Maximum Index Density of Soils Using Vibratory Table

ASTM D 4318 Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils

ASTM D 4397 Specification for Polyethylene Sheeting for Construction, Industrial and Agricultural Applications

ASTM D 4546 Test Method for One-Dimensional Swell or Settlement Potential of Cohesive Soils

ASTM E 329 Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction

ASTM F 477 Elastomerics Seals (Gaskets) for Joining Plastic Pipe

ASTM F 758 Smooth-Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport and Similar Drainage

D. D. AMERICAN WELDING SOCIETY (AWS), 550 NW LeJeune Road, Miami, FL 33135AWS Code for Welding in Building Construction (Structural Welding Code).

E. CONCRETE REINFORCING STEEL INSTITUTE (CRSI)933 N. Plum Grove Road, Schaumburg, IL 60195, (312) 490-1700

Manual of Standard Practice

F. COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) Division of Administration, Office of Bid Plans, 4201 E. Arkansas Avenue, Denver, CO 80222

Standard Specifications for Road and Bridge Construction (latest edition) Colorado Standard Plans, M&S Standards

G. FEDERAL HIGHWAY ADMINISTRATION (FHWA) Superintendent of Documents, US Government Printing Office, Washington DC, 20402

Manual of Uniform Traffic Control Devices (latest edition)

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section.

END OF SECTION 01091

SECTION 01095

DEFINITIONS AND CONVENTIONS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section contains a list of definitions of words or phrases and grammatical or contextual conventions commonly used in these contract documents.

1.02 REFERENCES

A. Related Documents: General Conditions, Special Conditions, and applicable provisions of Technical Specifications Division 1 apply to this Section.

1.03 DEFINITIONS

A. Alphabetical Listing of Definitions

1. **As indicated:** Shown on the drawings by graphic indication, notes or schedules, or written in the specifications or elsewhere in the contract documents.
2. **As directed, as approved, as requested:** Unless otherwise indicated, these terms imply "by the Project Manager" and require that an instruction be obtained by the Contractor from the Project Manager.
3. **Concealed:** Embedded in masonry, concrete or other construction; installed in furred spaces; within double partitions or hung ceilings; in trenches; in crawl spaces or in enclosures.
4. **Ensure:** To make certain in a way that eliminates the possibility of error.
5. **Exposed:** Not installed underground or "concealed" as defined above.
6. **Furnish or Provide:** To supply, install and connect complete and ready for safe and regular operation of particular work unless specifically otherwise noted.
7. **Indicated, Shown, or Noted:** As depicted on drawings or specifications.
8. **Install:** To erect, mount and connect complete with related accessories.
9. **Or equal, or approved equal:** Refers to products which, in the opinion of the Project Manager, are similar in all respects to products specified by proprietary brand name. (Refer to Section 01630 for procedures for submittal of proposed substitutions.)
10. **Rework:** To repair existing items or work required to be removed and replaced in order to accomplish the Work in accordance with the contract documents.
11. **Related Work:** Includes, but not necessarily limited to, mentioned work associated with, or affected by, the work specified.
12. Reviewed, Satisfactory, Accepted, or Directed: Assumes by or to the Project Manager.
13. **Similar, or Equal:** Same in materials, weight, size, design, construction, capacity, performance and efficiency of specified product.
14. **Supply:** To purchase, procure, acquire and deliver complete with related accessories.

15. **Unless Otherwise Indicated and Unless Otherwise Noted:** General note to perform work as indicated or shown on drawings or in specifications unless specifically directed otherwise elsewhere in the contract documents; may be abbreviated "U.O.N.", "U.O.I.", or "U.N.O.".

1.04 CONVENTIONS

A. Specifications Format

1. In order to standardize the location of information in the Contract Documents, the specifications generally are organized in one or more of the following formats:
   a. The 16-Division "MASTERFORMAT" published by the Construction Specifications Institute.
   b. The Standard Specifications for Road and Bridge Construction published by CDOT.
   c. The alpha-numeric system as published by the FAA.

B. Organization of Drawings and Specifications

1. Organization of the specifications into divisions and sections, and arrangement or numbering of drawings is intended solely for the convenience of the Contractor in his responsibilities to divide the Work among subcontractors or to establish the extent of work to be performed by any trade.

2. Neither the Owner nor the Project Manager assume any liability arising out of jurisdictional issues or claims advanced by trade organizations or other interested parties based on the arrangement or organization of drawings or specifications.

C. Gender and Number

1. For convenience and uniformity, parties to the Contract, including the Owner, Contractor, and Project Manager, and their subcontractors, suppliers, installers, consultants or other interested parties are referred to throughout the contract documents as if masculine in gender and singular in number. Such reference is not intended to limit the meaning of the contract documents to the masculine gender or singular number.

D. Singular vs. Plural

1. Materials, products, equipment or other items of work referred to in the singular shall be construed as plural where applicable by the intent of the contract documents and shall not limit quantities to be provided by the Contractor.

E. Imperative Mood

1. Specifications and notes on the drawings or elsewhere in the contract documents are generally written in the imperative mood as instructions to the Contractor, whether the Contractor is specifically addressed or not.

F. References to Subcontractors or Trades

1. References to subcontractors, trades or other entities which are not parties to the contract shall be construed as meaning the Contractor whose responsibility it shall be to divide the Work among subcontractors or trades. Such references are used as a matter of convention, and are not intended to preclude or direct the Contractor's responsibility to divide the Work.

G. Abbreviations

1. A list of abbreviations used in the contract documents is included in Technical Specifications Section 01070; an abridged list of abbreviations used on the drawings is included with the drawings.

2. Abbreviations are believed to be those in general use in the construction industry. Contact the Project Manager for clarification of abbreviations for which the meaning is not clear.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section.

END OF SECTION 01095

SECTION 01110

CONSTRUCTION SAFETY

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Work specified in this Section includes construction safety precautions and programs by the Contractor and the basis for reviews by the Project Manager.

1.02 RESPONSIBILITY

A. The General Conditions make it clear that all safety precautions during the construction process are the responsibility of the Contractor. The Contractor is responsible for the health and safety of his employees, agents, subcontractors and their employees, and other persons on the worksite; for the protection and preservation of the work and all materials and equipment to be incorporated therein; and for the worksite and the area surrounding the worksite. The Contractor shall take all necessary and reasonable precautions and actions to protect all such persons and property.

B. This Section shall be interpreted in its broadest sense for the protection of persons and property by the Contractor and no action or omission by the Project Manager or his authorized representatives shall relieve the Contractor of any of its obligations and duties hereunder.

1.03 SUBMITTAL

A. Refer to Technical Specifications Section 01300 and 01340 for the process. A Site Specific Safety Plan (SSSP) shall be submitted and approved under the general contract prior to commencing any work. If a Task Order is issued where the work is not covered by the approved SSSP then a revision to the plan specific for the work in the task order shall be resubmitted for approval.

B. City may at its sole option provide an Owner Controlled Insurance Program (OCIP). A copy of the OCIP Safety Manual is included in the Contract Documents. If an OCIP is provided, the Bidders shall consider the costs associated with the implementation of the OCIP Safety Manual requirements in their bid preparation, and to include subcontractor costs. In many cases, the provisions of the OCIP Safety Manual go above and beyond the requirements of 29 CFR 1926 (Occupational Safety and Health Administration construction safety regulations). These provisions include, but are not limited to:

1. Qualifications of full-time Contractor and Subcontractor Safety Representative
2. Pre-Project Hazard Analysis
3. Drug Free Work Environment
4. Job Hazard Analysis
5. Daily Pre-Task Planning
6. Risk Mitigation and Two Week Look Ahead
7. Stretch and Flex Program
8. Subcontractor Pre-Mobilization Meeting
9. Heat Illness Prevention

1.04 PROJECT MANAGER'S REVIEW

A. Provide a Contractor's SSSP as described below and in Part 1 of this Technical Specifications Section 01111.

B. The Contractor shall provide six copies of its SSSP to the DIA Project Manager for review at least ten (?) calendar days before on-site construction begins. The Contractor's program must meet, as a minimum, all applicable federal, state and local government requirements.

1. The Contractor must, as part of the Contractor‘s SSSP, submit six copies of the following information for acceptance by the DIA Project Manager prior to the commencement of construction activities. The SSSP must address all aspects listed below (if an OCIP is provided, refer to Section 5 of the OCIP Safety Manual in addition to these aspects). If an item is not applicable, this must be noted in the SSSP.
   a. Name of the Contractor's site safety representative.
   b. If the Contractor is running multiple shifts or working more than 40 hours per week, the name of an assistant site safety representative who can act in the absence of the site safety representative.
   c. Twenty-four hours per day emergency phone numbers of Contractor site management to be used in case of injury or accident. Provide at least four contacts.
   d. The Contractor's method of ditching and trenching excavation to be used including how slopes will be stabilized with calculations showing the slope stability. The Contractor shall also show how material will be stored beside the excavation. Stored material will include the excavated and backfilled material.
   e. How injuries or accidents will be handled including samples of the forms used to report injuries or accidents.
   f. How employees will be handled who are unable to safely perform their duties, including how the Contractor will determine whether an employee is unable to safely perform his duties.
   g. How and when equipment will be checked to see that it is safe, that all safety guards are in place, and that the equipment is being used for its designed purpose and within its rated capacity.
   h. How and when all electric devices will be checked for proper grounding and insulation. Describe the methods that will be used to lock out electric systems that should not be energized.
   i. How trash and human organic waste will be disposed of.
   j. How snow and ice will be removed by the Contractor in his project area.
   k. How concrete forms will be anchored to ensure their stability, including calculations showing that the forms will safely hold the maximum construction loads.
   l. How flammable materials will be stored and handled, and how any spills will be cleaned up and removed for disposal.
   m. What system will be used to prevent fires and, if fires do occur, who will be trained to fight them. Also, what fire fighting equipment will the Contractor have available and how will this equipment’s condition be monitored.
   n. How materials will be received, unloaded, stored, moved and disposed of.
   o. How personnel working above ground level will be protected from falling.
   p. How people working beneath the construction work will be protected.
   q. What will be done to protect personnel in case of severe weather.
   r. How adequate lighting will be provided and monitored.
   s. How air quality will be monitored to ensure that chemical exposures are below established OSHA Permissible Exposure Limits. How employees will be protected

if these limits are exceeded.

t. How the safety of work platforms, man lifts, material lifts, ladders, shoring, scaffolding, etc. will be ensured relating to load capacity and the protection of personnel using or working around them.

u. The type of personal protective equipment that will be used to protect employees from hazards.

v. The type of safety training that will be provided to employees to inform them of safe work procedures.

w. How audits and inspections will be performed to ensure compliance with the Safety Plan and applicable OSHA regulations.

x. Procedures to ensure that welding and other hot work is performed safely.

y. How compressed gases will be safely stored, handled and used.

z. Methods to ensure that employees safely enter, work in, and exit confined spaces.

aa. How the hazards of chemicals will be communicated to workers, including the use of material safety data sheets and chemical labels.

bb. Methods to ensure that forklifts and other powered industrial trucks are operated in a safe manner.

cc. How an effective hearing conservation program will be used to protect employees from high noise levels and prevent hearing loss.

dd. How employees will be protected from the effects of jet blast.

C. Prior to the start of any work by a contractor or subcontractor employee, the Contractor shall provide the Project Manager with a list of its employees, subcontractor's employees and other personnel the Contractor has requested to work at Denver International Airport, who have signified in writing that they have been briefed on, or have read and understand, the Contractor's SSSP.

PART 2 - PRODUCTS

2.01 CONTRACTOR'S SITE SPECIFIC SAFETY PLAN

A. Provide a Contractor's SSSP as described in Part 1 of Technical Specifications Section 01110.

PART 3 - EXECUTION

3.01 IMPLEMENT CONTRACTOR'S SAFETY PLAN

A. Implement the approved Contractor's Operational Safety Plan as described in Part 1 of this Technical Specifications Section 01110. Technical Specifications Section 01110.

B. If the Contractor experiences lost time or an injury rate greater then 75 percent of the national average for all construction, the Contractor shall audit its safety procedures and submit a plan to reduce its rates.

C. If at any time the lost time or injury rates experienced by the Contractor are 150 percent or more of the national average for construction, the Contractor shall immediately hire an independent safety professional who shall audit the Contractor's procedures and operations and make a report of changes that the Contractor should implement to reduce the rate including changing personnel.

1. Six copies of this report shall be submitted to the DIA Project Manager.

2. The Contractor shall immediately begin implementing the recommendations.

3. A weekly report shall be submitted by the Contractor on the status of the implementation of the recommendations.

4. Failure to comply with these requirements is a basis to withhold a portion of progress payments.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01110

SECTION 01200

PROJECT MEETINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section requires the Contractor's superintendent and Quality Control representative to attend meetings scheduled by the City for the collection and dissemination of information related to the subject contract.

B. The Project Manager will prepare the minutes of each meeting and distribute them to each of the participants.

1.02 OTHER MEETINGS

A. The Contractor will be advised of times, dates and places of contract meetings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 PRECONSTRUCTION MEETING

A. A Preconstruction Meeting will be scheduled by the City after the Contract has been signed by all parties. The purpose of this meeting is to introduce the City's Representatives to their counterparts in the Contractor's organization and to establish lines of communication between these representatives and outline some contract requirements. The Contractor's Superintendent and Quality Control Representative(s) shall attend this meeting.

B. The Project Manager will distribute a notice of this meeting, along with an agenda of the subjects to be addressed.

C. The Project Manager will explain and discuss the responsibilities and authorities of the City, the Designer, and the Project Manager's organizatioxn.

D. The Project Manager will provide highlights of the following information at this meeting:

1. Equal Employment Opportunity (EEO), Minority Business Enterprise (MBE) and Women Business Enterprise (WBE) requirements.
2. Insurance, laws, codes, traffic regulations and permit requirements of public agencies and their regulations.
3. Procedures for processing change orders.
4. Procedures for submitting shop and working drawings, product data and samples.
5. Monthly pay estimate cutoff dates.
6. Payment procedures.
7. Request for information procedures.
8. Communication procedures.
9. Contractor-required Daily Report showing the quantitative progress of work, the use of

men, material and equipment, problems, potential delays, weather, shift, down equipment, material and equipment received and information received from the City. Daily reports will be submitted to the Project Manager within 48 hours of start of work. Daily Reports are required every day, including weekends and holidays.

10. Scheduling and coordination requirements.
11. Quality control/assurance procedures.
12. Environmental requirements and permits.
13. As-built documents.
14. Project closeout requirements.

E. The Contractor will introduce the Contractor's representatives and briefly describe each person's responsibilities. The Contractor will provide the following:

1. A list of all subcontractors.
2. Office, storage areas and construction area layouts, along with temporary easements.
3. Safety, first aid, emergency actions and security procedures including the name of the Contractor's insurance company.
4. 60 day preliminary schedule.
5. Sequence of Work.
6. Construction methods and general worksite layout and haul plan.
7. Housekeeping procedures. Include a written plan for dealing with and preventing FOD (Foreign Object Damage).
8. The Contractor‘s general erosion and sedimentation control plans, noise, hazardous material, air and water pollution control plans and Quality Control Plan.
9. Coordination and notification for utility work.
10. The Contractor's procedures to coordinate its work with the work of other contractors and its procedures for sharing access to the worksite.
11. Deliveries and priorities of major equipment.
12. Submittal Schedule

F. Explanations provided by the City will not amend, supersede or alter the terms or meaning of any contract document, and the Contractor shall not claim reliance on such explanations as a defense to any breach or failure by the Contractor to perform as specified in the contract.

3.02 CONSTRUCTION PROGRESS MEETINGS

A. Progress meetings will be scheduled weekly and more often as necessary by the Project Manager to promote the competent and timely execution of the contract.

B. The meetings will be held at the worksite or at a location selected by the Project Manager. Meetings will be chaired by the Project Manager or the Project Manager’s representative.

C. The Contractor's personnel, as listed in Technical Specification Section 01200, 3.01.A, shall attend unless otherwise agreed by the Project Manager.

D. The Project Manager will be responsible for publishing minutes of the meetings.

E. At a minimum, the following items will be addressed at each meeting. The items addressed in the meeting do not waive notification or submittal requirements as required elsewhere in the contract.

1. Safety: Contractor shall report any safety issues
2. Quality Control
   a. The Contractor's Quality Control representative shall present and review all RAR's, CCR's, and NCR's issued and the status of each item.
   b. The Contractor's Quality Control Representative shall present and discuss the Independent Testing Agency weekly test report and/or testing schedule.
   c. The Contractor's Quality Control representative shall report on inspections by other agencies and any follow-up activity required.
   d. The Project Manager will present and discuss issues regarding quality control.
3. Quality Assurance
   a. The Project Manager will present and discuss issues regarding quality assurance.
4. Design activities: open discussion
5. Shop drawings/submittals
   a. The Contractor shall provide four copies of and review the Contractor's submittal schedule and provide any updated information and/or changes to the schedule.
   b. The Contractor shall provide information on the status of submittals requiring re-submittal.
   c. The Contractor shall review any accepted submittals that the Contractor plans to re-submit with changes.
6. Construction activities: Open discussion to include coordination items with other Contractors and or agencies.
7. Schedule
   a. The Contractor shall provide to the Project Manager four copies of the Contractor's three week look-ahead schedule and review at the meeting the items on the schedule. The schedule shall be in bar chart format based on the approved CPM, and shall include dates of testing activities, anticipated dates of inspection by DIA and other agencies, items in progress, percentage of completion of items, responsible subcontractor for the items.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable multiplier or work request bid item.

END OF SECTION 01200

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section summarizes the requirements for the submittal of documents to the City that are defined in these Specifications. It also describes the procedures for "supplemental" submittals.

PART 2 - PRODUCTS

2.01 SUBMITTAL SCHEDULE

A. The Contractor shall provide a submittal schedule within 14 days after Notice to Proceed. The Submittal Schedule shall be directly related to the CPM schedule, shall identify all the submittals, and shall include the following information for each submittal item:

1. Specification section, contract article, or special condition
2. Specification Subparagraph
3. Item description
4. Date the submittal shall be submitted
5. Name of subcontractor or supplier

B. The submittal schedule shall be updated every two weeks by the Contractor and submitted with the progress payment request.

C. One electronic submittal submitted on a single CD-ROM or DVD-ROM.

D. Unless stated otherwise, TWO copies of all submittals shall be furnished. Any submittal larger than 11 x 17 inches shall also be submitted as a Mylar. Two-sided submittals will be accepted.

2.02 ELECTRONIC SUBMITTALS

A. All submittals shall be delivered to the DIA Project Manager in electronic format.

1. Acceptable electronic formats
   a. Adobe Acrobat 8.0 or newer. All files shall be fully compatible with Adobe Acrobat 8.0. File shall have no security and bookmark every applicable submittal. All pages shall be completely legible and oriented to correct reading view.
2. Formats are acceptable only with written permission of the project manager or required by individual spec sections:
   a. Microsoft Office 2007 or newer. All files shall be fully compatible with Microsoft Office 2007.
   b. AutoDesk AutoCAD 2007 or newer. All files shall be fully compatible with AutoDesk AutoCAD 2007.
      1) AutoCAD files shall be self contained with no external x-references.
   c. AutoDesk Revit MEP 2012 or newer.

d. Other files pre-approved by the DIA Project Manager.

3. Electronic file names: Each electronic document shall have a unique file name. File name convention shall be as follows: CEXXXXX-AAA-BBBBB-CCCRZ
   a. XXXXX = DIA contract number
   b. AAA = sequential submittal number starting at 001.
   c. BBBBB = specification section containing submittal requirements
   d. CCC = sequential specification submittal number starting at 001.
   e. RZ = sequential revision number. RZ not required on initial submittals.
   f. Example A: “CE52006-005-01370-002”, five submittals have been logged overall with two submittals made to specification section 01370.
   g. Example B: “CE52006-009-01370-002R3, nine submittals made overall and three revisions to submittal 01370-002.

2.03 SUBMITTAL FORMAT – DRAWINGS

A. Consultant shall submit drawing data at each submittal to the City in both CADD and GIS formats including all attribute information. GIS/CADD drawing submittals shall adhere to the standards set forth in document Design Standards Manual 12 Chapter 7 CADD-GIS Data Submittal Requirements.

2.04 SUBMITTAL FORMAT - BUILDING INFORMATION MANAGEMENT (REVIT)

A. Consultant shall adhere to the standards set forth in document Design Standards Manual 12 Chapter 4 BIM.

1. Contact Mark Hughes at Mark.Hughes@flydenver.com (Ph: 303.214.5620) to coordinate all BIM submittal requirements.

2.05 INITIAL SUBMITTAL

A. Each submittal document shall include a title block showing the following information:

1. Date of submittal and revision dates.
2. Contract title and number.
3. The names of Contractor, subcontractor, supplier, manufacturer and when applicable, the seal and signature of an engineer registered in the State of Colorado, for the involved discipline.
4. Identification of product by either description, model number, style number or lot number.
5. Subject identification by contract drawing or specification reference.

B. On each submitted drawing, include a blank space on each sheet, three inches by four inches, in the lower right corner, just above the title block, in which the City or the Designer of Record may indicate the action taken.

C. Make submissions sufficiently in advance so that the City review may be completed not less than 30 days before Work represented by those submittals is scheduled to be performed.

D. Allow a minimum cycle of 30 days for review of each submittal by the City.

E. Accompany submittal documents with DIA transmittal form CM-30 (refer to Technical Specification Section 01999) that shall contain the following information:

1. Contractor's name, address and telephone number.
2. Submittal number and date.
3. Contract title and number.
4. Supplier's, manufacturer's or subcontractor's name, address and telephone number.
5. Identification of variations from contract documents.
6. Contractor's stamp and signature certifying his review.
7. Identification of submittal:
   a. If the submittal is being made on a General Condition or Special Condition, reference the General or Special Condition number.
   b. If the submittal is being made under a specification section, reference the specification number, paragraph number and subparagraph number.
   c. If the submittal is being made under a drawing, reference the drawing(s) number and subnumber.

F. The Contractor shall at the time of submission describe variations from the contract documents in writing, separate from the submittal document. If the Project Manager approves any such variations, an appropriate contract change order shall be issued except that, if the variation is minor and does not involve a change in price or in time of performance, a modification need not be issued. If a submission contains variations and the variation column is not marked on the transmittal form, it will not be considered for review and acceptance. Along with marking the transmittal as a variation, a description must be included which outlines all the differences including maintenance and utility services along with any cost savings from an item not containing the variation.

G. Changes in accepted submittal documents will not be permitted unless those changes have been accepted, in writing, by the City.

H. The form and quality of submittal documents shall comply with Technical Specifications Section 01340.

2.06 SUPPLEMENTAL SUBMITTALS

A. Supplemental submittal documents initiated by the Contractor for consideration of corrective procedures shall contain sufficient data for review. Make supplemental submittals in the same manner as initial submittals with the appropriate primary transmittal referenced.

PART 3 - EXECUTION

3.01 CONTRACTOR'S REVIEW

A. The Contractor shall review submittal documents, stamp and sign as reviewed and approved as complying with contract documents prior to submission to the City.

3.02 CITY REVIEW

A. Submittal documents will be reviewed by the City, the designer and the Project Manager for conformance to requirements of the contract drawings and specifications. Review of a separate item will not constitute review of an assembly in which the item functions. The City

will withhold approval of submittals that depend on other submittals not yet submitted. Review and acceptance will not relieve the Contractor from his responsibility for accuracy of submittals, for conformity of submittal document to requirements of contract drawings and specifications, for compatibility of described product with contiguous products and the rest of the system, or for protection and completion of the contract in accordance with the contract drawings and specifications.

B. The City, the designer, and/or the Project Manager will review the submittal documents for general conformance with the contract documents and mark the Action Code, sign and date the transmittal.

C. The Action Codes have the following meanings:

1. **A - ACCEPTED** is an approval, and means that the illustration and description appears to conform to the respective requirements of the contract documents.

2. **B - ACCEPTED AS NOTED** is an approval, and means that the illustration and description will conform to the respective requirements of the contract documents after changes in recognition of the reviewer's comments. Submittals so marked need not be resubmitted.

3. **C - REVISE AND RESUBMIT** means that the submittal is unacceptable and must be revised and resubmitted.

4. **E - NOT ACCEPTED** means that the submittal is not approved and that a new submittal in accordance with the contract documents shall be made.

5. **F - RECEIPT ACKNOWLEDGED**, means an item is received by the Project Manager but no review was made. This mark is for use in resubmitting items that were previously Accepted as Noted and the Contractor has incorporated the notes and wants the Project Managers' staff to have the same material that the Contractor's field staff is using.

3.03 CONTRACTOR'S RESPONSIBILITIES

A. Coordinate each submittal document with the requirements of the Work; place particular emphasis upon ensuring that each submittal of one trade is compatible with other submittals of that trade and submittals of other trades including producing as needed drawings showing the relationship of the work of different trades.

B. Contractor's responsibility for errors and omissions in submittal documents and associated calculations is not relieved by the City's review, correction and acceptance of submittals.

C. Contractor's liability to the City, in case of variations in the submittal document from the requirements of the contract documents, is not relieved by the City's review and acceptance of submittals containing variations unless the City expressly approves the deviation in writing, in which the City describes the variation.

D. The Contractor shall maintain a file of all approved submittal documents at the worksite. The complete file of approved submittal documents shall be turned over to the City with the as-built documents at the end of the job.

E. Schedule impact due to resubmittal requirements is the responsibility of the Contractor.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01300

SECTION 01310

SCHEDULE (LONG-DURATION PROJECT)

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the preparation of a preliminary schedule, construction schedule, related narratives and monthly progress reports, all encompassing complete performance of contract requirements.

B. The Contractor shall schedule and coordinate the work of all of its subcontractors and suppliers including their use of the worksite. The Contractor shall keep the subcontractors and suppliers informed of the project construction schedule to enable the subcontractors and suppliers to plan and perform their work properly.

C. The Contractor shall, in accordance with the requirements of the technical specifications, submit a construction schedule that shall provide for the expeditious and practicable execution of the Work.

D. The construction schedule for the performance of the Work shall be a Critical Path Method (CPM) system in bar chart format, unless an alternate system is specifically identified in the technical specifications, with reasonable detail including a time scaled network and computer printout as more fully detailed in the technical specifications.

E. Float or slack is defined as the amount of time between the early start date and the late start date or the early finish date and the late finish date of any activities in the schedule. Float or slack is not time for the exclusive use or benefit of either the Contractor or the City.

F. The Contractor shall submit a monthly progress report and schedule update in accordance with the scheduling provisions of the technical specifications.

G. The Contractor shall complete the Work within the contract time and in accordance with the most recent schedule submittal that has been approved in writing by the Project Manager.

1.02 PLANNING

A. The schedule shall show the total contract time, including project milestones, as indicated in the Special Conditions or elsewhere in the contract documents.

B. The Contractor shall prepare a work plan to complete the work within the contract time and complete those portions of work relating to each milestone date and other contract requirements. The Contractor shall generate a computerized Critical Path Method (CPM) schedule for the Work utilizing the Precedence Diagram Method (PDM) in Gantt Chart view. The computerized format shall be compatible with the City's Primavera system (Primavera Contractor, Primavera 3.1 or Primavera P6 or later). The Schedule shall be submitted to the Project Manager electronically in PDF format and on a CD in a dynamic format which will allow review and manipulation of any part of the schedule. The schedule activities shall be resource loaded showing labor man hours, major construction equipment by type, and value of the work. The value of the work shall summarize each pay item shown in the Schedule of Values and balance to their amount.

C. In addition to the construction activities the schedule shall include activities for furnishing materials and equipment and vendor shop drawing preparation. The construction schedule, a supporting narrative, and overall progress curve shall be submitted for approval within 30 days after Notice to Proceed. The overall progress curve will indicate planned progress monthly from start to finish of the project. The progress curve will be updated monthly with actual progress. Within 30 days the City will respond with approval or direction to revise and resubmit within ten days. Failure of the Contractor to have a construction schedule approved by the City will be considered cause for withholding progress payment(s).

D. To the extent that the construction schedule or any revisions thereof contains anything not jointly agreed upon in writing, or fails to show anything jointly agreed upon in writing, it shall not be considered to have the approval of the City. Failure to include any work item required for performance of this contract shall not excuse the Contractor from completing all work within applicable completion dates, regardless of the City's approval of the schedule.

E. Failure of the Contractor to comply with this Section will be considered cause for withholding progress payment(s) or termination for default.

1.03 SUBMITTALS

A. Refer to Technical Specifications Section 01300 for submittal procedures. Submit the following as indicated:

1. Preliminary schedule (with narrative) at Preconstruction Meeting
2. Construction schedule (with narrative and progress curve)
3. Monthly progress report (with narrative and updated progress curve)
4. Construction schedule change request (as needed)
5. As built construction schedule.

PART 2 - PRODUCT

2.01 PLOT AND REPORT FORMAT

A. Preliminary and Construction Schedule formats shall contain a title block with a minimum 18-point font showing:

1. Contractor's name
2. Contract number and title
3. Data date
4. Symbol definitions

B. Schedules shall contain a time line at the top.

C. The Activity Table (Layout) shall include at a minimum the following columns:

1. Activity ID
2. Activity Name
3. Original Duration
4. Schedule % Complete
5. Start

6. Finish
7. Total Float

D. A report shall accompany all schedules containing a list of all approved changes to the original approved (baseline) schedule.

E. Reports shall be submitted electronically in PDF format, or as directed by the Project Manager.

PART 3 - EXECUTION

3.01 PRELIMINARY SCHEDULE

A. The Contractor shall prepare a preliminary schedule covering the first 60 calendar days of the contract. This preliminary schedule shall be submitted at the Preconstruction Meeting and shall be accompanied by a narrative description of the work plan. Within 14 days, the City will respond with acceptance or direction to revise and resubmit within ten days.

B. The preliminary schedule shall show all significant work tasks that occur in the first 60 days, including planning, mobilization, shop submittals and approval time, procurement, fabrication and construction. It shall identify work items or milestones that affect or are affected by the City, other Contractor's work, utilities and other third parties and it shall list major data submittals required by the contract.

C. The preliminary schedule shall accompanied by a narrative describing the Contractor's approach to mobilization, procurement and construction during the first 60 days. The narrative shall elaborate on the basis of durations, production rates, and major equipment to be used, and shall identify all major assumptions used to develop the schedule.

D. In lieu of the Preliminary Schedule the Contractor may at his own discretion submit the Construction Schedule at the Preconstruction Meeting. If the Construction Schedule is submitted in lieu of the Preliminary Schedule, the City will respond within 30 days with acceptance or direction to revise and resubmit within 10 days.

3.02 CONSTRUCTION SCHEDULE

A. The construction schedule shall be a computerized CPM schedule utilizing the PDM formatted in Gantt Chart View that includes:

1. Work items identified in a Work Breakdown Structure (WBS) format that corresponds with the technical specifications.
2. The order, sequence and interdependence of all significant work items including construction procurement, fabrication, testing, startup and inspection, and delivery of critical or special materials and equipment, submittals and approvals of critical samples, shop drawings, procedures or other documents that could have a schedule impact.
3. Work items by the City, other Contractors, utilities and other third parties that may affect or be affected by Contractor's activities.
4. Proper referencing of all work items to identify applicable subcontractors or other performing parties.
5. Work item durations shall not exceed 20 working days. No more than 25 percent of the work item may be on the critical path.

6. Work items shall be resource loaded to show the direct craft manhours estimated to perform the work including work by subcontractors and the value of the work.

7. A narrative that explains the basis for the Contractor's determination of construction logic. It shall include estimated quantities and production rates, hours per shift, work days per week, and types, number and capacities of major construction equipment to be used and whether the Contractor plans to work weekends or holidays.

B. The construction schedule shall be prepared to include the data for the total contract duration and the critical path shall be identified, including critical paths for interim completion dates. Scheduled start or completion dates imposed on the schedule by the Contractor shall be consistent with contract milestone dates. Milestone events shall be the schedule dates specified in the Special Conditions and shall be prominently identified and connected to the appropriate work item, denoting its start or completion. Work items related to any interim milestone shall be coded for that milestone.

C. The Contractor shall submit the following documents to the City upon completion of preparation of the construction schedule:

1. A time phased CPM schedule utilizing the PDM showing all logic ties and the Gantt Chart view on a CD and an electronic copy in PDF format.

2. A physical progress curve showing either manpower or other appropriate key contract items derived from the construction schedule approved by the project manager and against which physical progress performance will be measured for schedule and payment purposes. The physical progress curve will indicate planned progress monthly from start to finish of the project.

3. The narrative described in Technical Specifications Section 01310-3.02.A.7.

3.03 PROGRESS REPORTING

A. The Contractor shall submit a monthly progress report at the end of each month following the Notice to Proceed. At the end of each month, the Contractor and Project Manager shall agree on the progress of the work and the Contractor shall update the construction schedule accordingly. The updated construction schedule is a prerequisite to the submittal of the Contractor's application for progress payment. The schedule shall be made in accordance with Technical Specifications Section 01310-3.02. This review does not constitute an approval of the construction schedule and shall not be used for the purposes of modifying the initially approved construction schedule.

B. The Contractor shall submit the monthly progress report consisting of a written narrative, an updated schedule and a physical progress curve. This report will be reviewed in a meeting between the Contractor and Project Manager.

1. The narrative report shall describe overall progress of the work, provide a critical path analysis, discuss significant problems with proposed corrective action, and show the status of major changes and any other changes in sequence of the work.

2. A Gantt chart schedule shall be provided showing the Contractor’s completion status (progress) on each work item along with logic ties and formats described in Technical Specifications Section 01310-3.02.C.1.

3. The physical progress curve shall be updated to show actual progress.

C. If the latest completion time for any work item does not fall within the time allowed by the construction schedule, the sequence of work and/or duration shall be revised by the

Contractor through concurrent operations, additional manpower, additional shifts or overtime, additional equipment, or alternative construction methods until the schedule produced indicates that all significant contract completion dates, occupancy dates and milestones will be met. No additional costs will be allowed if such expediting measures are necessary to meet the agreed completion date or dates except as provided elsewhere in the contract documents.

3.04 SCHEDULE CHANGES

A. The Contractor's request for construction schedule changes shall be made on the latest approved construction schedule and shall be accompanied by a narrative description and justification for the change and shall be submitted in accordance with the General Conditions Title 1105 on changes in time. Minor revisions submitted at monthly progress review meetings are not considered as changes in this context.

B. The construction schedule may be changed when one or more of the following occur:

1. When a change order significantly affects the contract completion date or sequence of work items.

2. When the Contractor elects to change the sequence or duration of work items affecting the critical path.

3. When the City directs a change that affects a milestone date(s) specified in the Special Conditions or alters the length of a critical path.

C. If, after submitting a request for change to the construction schedule, the Project Manager does not agree with the request, the Project Manager will schedule a meeting with the Contractor to discuss the differences. If a settlement cannot be reached on the change in the construction schedule or if the Contractor has failed to submit revisions to the network, the Project Manager has the option of providing suggested logic and/or duration times in all subsequent updating reports. The suggested logic and/or duration times will remain in effect until the change in the construction schedule is settled or until the logic and duration are superseded.

1. If the Contractor has any objections to the data furnished by the Project Manager, he shall advise the Project Manager within ten days in writing, fully supporting the objections with a counterplan. The revisions suggested by the Project Manager shall be used for updating reports until the Project Manager approves the counterplan.

2. If the Contractor does not submit a counterplan and data within ten days after the date of the Project Manager's suggested logic, the Contractor is deemed to have concurred with the Project Manager's suggested logic/duration time changes. The Project Manager's plan will be the basis of negotiations for any adjustment of the time and cost for performance of the Work.

3.05 CONTRACT EXTENSIONS

A. If the Contractor is granted an extension of time for completion of any milestone or contract completion date under the provisions of the contract, the determination of the total number of extended days will be based upon the current analysis of the schedule and upon all data relevant to the extension. Such data shall be incorporated in the next monthly update of the schedule.

B. The Contractor acknowledges and agrees that delays in work items which, according to schedule analysis, do not affect any milestone dates or the contract completion date shown

on the CPM network at the time of the delay will not be the basis for a contract extension.

3.06 AS-BUILT CONSTRUCTION SCHEDULE

A. After all contract work items are complete, the Contractor shall submit an as built construction schedule showing actual start and finish dates for all work items and milestones.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01310 (LP)

SECTION 01340

SHOP AND WORKING DRAWINGS, PRODUCT DATA AND SAMPLES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section consists of preparing and submitting shop and working drawings, product data, samples and record documents required by other technical specifications sections.

1. The Contractor shall submit all shop drawings, working drawings, product data and samples, as defined in Title 1 of the General Conditions, to the Project Manager in accordance with the requirements in the technical specifications. The Project Manager will return one copy of the shop drawings, working drawings and product data to the Contractor with a written transmittal within the time periods noted in the technical specifications.

B. The Contractor shall not submit as shop drawings copies or reproductions of drawings issued to the Contractor by DIA.

1.02 SUBMITTALS

A. Refer to Technical Specifications Section 01300 for submittal procedures.

B. All submittals shall be delivered to the DIA Project Manager in electronic format. All submittals must be of a consistent format (all Acrobat or all Word, etc). No combination of electronic file types will be allowed unless required by a specific specification section..

1. Acceptable electronic formats
   a. Adobe Acrobat 8.0 or newer. All files shall be fully compatible with Adobe Acrobat 8.0
   b. Microsoft Office 2007 or newer. All files shall be fully compatible with Microsoft Office 2007.
   c. AutoDesk AutoCAD 2007 or newer. All files shall be fully compatible with AutoDesk AutoCAD 2007.
      1) AutoCAD files shall be self contained with no external x-references.
   d. AutoDesk Revit MEP 2012 or newer.
   e. Other files pre-approved by the DIA Project Manager
2. Adobe Acrobat Requirements:
   a. Drawings shall have security set to “No Security”. Commenting, printing, adding photos, form fields and document signing must be allowed.
   b. PDF submittals shall be one continuous file. No external links are allowed.
   c. All individual components of submittals shall be bookmarked inside the PDF file.
   d. All original documents shall be directly converted from the original electronic format to PDF. Scanning of files shall only be allowed by the DIA Project Manager when the original electronic information is not obtainable.
   e. Failure to comply with these requirements will result in a return of file to the Contractor for immediate revision.
3. Electronic files submitted shall correspond with DIA File Control Numbering System

available from the DIA Project Manager. All files shall contain the prefix **CEXXXXX.14.02.submittalnumber.specsection.item.revision**.

a. SUBMITTALNUMBER attribute shall be obtained from the DIA Project Manager.

b. SPECSECTION attribute shall be a five digit number corresponding to the specification section requiring submitted data.

c. ITEM attribute will be a two digit number designating the corresponding submittal item number.

d. REVISION attribute will be for revised and resubmitted submittals, an “R” followed by a number (IE: R3).

4. Building Information Management (Revit) Requirements:

a. Contact Mark Hughes at Mark.Hughes@flydenver.com (Ph: 303.214.5620) to coordinate all BIM requirements.

C. Quantities

1. One DVD-ROM or CD-ROM containing electronic files of each shop or working drawing.

2. One DVD-ROM or CD-ROM containing electronic files of manufacturer's standard schematic drawings.

3. One DVD-ROM or CD-ROM containing electronic files of manufacturer's calculations and manufacturer's standard data.

4. One DVD-ROM or CD-ROM containing electronic files of manufacturer's printed installation, erection, application and placing instructions.

5. Nine samples of each item specified in the various specification sections, unless otherwise specified.

6. One DVD-ROM or CD-ROM containing electronic files of inspection, test reports and certificates of compliance.

7. Note: If manufacturer’s printed information is in color, all copies of submittals must be in color.

D. Review

1. Submittal review comments by the City will be in electronic form and incorporated into the electronic submittal file.

2. Resubmittals of electronic documents shall modify the original electronic file with new information and include the City’s comments with appropriate responses and additional information.

1.03 CHANGES

A. Changes in products for which shop or working drawings, product data or samples have been submitted will not be permitted unless those changes have been accepted and approved in writing by the Deputy Manager of Aviation as provided in Technical Specifications Section 01630.

1.04 QUALITY CONTROL

A. Shop drawings and record documents shall be prepared to a high standard of quality such as that set forth in MIL STD 100, ANSI Standard Drafting Manual Y14 or other equivalent specification defining equal drafting quality for microfilming.

PART 2 - PRODUCTS

2.01 SHOP AND WORKING DRAWINGS

A. Prepare shop and working drawings on a reproducible sepia sheet size of 24 x 36 inches to a scale large enough to easily depict and annotate each of the various items.

B. Include the following as they apply to the subject:

1. Contract title, work order and number.
2. Respective contract drawing numbers.
3. Applicable specification section numbers.
4. Relation to adjacent structure or materials.
5. Field dimensions clearly identified as such.
6. Applicable standards such as ASTM or Federal Specification number, FAA, AASHTO and pertinent authority specifications or standards.
7. Identification of deviations from the contract drawings and specifications.
8. Drawing name, number and revision.
9. Contractor's stamp, initialed or signed, certifying:
   a. Verification of field measurements.
   b. Review of submittals for compliance with contract requirements.
   c. Compatibility of the Work shown thereon with that of affected trades.
10. Blank space on each sheet per Technical Specifications Section 01300, paragraph 2.02.B.

C. Drawings of equipment and other items that contain multiple parts shall include exploded views showing the relationship of parts and the description of the parts into the smallest units that may be purchased or serviced.

2.02 PRODUCT DATA

A. Modify manufacturer's standard and/or schematic drawings to delete information which is not applicable to the contract. Supplement standard information with additional information applicable to this contract.

B. Modify manufacturer's standard(s), diagrams, schedules, performance charts, illustrations, calculations and other descriptive data to delete information which is not applicable to the contract. Indicate dimensions, clearances, performance characteristics and capacities. Include with the submittal electrical, plumbing, HVAC and any other diagrams, as applicable.

C. Modify erection, application and placing instructions to delete information that is not applicable to the contract or work order.

D. Include the following:

1. Contract title, work order and number
2. Respective contract drawing numbers
3. Applicable contract technical specification section numbers

4. Applicable standards such as ASTM or Federal Specification number, FAA, AASHTO and pertinent authority specification or standards
5. Identification of deviations from the contract drawings and specifications
6. Contractor's stamp, initialed or signed, certifying:
   a. Dimensional compatibility of the product with the space in which it is intended to be used
   b. Review of submittals for compliance with contract requirements
   c. Compatibility of the product with other products with which it is to perform or which will be next to it.
   d. The products electrical, plumbing, control and HVAC requirements conform to contract documents and the necessary utilities are provided for in the contract documents.

E. Certificates of compliance shall be submitted for all products listed below:

1. Products:
   a. Equipment Name #1
   b. Equipment Name #2
2. The certificate of compliance shall:
   a. State that the product complies with the respective specification and contract drawing requirements
   b. Be accompanied by a certified copy of test results pertaining to the product
   c. Show the submittals date, Contractor's name and address, contract title and number, product represented and its location in the contract, producer's name, product trade name and catalog number, place of product origin, test date, testing organization's name and address, quantity of the product to be furnished and related contract drawing and specification section numbers
   d. Be signed by an officer or another authorized representative of the producer and notarized
   e. Submit one electronic copy.
   f. Be received by the City not later than 30 days before the acceptance is needed of the products for ordering.

2.03 SAMPLES

A. Submit samples of sizes and quantities to clearly illustrate full color range and functional characteristics of products and materials including attachment devices.

B. Erect field samples and mock ups at the worksite as specified in the several technical specifications sections and at locations acceptable to the Project Manager. All field samples shall be erected in a location that will be readily visible throughout the life of the contract to allow comparison of the work as it progresses to the field sample.

C. The Contractor shall verify, through appropriate inspections and tests, that the samples submitted meet the specifications and shall provide inspection and test data with the samples. The review and comments on the sample shall not relieve the Contractor of his responsibility for completion of the contract.

D. Show the following information:

1. Contract title and number
2. Respective contract drawing numbers
3. Applicable technical specification section numbers
4. Applicable standards such as ASTM or Federal Specification number
5. Identification of deviations from the contract drawings and specifications
6. Contractor's stamp, initialed or signed, certifying:
   a. Dimensional compatibility of the product with the space in which it is intended to be used
   b. Review of submittals for compliance with contract requirements
   c. Compatibility of the product with other products with which it is to perform or which will be next to it
7. If multiple samples are submitted and the Project Manager is requested to make a choice, each sample shall have a unique identification number attached to it so the returned transmittal can state the identification number of the accepted sample and the Contractor will know which one it is.

PART 3 - EXECUTION

3.01 CONTRACTOR RESPONSIBILITIES

A. Reference requirements of General Conditions Article 405.

B. Verify field measurements, catalog numbers and similar data.

C. The Contractor shall not start work for which submittals are required until a transmittal has been received by the Contractor showing acceptance or acceptance as noted by the Project Manager.

D. Before making submittals ensure that products will be available in the quantities and at the times required by the contract.

E. Submit final, corrected, reproducible sepias of contract and shop and working drawings showing the Work as actually installed, placed, erected and applied. Refer to Technical Specification Section 01700, Contract Closeout.

3.02 REVIEW BY THE CITY

A. One electronic copy of the marked-up shop and working drawing and one electronic copy of the product data will be returned to the Contractor by the Project Manager. Only the transmittal form, appropriately marked, will be returned on sample submittals.

B. Contractor's responsibility for errors and omissions in submittals for compatibility will not be reduced, waived or otherwise limited by the review and acceptance of submittals by the City.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable multiplier for the division under which the work falls.

END OF SECTION 01340

SECTION 01370

SCHEDULE OF VALUES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section consists of preparing and submitting the Schedule of Values ("Schedule") as referenced in the General Conditions. The Schedule will be built upon a breakdown of the Work using specification sections and milestones. The Work also includes the preparing and submitting of updated copies of the Schedule if the Schedule is affected by change orders.

B. A Schedule of Stored Material is a detailed cost breakdown for permanent materials that will be temporarily stored prior to their being installed and for which the Contractor seeks partial payments. The Schedule of Stored Material will be incorporated as a part of the Schedule of Values.

C. Within 14 calendar days of issuance of the Notice to Proceed, the Contractor shall submit the Schedule of Values including the Schedule of Stored Material if applicable. The Schedule of Values and Schedule of Stored Material used to prepare the work/cost breakdown for the Schedule will be used for the Contractor's billings.

D. Any contract allowances shall be included in the Schedule. Expenditure of allowances shall be done through the use of the Allowance Authorization form. Use of this form does not increase or decrease the contract value.

1.02 RELATED DOCUMENTS

A. General Contract Conditions, Title 9 Compensation

B. Technical Specifications Section 01300 Submittals

C. Technical Specifications Section 01340 Shop and Working Drawings, Product Data and Samples

D. Technical Specifications Section 01999 Standard Forms

1.03 SUBMITTAL

A. The Schedule shall be submitted in a format approved by the Project Manager.

B. The Schedule shall identify each item of work. Work items in the Schedule shall represent all work and shall be referenced with the Technical Specifications section numbers, specification subparagraph, specification section title and the bid item number used for the Schedule of Prices and Quantities when applicable. The Schedule shall address the subcontractor, fabricator or supplier furnishing the materials and or labor for each work item.

C. Upon request by the City, the Contractor shall support values given with the data which will substantiate the correctness of the values.

D. The Schedule will be utilized only as a basis for review of the Contractor's application for

progress payment.

1.04 REVIEW AND RESUBMITTAL

A. If review by the City indicates that changes to the Schedule are required, the Contractor shall revise and resubmit the Schedule.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 PREPARING SCHEDULE OF VALUES

A. Breakdown of the items used in the Schedule shall include costs as follows:

1. Delivered cost of product with applicable taxes paid
2. Total installation cost with overhead and profit
3. Breakdown costs of each lump sum item with a list of products and major operations for which the Contractor seeks to receive progress payments to recover his costs for that bid Item
4. Each unit price item as listed in the bid Schedule of Prices and Quantities shall list products and major operations for which the Contractor seeks to receive progress payments for that bid item.

3.02 PREPARING SCHEDULE OF STORED MATERIAL

A. The Contractor shall submit with the Schedule an indication of whether products will be stored on or off the worksite. The Schedule of Stored Material shall show quantities and types of products that will be stored.

B. Material allowances consist of only the net cost of the product, the cost of delivery and unloading at the storage site, the cost of applicable sales taxes and all discounts.

C. In no case will the cost paid for a permanent material be greater than 90 percent of the contract price for the work in which they are included.

3.03 PAYMENT FOR STORED MATERIALS

A. Only materials that are described in the specifications and on the drawings will be considered permanent materials. Permanent materials are materials that will be left in the work after the contract is completed.

B. Nothing in these specifications shall be interpreted as requiring the City to pay for stored materials. The Project Manager shall decide on a case-by-case basis whether stored materials shall be paid for. No payment will be made for stored materials which have not been submitted and accepted.

C. The Contractor must, at all times, store permanent materials in accordance with manufacturer's recommendations. Any material not properly stored will not be paid for. Amounts will be deducted from payments for any stored permanent material previously paid for and subsequently found to be improperly stored or not present, based upon a physical inventory of stored permanent material.

D. Only the neat line quantity of material needed for the finished product may be paid for.

E. All requests for stored permanent material payment must be accompanied by paid invoices clearly showing the quantity of permanent material, the type of permanent material and discounts or rebates and the net amount paid to the supplier along with a certificate stating that the permanent material is free of any liens or judgments preventing its use by the City.

F. If the permanent material is stored outside the Denver area the Contractor must pay for the City representative's transportation and lodging to see the stored material as needed. Acceptable lodgings must, as a minimum, have a Mobil Travel Guide Rating Criteria® rating of Two-Star or the American Automobile Association Lodging Listing Requirements & Diamond Rating Guidelines® rating of Two Diamonds. The minimum transportation shall be by regularly scheduled commercial air carrier at coach rates. The Project Manager will determine if an overnight stay is required.

G. All permanent material stored off site, for which payment is being requested must be insured and stored in bonded, insured warehouses.

H. Any permanent material on which payment is requested must be in such a form that it cannot be used on work other than this contract, or stored in a manner acceptable to the Project Manager to ensure that the permanent material cannot be used on work other than this contract.

3.04 ALLOWANCE AUTHORIZATION AND PAYMENT

A. Contractor shall request written approval for expenditure of any contract allowances PRIOR TO performing the Work involved. List work to be performed and estimated cost in the requesting correspondence.

B. Original copies of all invoices and receipts must be submitted with the Allowance Authorization as part of the request for payment.

C. Using the format provided by the City, the Contractor’s request for payment of all contract allowances shall be included in the Schedule of Values.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01370

SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section consists of photographing construction and of submitting photographic prints. In digital format.

1.02 QUALITY CONTROL

A. Provide digital photographs with sharp and clearly shown details.

1.03 SUBMITTALS

A. Refer to Division 1 for submittal procedures.

B. Submit digital photographs of such quality that when printed in 8x10 inch prints will be sharp and clear.

C. Photographs shall be submitted to the Project Manager weekly, or as otherwise indicated, to show the progress of work. Photos shall be submitted on CDROM or DVDROM. Label CD\DVD and case with the contract name and number, photograph numbers, date of photos, and name of photographer or Photography Company. Include a map showing the location where each photograph was taken and the direction of the photograph to coincide with the numbers on the photographs.

D. The Contractor shall provide the DIA Project Manager, within fifteen (15) days from Notice to Proceed (NTP), a 10.1 mp Nikon Cool Pix P80, or other model approved by DIA Project Manager, digital camera with date and time stamp function, including all standard specifications, or equal as approved by the DIA Project Manager. The following additional accessories shall be provided:

One (1) spare Li-ion battery, number EN-EL5 (or equivalent for model of camera supplied), one (1) camera carrying case, two (2) each 4 GB SD memory cards (or memory compatible for camera supplied). The City will take possession of the camera and accessories.

PART 2 - PRODUCTS

2.01 PHOTOGRAPHS

A. Provide commercial quality, digital color photographs in PDF format. PDF file shall be security-free, bookmarked by date with all photos rotated to the correct orientation. Identify the following information on each photograph on the lower right corner.

1. Project title and number
2. Subject description (include work order number or change order number if applicable)
3. Station point of camera and direction of view. Include letter size diagram of project indicating Station point

4. Date taken
5. Name of Contractor.
6. Photograph number

PART 3 - EXECUTION

3.01 TIMES FOR PHOTOGRAPHY

A. Photograph the worksite each week or as directed by the Project Manager.

B. Location of views and time of photography will be as required by the Project Manager.

C. Number photographs in sequence, beginning with the number one and locate them on a key map, including an arrow to show the camera's line of site.

D. Photograph the worksite within five days of the date of Notice to Proceed. Include the proposed haul route showing existing damage if any.

E. A minimum of 24 different locations shall be required to clearly depict the various properties of the worksite.

F. After construction operations have been initiated at the worksite, and until completion and acceptance of the Work, make the following photographs:

1. Photograph the area around the Work at eight (8) locations or number of locations directed by DIA Project Manager.
2. Photograph the area inside the Work at sixteen (16) locations or number of locations directed by DIA Project Manager.

G. The location of views to be photographed, the day and time of photographing will be as required by the Project Manager.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01380

SECTION 01400

CONTRACTOR QUALITY CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section identifies the Quality Control activities to be performed during all phases of the contract by the Contractor.

B. The Contractor shall have in place his Quality Control Program as necessary to ensure that all materials and work are completed in compliance with contract documents. The Contractor is solely responsible for Quality Control and shall provide the necessary quality control personnel to assure that all materials, workmanship, and tests are in conformance with the project documents with the exception of those tests and/or audits that may be conducted by the City as defined in the contract documents.

C. Test schedules and/or testing requirements for materials used on this project are included in the technical specifications. Laboratory and field testing identified in the technical specifications shall be conducted by an Independent Testing Agency (ITA) retained by the Contractor.

1.02 SUBMITTALS

A. Refer to Technical Specification Section 01300 and Technical Specifications Section 01340, for submittal requirements.

B. Quality Control Plan: Within 10 days after Notice to Proceed, the Contractor shall submit a Quality Control Plan for review and acceptance. The Quality Control Plan shall be accepted by the DIA Project Manager prior to any work or materials remaining in place. Acceptance by the DIA Project Manager does not relieve the Contractor of compliance with the contract requirements. The Contractor Quality Control Plan shall address the following as a minimum:

1. A general description of Quality Control monitoring to be performed until final acceptance by DIA. Include monitoring activities of Work and the worksite during times that no construction activity is scheduled to take place.

2. An individual designated by the Contractor whose sole responsibility is Quality Control Management. This individual shall be highly qualified in all phases of construction as it relates to this project and shall have the authority to direct work changes required to bring the Work into conformance with contract requirements, including stopping non-conforming work in progress. A resume of the proposed Quality Control Manager including applicable education, experience and certifications shall be included in the Quality Control Plan.

3. Quality Control inspection staff as needed to assist the Quality Control Manager with implementation of the Quality Control Program. Duties of the Quality Control Inspectors shall be limited strictly to inspection of the ongoing work. Sampling and testing of materials shall be performed by Quality Control personnel other than Quality Control Inspectors. Quality Control Inspectors shall inspect only those work elements for which they are qualified. Resumes of the proposed Quality Control Inspectors including applicable education, experience and certifications shall be included in the Quality Control Plan.

4. An Organization Chart identifying all Quality Control staff by name and function. The chart shall indicate the total staff required to implement all elements of the Quality Control Program, including inspection and testing for each item of work. If necessary, different Quality Control staff can be utilized for specific inspection and testing functions for different items of work. The chart shall show that the Quality Control Manager, Quality Control Inspectors, and Quality Control testing personnel are outside of the production staff with clear lines of authority for Quality Control.

5. Each technical specification division's requirements for quality control identifying each item requiring submittal and approval/acceptance prior to installation of work, all inspections to be performed during work and prior to acceptance of work,each item of work requiring testing by the independent testing agency, and the testing frequency.

6. Establish controls and documentation format to ensure that items or materials that have been accepted through receiving inspection are used or installed. Identification and traceability shall be provided throughout all inspections, test activities and records. For stored items, provisions shall be made for the control of item/material identification, consistent with the expected duration and type of storage.

7. A methodology of monitoring, testing and exercising of all equipment, valves and/or assemblies to ensure the Work installed is in proper working order.

8. A list of suppliers and subcontractors. This list shall include items to be supplied by each supplier and/or subcontractor and shall identify work to be performed by each subcontractor. The list shall be updated and resubmitted as required.

9. Emergency contact information including name, company, title, work phone number, home phone number and other means of contact. The Emergency Contact list shall include at least four individuals. The Emergency Contact list shall be maintained on a daily basis. In the event there is any change in any of the information, the Contractor shall forward the updated list to the Project Manager and to DIA Maintenance Control (303-342-2800). The Emergency Contact list shall include the project number, project title and date of issue.

C. Contractor's Daily Foreman Report:

1. A Contractor's Daily Foreman report shall be completed on form included in Technical Specifications Section 01999. The Foreman may add sheets of information to this form as needed. The report shall address as a minimum the following: daily activities, quantities of material placed and completed, weather, safety issues, personnel by trade, equipment on site with time used, equipment under repair, work delays, possible delays, and materials delivered.

2. The Contractor's Daily Foreman Reports reporting shall be computerized or typed and may contain an electronic signature. Reports shall be transmitted to the DIA Project Manager electronically on the following work day.

D. Contractor's Daily Quality Control Inspection Report:

1. Contractor's Daily Quality Control Inspection Reports shall be completed on the form included in Technical Specifications Section 01999. The reports shall be written by the Quality Control Manager and all Inspectors. The Quality Control Manager and Inspectors may add sheets of information to this form as required. The report shall address as a minimum the following: the work requiring inspection identified by the technical item number and description, results of the inspections, material compliance with approved submittals, proper storage of materials and equipment, adherence to plans and technical specifications, review and description of quality control tests,

compliance of testing frequencies, location and nature of defects or deviations found, causes for rejection, and corrections required to bring the Work into conformance with the contract.

2. Contractor's Daily Quality Control Inspection Reports shall be computerized or typed and may contain an electronic signature of the author. Reports shall be transmitted to the DIA Project Manager electronically on the following work day.

E. Corrective Action Report (CAR)

1. Conditions adverse to quality will be reviewed by the Contractor to determine the cause and to recommend a corrective action that will preclude recurrence. The condition, its cause and the corrective action planned shall be reported to the Project Manager prior to implementation. Follow-up action shall be taken to verify implementation of the corrective action. The Contractor will document the corrective action and a copy of the Corrective Action Report (CAR) will be transmitted to the DIA Project Manager.

1.03 DOCUMENTATION

A. The Contractor shall not change or alter approved submittals, procedures, specifications, drawings or other pertinent documentation without the Project Manager's written authorization.

B. All records and documents that are quality related shall be prepared, identified and maintained by the Contractor and shall be made available to DIA upon request. Records shall be protected from damage, deterioration or loss. A copy of the records and documents shall be maintained at the Work site at all times unless the Project Manager has approved other locations in writing. Retention time for all quality records shall be not less than three years from date of Final Acceptance of the contract.

C. The Contractor shall maintain records at the actual worksite and at Contractor's office to show the inspection status of materials and items installed in order to ensure that the required inspections and tests have been performed in a timely and correct manner.

1.04 INSPECTIONS AND TESTS

A. Inspections, tests and system shut down requests, conducted by persons or agencies other than the Contractor, shall not in any way relieve the Contractor of his responsibility and obligation to meet all specifications and the referenced standards. The Contractor's designated Quality Control Representative shall inspect the work and shall ensure the work complies with the contract requirements prior to any requests for inspection or testing.

B. When the specifications, laws, ordinances, rules, regulations or orders of any public agency having jurisdiction require the Project Manager's surveillance of inspections or tests, the Contractor shall notify the Project Manager of the place, date and time 48 hours prior to the inspection and/or test. The Contractor shall be responsible for notifying and requesting inspection by other agencies including but not limited to the Denver Building Inspection Division, Denver Fire Department and Denver Water Department. Prior to request for other agency inspections, the Contractor shall meet and plan inspection times with the Project Manager and or the Project Manager's designated representative.

C. Special inspections or tests may be required by the technical specifications, City, State and/or Federal Agencies in addition to those tests already performed. The Contractor shall notify the Project Manager at least 48 hours in advance of the additional inspections or tests.

D. Quantities will be verified as defined in the Pre-Work Meetings.

1.05 INSPECTION PLAN

A. The Contractor shall utilize the following six-point inspection plan to ensure the conformance of the Work performed by the Contractor meets the requirements of the contract drawings and specifications, the referenced codes and standards and the approved submittals:

1. Prework Coordination: Prior to the start of construction work on the contract and prior to the start of work under each separate specification section and prior to the start of work where a change in a construction operation is contemplated by the Contractor and prior to a new subcontractor starting work, a coordination meeting will be held with the Contractor's superintendent, Quality Control and Safety representative(s), the ITA representative, the DIA Project Manager and DIA inspectors. Supervisory, Safety and Quality Control, representatives of all applicable subcontractors will also attend. Prior to the meeting, the Contractor's Quality Control Manager shall provide the DIA Project Manager with a meeting agenda for review. The Contractor's Quality Control Manager shall conduct the meeting and distribute the approved agenda. The Quality Control Manager shall develop and electronically distribute finalized meeting minutes within 24 hours upon completion of the meeting.

2. The purpose of the meeting is to ensure that the Contractor's personnel have no misunderstandings regarding their safety and quality procedures as well as the technical requirements of the contract. The following items shall be presented and reviewed by the Contractor:
   a. Contract requirements and specifications
   b. Shop drawings, certifications, submittals and as-built drawings
   c. Testing and inspection program and procedures
   d. Contractor's Quality Control program
   e. Familiarity and proficiency of the Contractor's and subcontractor's workforce to perform the operation to required workmanship standards including certifications of installers
   f. Safety, security and environmental precautions to be observed
   g. Any other preparatory steps dependent upon the particular operation
   h. The Contractor's means and methods for performing the Work.

3. Initial Inspection: Upon completion of a representative sample of a given feature of the Work and no later than two weeks after the start of a new or changed operation, the Project Manager and/or the Project Manager's designated representatives will meet with the Contractor's Quality Control representative and applicable subcontractor's supervisor and their Quality Control representatives to check the following items, as a minimum:
   a. Workmanship to established quality standards
   b. Conformance to contract drawings, specifications and the accepted shop drawings
   c. Adequacy of materials and articles utilized
   d. Results of inspection and testing methods
   e. Adequacy of as-built drawings maintained daily.

4. Once accepted, the representative sample will become the physical baseline by which ongoing work is compared for quality and acceptability. To the maximum practical extent, approved representative samples of work elements shall remain visible until all work in the appropriate category is complete. Acceptance of a sample does not waive or alter any contract requirements or show acceptance of any deviation from the contract

not approved in writing by the Project Manager.

5. Follow-up Inspection: The Contractor's Quality Control representative will monitor the work to review the continuing conformance of the work to the workmanship standards established during the preparatory and initial inspections.

6. Completion Inspection: Forty-eight hours prior to the completion of an item or segment of work and prior to covering up any work, the Contractor will notify the Project Manager who will verify that the segment of work is substantially complete, all inspections and tests have been completed and the results are acceptable. The purpose of this inspection is to allow further corrective work upon, or integral to, the completed segment of work. THIS IS NOT AN ACCEPTANCE INSPECTION. If any items are determined to be deficient, need correction or are non-conforming, a Deficiency List will be prepared and issued to the respective Contractor for correction, repair or replacement of any deficient or non-conforming items. The Project Manager and Contractor's Quality Control representative will verify the correction of the deficient and/or non-conforming items prior to the start of the next operation.

7. Pre-Final Acceptance Inspection: Prior to requesting a Pre-Final Acceptance Inspection by DIA, all work and operational systems to be inspected shall be satisfactorily completed and tested by the Contractor. The Contractor's written request for this inspection shall be made 72 hours in advance. With the request shall come a list of any known deficiencies and when they will be corrected. If the list is too large or contains too many significant items, in the opinion of the Project Manager, no inspection will be held because of the incompleteness of the work.

8. The Project Manager will schedule the Pre-Final Acceptance Inspection and will prepare a list of deficient items (punch list) discovered during the inspection. If during the inspection the list becomes too large or too many significant items are on the list, the inspection will be canceled. After the inspection is completed, the Deficiency List will be transmitted to the Contractor for correction of the deficient items.

9. Final Acceptance Inspection: After the Contractor has completed all items on the Deficiency List (generated from the Pre-Final Acceptance Inspection) he shall request a Final Acceptance Inspection. The request shall be made in writing at least 72 hours in advance of the inspection. All areas must be cleaned and ready for turnover prior to this inspection. The Project Manager, the design consultant, a representative of the funding agency (if applicable) and other interested parties will inspect the subject Work to ensure that all deficiencies have been satisfactorily attended to and that no new deficiencies have appeared and that all systems are completely functional. Any outstanding or additional deficient items will be noted and handled per the requirements of the Pre-Final Acceptance Inspection noted above until the Work is acceptable to the Project Manager.

1.06 SAMPLES

A. The Contractor shall maintain at the worksite a copy of all samples submitted and accepted by DIA. Samples shall be made available to the designer or the Project Manager's designated representatives for review and comparison in the field. The Project Manager prior to use on the project must accept all items and materials.

B. The installed work will be compared to the samples and if any of the work is not of the same quality, material, finish, color, texture or appearance as the sample, that portion that is not the same will be considered defective and in nonconformance.

C. Contractor selection of samples will only be considered if taken at random. The Contractor

shall permit representatives of DIA to witness the selection of samples. Inspection or tests of items or materials that fail shall be sufficient cause to terminate further inspections/tests of the same brand, make or source of that product.

D. The Contractor is obligated to correct any item deemed deficient.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 REQUIREMENTS

A. All materials required for the contract shall be new except where specified otherwise. The Project Manager may elect to perform additional inspections and/or tests at the place of the manufacture, the shipping point or at the destination to verify conformance to applicable specifications. Inspections and tests performed by DIA shall not relieve the Contractor from the responsibility to meet the specifications, nor shall such inspections/tests be considered a guarantee for acceptance of materials that will be delivered at a later time.

B. The Contractor is obligated to correct or remove non-conforming materials, whether in place or not. If necessary, the Project Manager will send written notification to the Contractor to correct or remove the defective materials from the project. If the Contractor fails to respond, the Project Manager may order correction, removal and/or replacement of defective materials by others, in which case the Contractor shall bear all costs incurred by such actions.

C. Materials accepted on the basis of a Certificate of Compliance may be sampled and inspected/tested by DIA or its designer at any time. The fact that the materials were accepted on the basis of such certification shall not relieve the Contractor of his responsibility to use materials that conform to the specifications.

D. The Contractor shall impose upon his suppliers the same quality control requirements, including inspection and test procedures, as imposed upon him by the specifications and referenced standards. The Contractor shall apply appropriate controls, designed to ensure that all materials supplied meet the requirements and specifications.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable multiplier for the division under which the work falls. If the City is required to re-inspect work or conduct a special test because a previous inspection, requested by the Contractor, showed that the work was defective or not in conformance, the Deputy Manager or his authorized representative may deduct from the contract value the cost of re-inspection at the rate of $100.00 per man-hour.

END OF SECTION 01400

SECTION 01401

INDEPENDENT TESTING AGENCY

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall employ the services of an Independent Testing Agency (ITA). This Section identifies the requirements for the Contractor to employ an Independent Testing Agency and identifies the required activities of the Independent Testing Agency.

B. Laboratory and field testing requirements to be conducted by the ITA for materials and construction on this project are included in the appropriate technical specifications. Where the technical specifications reference the CDOT Standard Specifications for Road and Bridge Construction, the references shall also mean CDOT Field Materials Manual for schedule of tests unless otherwise stated. As a minimum the ITA described in this section shall perform all applicable tests listed in the manual including the independent assurance sampling and testing. In the event of such a conflict between the schedule and a specification in these technical provisions, the more comprehensive testing shall govern unless otherwise noted.

C. Inspections and tests conducted by the ITA shall not in any way relieve the Contractor of his responsibility and obligation to meet all specifications and referenced standards. Employment of the ITA does not relieve the Contractor of providing the required Quality Control program.

D. When inspections or tests by the ITA prove that the item or material does not meet all applicable specifications and requirements, the cost incurred for the re-testing or re-inspection shall be borne by the Contractor (see paragraph 5.01 of this Technical Specifications Section).

E. Samples will only be considered if taken at random. The Contractor shall permit representatives of the City to witness the selection of samples. Inspection or tests of items or materials that fail shall be sufficient cause to terminate further inspections/tests of the same brand, make or source of that product.

F. The Contractor is obligated to correct any item deemed deficient at no additional cost to DIA.

1.02 RELATED DOCUMENTS

A. ASTM C 1077 - Standard Practices for Laboratory Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

B. ASTM D 3666 – Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

C. ASTM D 3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D. ASTM E 329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

E. ASTM E 543 - Specification for Agencies Performing Nondestructive Testing.

F. Standard testing practices for other disciplines.

1.03 SUBMITTALS

A. All submittals shall comply with requirements of Technical Specifications Sections 01300 and 01340 for submittal requirements.

1.04 CONTRACTOR SUBMITTAL OF PROPOSED TESTING AGENCIES

A. The Contractor shall employ the services of an Independent Testing Agency (ITA) that has been accredited by AASHTO or CCRL or an approved equal to perform the test(s) required in the contract. The ITA may also provide technicians to perform the required inspections. However, inspection and testing cannot be performed simultaneously by the same technician. The Contractor shall receive written acceptance from the Project Manager of the Independent Testing Agency prior to any permanent work being installed or tested.

B. The Contractor shall not submit for acceptance to the DIA Project Manager any testing agency or laboratory utilized in the design or construction document preparation or presently employed by DIA as part of DIA Quality Assurance.

C. For consideration of acceptance, the Contractor shall submit to the DIA Project Manager the following items received from the ITA:

1. Affidavit of current accreditation from a national certification and/or accreditation program.
2. Evidence that the ITA Laboratory is accredited to perform the testing required in the Technical Specifications.
3. Resumes and evidence of professional engineer registration and licensing in the State of Colorado for the personnel reviewing and signing test reports.
4. Resumes and current certifications verifying that ITA management and supervisory personnel, laboratory staff, field testing technicians, and inspecting technicians are qualified in accordance with ASTM C 1077, D 3666, D 3740, and E 329 requirements to perform the work. NICET, ACI, WAQTC, LabCAT, CDOT, NRMCA, PCA, AWS, ASNT certifications or a degree in a related engineering field with construction field experience can demonstrate qualifications. A list summarizing all management, supervisory, laboratory, field testing, and inspection personnel assigned to the project including the testing and/or inspection each individual will be performing, certifications held by each individual, and the expiration date of each certification.
5. A matrix indicating each technical specification section, paragraph, quantity and type of sampling and/or testing required.
6. Copies of all laboratory, field testing, and inspection report forms.

1.05 SUBMITTAL OF REPORTS

A. Test results shall be submitted by the Contractor to the DIA Project Manager after completion of inspections/tests by the ITA and prior to incorporation of the item(s) into the Work unless the test or inspection must be done during or after installation.

All field test results including but not limited to fresh concrete properties and in-place moisture-density shall be reported in legible draft form to the DIA Inspection immediately at the test site. Any failing test shall be reported separately to the DIA Inspector or DIA Project

Manager within 2 hours after the discovery. The draft test results shall also be attached to the Daily Quality Control Inspection Report (reference Technical Specifications Section 01400, paragraph 1.02.D) and transmitted to the DIA Project Manager on the next work day.

B. Typed test reports shall be provided to the DIA Project Manager as specified in paragraph 1.06 Weekly Reports. The test reports shall be numbered sequentially in chronological order. Individual tests shall be numbered sequentially. The reports and tests shall also be organized per specification section. All test results must be reviewed and signed by a registered licensed engineer in the State of Colorado. The signature represents that the test procedures used are in strict conformance with the applicable testing standard, the calculated data are true and accurate, the tools and equipment used were in calibration, the sample was not contaminated and the persons running the test were qualified.

C. Reports of inspections and test activities are record documents and shall be maintained in a manner that provides integrity of item identification, acceptability and traceability. Reports shall identify the following:

1. Contractor's name
2. DIA Contract number and title
3. Independent Testing Agency name
4. Name of item(s) inspected/tested including a physical description and, as applicable, model and make
5. Quantity of items
6. Inspection/test procedure used. If national standards are used, any deviation from these standards
7. Date the sample was taken and the date the test was made
8. Location (by coordinates, building grid or station number) of where tests and/or samplings were performed including environmental condition where applicable. Include plan drawing indicating location of test and work item sampled or tested
9. Name of inspector/tester
10. In the event the testing or sampling is a re-test or re-sampling, reference the previous respective testing or sampling report
11. Specified requirements in the contract that the item must meet. Include reference to technical specification section and paragraphs
12. Acceptability
13. Deviations/nonconformance
14. Corrective action
15. Evaluation of results
16. All information required for the specific test as specified in the applicable ASTM standard
17. Signature of authorized evaluator.

1.06 WEEKLY SUMMARY REPORTS

A. The ITA and Quality Control Manager shall prepare and submit to the DIA Project Manager a weekly summary report each week which summarizes by specification section all work

activities and results for the quality control tests and inspections conducted during that period. The weekly summary report shall be submitted within two (2) weeks from the end of the reporting period. At a minimum, the weekly summary report shall identify all inspections, test types, test locations, testers, test results, specifications, whether the test passed or failed, quantity of materials placed and the number of tests performed for each material, and the material supplier, installer and Contractor. Re-tests shall be identified in a fashion that easily correlates to the failing test. Any failed tests that have not been corrected when the report is published shall be highlighted and noted in the cover letter of the report. The ITA shall identify costs of re-testing or additional site visits required due to scheduling changes by the Contractor. A current Corrective Action Report log (CAR) shall also be included in the weekly summary report.

B. The weekly report shall be submitted per Technical Specifications Sections 01300 and 01340 requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 REMOVAL OF NONCONFORMING MATERIAL

A. The Contractor is obligated to correct or remove nonconforming materials, whether in place or not. If necessary, the DIA Project Manager will send written notification to the Contractor to correct or remove the defective materials from the project. If the Contractor fails to respond, the DIA Project Manager may order correction, removal and/or replacement of defective materials by others, in which case the Contractor shall bear all costs incurred by such actions.

3.02 PERFORMANCE

A. If the DIA Project Manager determines that the ITA or its personnel are not effectively enforcing or performing the testing and documentation requirements specified in the contract, the DIA Project Manager will, in writing, require the Contractor to remove and replace ITA or such personnel at no cost to DIA.

3.03 CONTROL OF MEASURING AND TEST EQUIPMENT

A. The ITA shall select measuring and test equipment in such a manner as to provide proper type, range, accuracy, calibration and tolerance for determining compliance with specified requirements. Measuring and test devices shall be calibrated, adjusted and maintained at prescribed intervals prior to use based upon equipment stability and other conditions affecting measurement. Provisions shall be made for the proper handling and storage of equipment. Calibration shall be accomplished using certified standards that have a known traceable relationship to the National Institute of Standards and Technology. Every calibrated measuring and test device shall show the current status, date of last calibration and the due date for the next calibration. Calibration records shall be maintained onsite as quality records and shall be made available for inspection upon the Project Manager's request.

PART 4 - METHOD OF MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under the Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item. If the City is required to re-inspect work because the previous inspection showed that the work was defective or not in conformance, the Deputy Manager or his authorized representative may deduct from the contract value the cost of re-inspection at the rate of $100.00 per man-hour.

END OF SECTION 01401

SECTION 01402

DIA QUALITY ASSURANCE

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section identifies DIA Inspection activities to be performed by inspectors employed by DIA and working under the direction of the Project Manager.

B. Inspection and tests, conducted by persons or agencies other than the Contractor, shall not in any way relieve the Contractor of his responsibility and obligation to meet all specifications and the referenced standards.

C. The inspection and approval of work by other agencies above does not constitute inspection or acceptance of work required by DIA. Technical specifications may contain requirements more stringent than Building Inspection Division or other code agency requirements.

1.02 RELATED DOCUMENTS

A. Technical Specifications Section 01400 – “Contractor Quality Control”

B. General Conditions Title 17, Section 1701 – “Construction Inspection by the City”

C. General Conditions Title 17, Section 1702 – “Authority of Inspectors”

D. General Conditions Title 17, Section 1703 – “Observable Defects”

E. General Conditions Title 17, Section 1704 – “Defects – Uncovering Work”

F. General Conditions Title 17, Section 1705 – “Latent Defects”

G. General Conditions Title 17, Section 1706 – “Removal of Defective Materials and Work”.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 MANUFACTURING AND FABRICATION INSPECTIONS

A. The Project Manager may elect to perform additional inspections and/or tests at the place of the manufacture, the shipping point or at the destination to verify conformance to applicable specifications. Inspections and tests performed by DIA shall not relieve the Contractor from the responsibility to meet the specifications, nor shall such inspections/tests be considered to be a guarantee for acceptance of materials that will be delivered at a later time.

B. The Project Manager or his authorized representative may inspect at its source any material or assembly to be used in the Work. Manufacturing plants may be inspected from time to time for the purpose of determining compliance with specified manufacturing methods or materials to be used in the Work and to obtain samples for testing and further inspection.

C. Should the Project Manager conduct plant inspections the following conditions shall exist:

1. The Project Manager shall have the cooperation and assistance of the Contractor and the producer with whom the Contractor has contracted for materials.

2. The Project Manager shall have full access during scheduled production or warehousing working hours to parts of the plant that are concerned with the manufacture, production, storage or shipping of materials being furnished.

3. The Contractor shall arrange for adequate office or working space that can reasonably be needed for conducting a plant inspection. Office or working space shall be conveniently located with respect to the plant and/or warehouse as required by the Project Manager.

D. It is understood and agreed that DIA shall have the right to re-test at DIA's expense any materials that have been tested and accepted at the source of supply after it has been delivered to the site.

3.02 INSPECTIONS AND TESTS

A. It is understood and agreed that DIA shall have the right to take samples and perform testing of samples at different intervals or at intervals concurrent to the Contractor's testing program. The Contractor shall be issued a Nonconformance Report or a Remedial Action Request in the event DIA tests fail.

B. Materials accepted on the basis of a certificate of compliance may be sampled and inspected/tested by DIA or its designer at any time. The fact that the materials were accepted on the basis of such certification shall not relieve the Contractor of his responsibility to use materials that conform to the specifications.

C. DIA inspection shall include but not be limited to Initial Inspection, Follow-up Inspection, Completion Inspection, Pre-Final Acceptance Inspection, and Final Acceptance Inspection. The Contractor shall comply with the requirements of these inspections as identified in Technical Specifications Section 01400.

3.03 NONCONFORMING WORK AND MATERIALS

A. Remedial Action Request (RAR)

1. The Project Manager will request the Contractor to take remedial action when nonconforming work is discovered and/or when test results indicate nonconforming work.

2. The Project Manager will document remedial action that cannot be taken immediately (the same day) by issuing a Remedial Action Request form to the Contractor. Remedial Action Requests are appropriate when the affected element of work is in-progress and discrepancies can be rectified as the work proceeds. RAR's shall be written when work can be brought back into conformance with the contract documents.

3. When issued, a Remedial Action Request will preclude payment for elements noted and will remain in effect until corrective actions have been submitted, approved and performed.

4. Upon satisfactory completion of the remedial action, the Contractor shall transmit the RAR form with the Contractor's statement of action taken (including any applicable test results) to the Project Manager. The Project Manager will perform a follow-up inspection to verify the RAR has been satisfactorily completed. The RAR then will be closed.

B. Nonconformance Report (NCR)

1. The Project Manager will issue a Nonconformance Report to the Contractor whenever there are violations of the terms of the contract that cannot be immediately brought back into conformance, including materials received and/or items of the work found not to be in conformance with contract requirements. When issued, a Nonconformance Report will preclude payment for elements noted and will remain in effect until corrective actions have been submitted, approved and performed.

2. The Nonconformance Report form will describe the nature and extent of nonconforming elements and will include space for the Contractor's corrective action proposal, the designer's review of the Contractor's proposal, reinspection and/or verification of approved corrective rework and a space for the Project Manager's disposition of the nonconformance matter. Copies of the Nonconformance Report, at each step of its processing (i.e., initial issuance to Contractor through final disposition), will be sent to the Project Manager.

3. The Project Manager will make the disposition of nonconforming items/materials.

C. The Contractor is obligated to correct any item deemed deficient.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the unit price item, work order or lump sum bid item. If the City is required to re-inspect work because the previous inspection showed that the work was defective or not in conformance, the Deputy Manager or his authorized representative may deduct from he contract value the cost of re-inspection at the rate of $75.00 per man-hour.

END OF SECTION 01402

SECTION 01410

CUTTING AND PATCHING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Reference General Contract Conditions, GC 315.

B. Reference Technical Specifications, Section 01411.

1.02 DEFINITIONS

A. Cutting: Removal of existing construction to permit installation of or to perform other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.03 SUBMITTALS

A. Refer to Technical Specifications Sections 01300 and 01340 for submittal procedures.

B. Cutting and Patching Proposal: Submit a proposal describing procedures at least 30 calendar days before the time cutting and patching will be performed, requesting approval to proceed. Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work. The proposal shall include the following information:

1. Identification of the contract and the Contractor's name.
2. Description of proposed work:
    a. Scope of cutting, patching, alteration or excavation
    b. The necessity for cutting or alteration
    c. Drawing showing location of the requested cutting or alteration, along with radar or x-ray report.
    d. Trades that will execute the work
    e. Products proposed to be used
    f. Extent of refinishing to be done
    g. Alternatives to cutting and patching
3. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in the building's appearance and other significant visual elements.
4. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
5. Proposed Dust Control and Noise Control Measures: Submit a statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.

6. Effect on the work and other surrounding work or on structural or weatherproof integrity of project
7. Written concurrence of each contractor or entity whose work will be affected.
8. Cost proposal, when applicable

1.04 QUALITY CONTROL

A. Operational Elements: Do not cut and patch the following operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance, decreased operational life or safety unless approved by the Project Manager:

1. Primary operational systems and equipment
2. Air or smoke barriers
3. Fire protection systems
4. Control systems
5. Communication systems
6. Conveying systems
7. Electrical wiring systems
8. Operating systems of special construction as described in Division 13 and 16
9. HVAC systems.

B. Miscellaneous Elements: Do not cut and patch the following elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or those results in increased maintenance, decreased operational life or safety unless approved by the Project Manager:

1. Water, moisture or vapor barriers
2. Membranes and flashings
3. Exterior curtain wall construction
4. Equipment supports
5. Piping, ductwork, vessels and equipment
6. Noise control and vibration control elements and systems
7. Stud walls.

C. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in DIA's sole opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactorily manner.

1. If possible, retain the original installer or fabricator to cut and patch exposed Work listed below. If it is impossible to engage the original installer or fabricator, engage another recognized, experienced and specialized firm as approved by the Project Manager:
   a. Processed concrete finishes
   b. Stonework and stone masonry

c. Ornamental metal
d. Matched-veneer woodwork
e. Preformed metal panels
f. Firestopping
g. Window wall systems
h. Terrazzo
i. Wall coverings
j. HVAC enclosures, cabinets or covers,.

D. Cutting and Patching Conference: Before proceeding, meet at the Project site with all parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.05 WARRANTY

A. Existing Warranties: Remove, replace, patch and repair materials and surfaces cut or damaged during cutting and patching operations by methods and with materials so as not to void existing warranties.

1. If possible, retain the original installer or fabricator to patch the exposed Work listed below that is damaged during selective demolition. If it is impossible to engage the original installer or fabricator, engage another recognized, experienced and specialized firm as approved by the Project Manager:
   a. Ornamental metal
   b. Preformed metal panels
   c. Firestopping
   d. Terrazzo
   e. ProCoat paint finishes
   f. Granite flooring
   g. Wall coverings
   h. HVAC enclosures, cabinets or covers.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: All patching material shall be of the type specified for the material being patched. Comply with requirements specified in other Sections of these Technical Specifications.

B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials as approved by the Project Manager.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are

to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
2. Immediately notify the Project Manager, in writing, of unsuitable, unsafe or unsatisfactory conditions.
3. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.
4. Proceed with patching only after construction operations requiring cutting are complete and inspected by the Project Manager.

3.02 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut to ensure structural value or integrity.

B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Services: Where existing services are required to be removed, relocated or abandoned, bypass such services before cutting to avoid (or minimize) interruption of services to occupied areas.

3.03 POLLUTION CONTROLS

A. Dust Control: Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.

1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions such as ice, flooding and pollution.
2. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosures. Vacuum carpeted areas.

B. Disposal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

C. Cleaning: Clean adjacent structures and improvements of dust, dirt and debris caused by selective demolition operations. Return adjacent areas to the condition existing before selective demolition operations began.

3.04 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Execute cutting and demolition by methods that will prevent damage to other work and will provide a proper surface to receive patching.

1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

2. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerance and finishes.

3. Restore work that has been cut or removed; install new products to provide complete work in accordance with requirements of the contract documents.

4. Fit work airtight and fire safe to pipes, sleeves, ducts, conduit and other penetrations through surfaces as required by the contract documents.

B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and other similar operations, including excavation, using methods least likely to damage elements retained to adjoining construction. If possible review proposed procedures with original installer and comply with original installer's written recommendations.

1. In general, use ground fault hand or small power tools designed(to short if metal is hit) for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to the size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.

3. Concrete: Use a cutting machine such as an abrasive saw or a diamond-core drill.

4. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Technical Specifications.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing. For continuous surfaces, refinish entire unit to the nearest break line. For an assembly, refinish entire unit.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

a. Where patching occurs on a painted surface, apply primer and intermediate paint coats over the patch and apply the final coat over the entire unbroken surface containing the patch. Provide additional coats until the patch blends with adjacent surfaces.

4. Ceilings: Patch, repair or re-hang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

D. Fire Rated Construction: Where rated elements are cut, reconstruct to approved designs to provide original fire rating.

3.05 CORE DRILLING

A. The Contractor shall execute a minimum of x-rays or ground penetrating radar at each

location planned for core drilling prior to submittal to the Project Manager and to utility representatives for approval for core drilling. The request for approval shall be submitted seven days in advance of the planned activity. The request for approval shall indicate on the x-ray or radar information regarding alternate locations or core drilling to avoid structural members and any embedded conduit. Embedded conduit may be metallic or plastic. The x-ray or radar system shall be capable of detecting both types of conduit.

B. Core drilled “cores” and the core-drilled opening shall be inspected by DIA Project Manager representatives prior to installation of any systems in new openings.

C. X-ray activities may not be performed during hours of activity or occupancy in the area of the x-ray system. The Contractor shall provide all manpower and barriers required to secure the areas affected by x-ray activities.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable multiplier for the division under which the work falls.

END OF SECTION 01410

SECTION 01411

SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Technical Specifications Section 01566 Environmental Controls

1.02 SUMMARY

A. This Section includes the following:

1. Demolition and removal of selected portions of a building or structure.

2. Repair procedures for selective demolition operations.

1.03 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Detach items from existing construction, wrap and label and deliver them to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.04 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain DIA’s property, demolished materials shall become the Contractor's property and shall be removed from the project site.

1.05 SUBMITTALS

A. Refer to Technical Specifications Section 01300 and 01340 for submittal procedures.

B. Qualification Data: For firms and persons specified in Technical Specifications Section 01400 Contractor Quality Control to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

C. Proposed Dust Control and Noise Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.

D. Submit a Schedule of Selective Demolition Activities that indicates the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure that DIA's and other tenants' on-site operations are uninterrupted.

2. Interruption of utility services.

3. Coordination for shutoff, capping, and continuation of utility services.

4. Coordination of DIA's continuing occupancy of portions of existing building and of DIA's partial occupancy of completed Work..

1.06 QUALITY CONTROL

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI A10.6 and NFPA 241.

C. Predemolition Conference: Conduct conference at the Project site with all parties involved with demolition. Review methods and procedures related to selective demolition including, but not limited to, the following:

1. Inspect and discuss condition of construction to be selectively demolished.

2. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

3. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

1.07 PROJECT CONDITIONS

A. Painting: Comply with manufacturer's recommendations for application conditions.

B. When there are occupied portions of buildings immediately adjacent to selective demolition area, conduct selective demolition so DIA’s or tenant’s operations will not be disrupted. Provide not less than 72 hours' notice to Project Manager of activities that will affect DIA’s or tenant’s operations.

C. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.

D. DIA assumes no responsibility for condition of areas to be selectively demolished. DIA will maintain conditions existing at time of inspection for bidding purpose as far as practical.

E. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Project Manager.

F. Storage or sale of removed items or materials on-site will not be permitted.

G. Utility Service: Maintain existing utilities indicated to remain in service and protect them

against damage during selective demolition operations.

H. Maintain fire-protection facilities in service during selective demolition operations.

1.08 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition by methods and with materials so as not to void existing warranties.

1. If possible, retain original installer or fabricator to patch the exposed Work listed below that is damaged during selective demolition. If it is impossible to engage the original installer or fabricator, engage another recognized experienced and specialized firm.
   a. Ornamental metal
   b. Preformed metal panels
   c. Firestopping
   d. Terrazzo
   e. Wall covering
   f. ProCoat paint finishes
   g. HVAC enclosures, cabinets or covers.

PART 2 - PRODUCTS

2.01 REPAIR MATERIALS

A. Use repair materials identical to existing materials.

1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that, when installed, will match the visual and functional performance of existing materials, as approved by DIA.

2. Use materials whose installed performance equal or surpass that of existing materials.

B. Comply with material and installation requirements specified in individual specification sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

B. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

C. When unanticipated mechanical, electrical or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to Project Manager.

D. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.02 UTILITY SERVICES

A. Existing Utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.

1. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by the Project Manager and authorities having jurisdiction.

3.03 PREPARATION

A. Site Access and Temporary controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct roads, streets, walks, walkways, or other adjacent occupied or used facilities without written authorization from the Project Manager and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

2. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.

3. Protect existing site improvements, appurtenances and landscaping.

4. Erect a plainly visible fence around drip lines of individual trees or around perimeter drip lines of groups of trees.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities.

1. Provide protection to ensure safe passage of people around selective demolition area, and to and from occupied portions of buildings.

2. Provide temporary weather protection during intervals between selective demolition operations of existing construction on exterior surfaces and new construction to prevent water leakage and damage to structure and interior areas.

3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

4. Cover and protect furniture, furnishings and equipment that have not been removed.

C. Temporary Enclosures: Provide temporary enclosures for protection of existing buildings and construction projects, both in progress and completed, from exposure, foul weather and other construction operations. Provide temporary weather tight enclosures for building exteriors.

1. Where heating or cooling is needed and permanent enclosures are not complete, provide insulated temporary enclosures. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.

D. Temporary Partitions: Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.

3.04 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting

members on the next lower level.

2. Neatly cut openings and holes plumb, square and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings that are to remain.

3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

4. Dispose of demolished items and materials promptly.

5. Return elements of construction and surfaces that are to remain to the same condition existing before selective demolition operations begin.

B. Existing Facilities: Comply with DIA's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.

C. Removed and Salvaged Items: Comply with the following:

1. Clean all removed and salvaged items.

2. Pack or crate items after cleaning. Identify contents of containers.

3. Store items in a secure area until turned over to DIA.

4. Transport items to DIA's storage area as designated by the Project Manager.

5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items: Comply with the following:

1. Clean and repair items to a functional condition adequate for the intended reuse. Paint equipment to match new equipment.

2. Pack or crate items after cleaning. Identify contents of containers

3. Protect items from damage during transport and storage.

4. Reinstall items in locations indicated in message schedule. Comply with installation requirements for new materials and equipment. Provide connections, supports and miscellaneous materials necessary to make the items functional for the use indicated.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the Project Manager, items may be removed to a suitable protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.05 PATCHING AND REPAIRS

A. General: Promptly repair damage to adjacent construction caused by selective demolition operations.

B. Patching: Comply with Technical Specification Section 01410, Cutting and Patching.

C. Repairs: Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.

1. Completely fill holes and depressions in existing masonry walls that are to remain with an approved masonry patching material applied according to manufacturer's written recommendations.

D. Finishes: Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.

E. Floors and Walls: Where walls or partitions that are demolished extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish color, texture and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

1. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements as specified in other sections of these specifications.

2. Where patching occurs on a painted surface, apply primer and intermediate paint coats over the patch and apply a final paint coat over the entire unbroken surface containing the patch. Provide additional coats until the patch blends with adjacent surfaces.

3. Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

F. Ceilings: Patch, repair or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.06 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

B. Burning: Do not burn demolished materials.

C. Disposal: Shall be in accordance with Technical Specifications Section 01566.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01411

SECTION 01500

TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section consists of furnishing, installing, operating, maintaining and removing temporary construction barriers, enclosures and field facilities including the Contractor's construction offices, staging areas, yards, storage areas, electrical power, telephone, water, fire protection and sanitary service. A construction office is at the Contractor's option (Project Manager's option).

B. Construction Offices,Construction Yards and Storage Areas

1. The Contractor's offices, construction yards laydown and storage areas shall be located as shown on the contract drawings and/or as designated by the Project Manager. All construction offices, staging areas and material storage areas are to occur within these areas.

2. Any activity that is expected to result in disturbance of the ground surface equal to or greater than one acre or part of a larger project that is expected to disturb equal to or greater than one acre, is required to be identified in the Construction Activities Stormwater Management Plan (CASMP) and/or Stormwater Management Plan (SWMP). These areas include, but are not limited to, laydowns, borrow areas, stockpiles, and storage areas regardless of the location.

3. All areas of ground disturbance are required to be stabilized in accordance with State, local, and airport rules and regulations prior to permit termination and/or closure of the contract .

4. The Contractor shall restore any area on DIA property that becomes contaminated as a result of its operations in accordance with Airport Rule and Regulation 180. Restoration shall be either to applicable standards under Federal and State law or to such other levels as may be required by the Manager of Aviation, at the Manager's sole discretion.

5. All temporary facility sites must be inspected prior to contract closeout. The DIA Project Manager or authorized representative shall conduct an inspection of contractor areas used during the life of the project. These areas include but are not limited to, staging areas, laydown areas, borrow areas, and contractor yards and offices. The DIA PM will ensure these areas have been properly stabilized in accordance with DIA Rules and Regulations and restored to the condition in which the City initially provided to the Contractor. A representative from DIA Environmental Services shall be present during the final walk through.

6. Contractor materials shall be managed in accordance with applicable Environmental Regulations.

7. Temporary facilities which the Contractor desires to locate in secondary laydown and staging areas adjacent to the Work or within the project limits are subject to approval by the Project Manager. If approved, these areas must also be included in the CASMP and/or SWMP.

8. Access to and security of the Contractor's construction offices, yard, temporary facilities and storage areas shall be as shown on the Contract Drawings or as specified in the contract Special Conditions.

9. Contractor Field Office
    a. The Contractor shall acquire all necessary permits for installation and construction work related to the Contractor's field office and fencing.
    b. The Contractor shall provide, as part of his on-site field office, a conference room for weekly meetings. Minimum size to accommodate 15 people with the currently approved schedule posted on a wall. The conference room shall have one available telephone.
    c. Jack the mobile office unit off its wheels and provide support. Enclose the underside of the trailer with weatherproof skirting.
    d. Install tie downs in compliance with code.
    e. Provide access to the field office and easily accessible space for parking six full size passenger automobiles as a minimum. Grade the field office site, access roadway and parking area for drainage, and surface with gravel paving or crushed stone.
    f. Water and sewer lines to the field office, if installed, shall be installed so they will not freeze.

C. Electrical Service

1. Provide lighting and power for field offices, storage facilities and other construction facilities and areas.
2. Provide power centers for electrically operated and controlled construction facilities including tools, equipment, testing equipment, interior construction lighting, heating, cooling and ventilation equipment.
3. Provide night security lighting at secured areas within construction limits at offices, storage facilities, temporary facilities and excavated areas.
4. Provide battery operated or equivalent emergency lighting facilities at construction areas where normal light failures would cause employees to be subjected to hazardous conditions. Test such facilities monthly and maintain a record of these tests for the Project Manager's review.
5. Bear all costs of temporary electric and water service permits, fees and deposits required by the governing authorities, and connection charges and temporary easements including installation, maintenance and removal of equipment.

D. Telephone Service

1. The Contractor shall furnish, install and maintain at least two telephones in his main field office. These phones shall be manned at all times by the Contractor's personnel or by an answering machine.
2. The Contractor shall supply one separate facsimile line for facsimile equipment.

E. Water Service

1. The Contractor shall make all connections and extensions required and shall make use of water in direct support of the Work. The Contractor shall install an approved Water Department tap at the City's water source prior to obtaining any water. The Contractor shall arrange and pay for its supply/distribution system from the City's point of connection. The location and alignment of the Contractor's temporary supply/distribution system must be approved by the Project Manager prior to its installation. The Contractor shall leave in place all above ground and underground water distribution facilities unless otherwise directed by the Project Manager.

2. The Contractor shall not use in place fire hydrants or standpipes as sources for construction water or potable water.

F. Fire Protection

1. Furnish, install and maintain temporary portable fire protection equipment throughout the construction period at all buildings (including the project site), maintenance shops, and fuel storage on all large construction equipment and at the location of any flammable materials or construction materials.

G. Sanitary Service

1. Furnish, install and maintain temporary sanitary facilities and services throughout the construction period.

2. Ensure that separate or single user toilets shall be provided to ensure privacy between the sexes.

3. Provide general washing facilities adequate for the number of employees.

4. Provide special washing facilities adequate for the number of employees engaged in the application of paints, coating and other volatile or hazardous materials.

1.02 QUALITY CONTROL

A. Provide products for, and the execution of, the Work of this Section that will satisfy the requirements of the NEC, OSHA and local codes. Provide products that satisfy requirements of NEMA and are UL listed.

1.03 SUBMITTALS

A. Refer to Technical Specifications Sections 01300 and 01340 for submittal procedures.

B. Submit a shop drawing within five days of the Notice to Proceed that shows the following:

1. Temporary facilities equipment and materials (include manufacturer's literature)

2. Details and layout of temporary installations including fences, roads, parking, buildings, storage areas and drainage plans.

3. Lighting plan showing temporary lighting facilities, electrical service panel location, electrical circuit diagram and anticipated light level on the working roadway, pathway or construction surface.

4. As-built description of any temporary underground utilities referenced to the Airport grid and benchmark system within five days of completion of the installation.

PART 2 - PRODUCTS

2.01 ELECTRICAL SERVICE

A. Provide temporary power and lighting equipment consisting of fixtures, transformers, panel boards, groundings, lamps, switches, poles, conduits and wiring sized and capable of continuous service and having adequate capacity to ensure a complete operating system. Comply with NEMA.

B. Provide temporary extension cords to supply tools not longer than 200 feet, except that additional length may be used if equipment will be grounded within 200 feet of tool or power.

C. Portable power generators shall be grounded.

2.02 TELEPHONE SERVICE

A. Provide equipment that is compatible with that of Qwest Communications Company and the telephone exchange to which the Contractor connects.

2.03 DRINKING WATER SERVICE

A. Provide sanitary materials and equipment that satisfies the requirements of codes and regulations pertaining to temporary water systems. Bottled products may be used if those products comply with codes. Clearly label portable containers having a dispensing tap and used only for drinking water. Provide single service disposable cups and a sanitary container for dispensing cups. A trash receptacle shall be provided and maintained beside each portable water supply.

2.04 FIRE PROTECTION

A. Fire extinguishers shall be UL rated and shall comply with the Uniform Fire Code.

2.05 SANITARY SERVICE

A. Provide materials and equipment adequate for the intended purposes, which will neither create unsanitary conditions nor violate the codes applicable to temporary sanitary facilities. Enclosures for toilet and washing facilities shall be weatherproof, sight proof, ventilated and sturdy.

B. Provide portable type toilet facilities that satisfy the requirements of OSHA.

C. Provide washing facilities as needed. Furnish soap, single-service paper towels, towel dispenser and towel receptacle. If paints, coatings and other volatile or hazardous materials injurious to humans will be applied as part of the contract, provide washing facilities with warm water of approximately 120 degrees F.

PART 3 - EXECUTION

3.01 ELECTRICAL SERVICE

A. The approximate location of primary power lines is shown on the Construction Drawings. The Contractor shall locate electrical service where it will not interfere with equipment, storage spaces, traffic, and prosecution of the Work or the work of others. Installation shall present a neat and orderly appearance and shall be structurally sound. Maintain service in a manner that will ensure continuous electrical service and safe working conditions.

3.02 TELEPHONE SERVICE

A. Install temporary telephone service in a neat and orderly manner and make structurally and electrically sound to ensure continuous service. Modify, relocate and extend as work progress requires. Place conduit and cable where those products will not interfere with traffic, work areas, materials, handling equipment, storage areas and the work of other contractors. Service lines may be aerial.

3.03 WATER SERVICE

A. Install the systems in a neat and orderly manner. Make them structurally and mechanically sound. Provide continuous service. Modify, relocate and extend the systems as the work progresses.

B. Locate systems where they will be convenient to work stations, sanitary facilities and first aid station but will not interfere with traffic, work areas, materials handling equipment, storage areas or the work of other contractors.

C. Provide sanitary bubbler drinking fountains if potable water service is available. Disinfect water piping before using for the potable water service.

D. Install vacuum breakers, backflow preventers and similar devices in a manner and location which will prevent temporary water from returning to the water mains.

E. Do not incorporate any part of temporary water distribution system into the permanent water distribution system.

3.04 FIRE PROTECTION

A. Install products in conformance with the requirements of the applicable Denver Fire Department and OSHA regulations.

1. Provide functional fire extinguishers that are clearly identified for fire and an accessible supply of water during the period of construction. These fire extinguishers shall remain in place until permanent fire protection systems are functional.

2. Furnish not less than one 20-pound fire extinguisher, type 2A-20ABC within ten feet of cutting and welding operations.

3. Provide 20-pound fire extinguishers, type 2A-20ABC no further then 100 feet apart in buildings.

4. Provide not less than one 20-pound fire extinguisher, type 2A-20ABC on any equipment of 75 horsepower or more.

B. Instruct construction personnel as to location and use of temporary fire protection equipment.

C. Fire extinguishers shall be located for easy access. Their location shall be clearly marked so that they can be seen at least 75 feet away.

3.05 SANITARY SERVICE

A. Place temporary sanitary (and washing) facilities in a neat and orderly manner within the limits of the work and convenient to the work stations. Make these facilities structurally and mechanically sound. Modify, relocate and extend the facilities as required by progress of the work.

B. Service toilets at those time intervals which will minimize the accumulation of wastes and prevent creation of unsanitary conditions, but not less than once a week.

C. The waste from the sanitary and wash facilities shall be disposed of in accordance with all applicable rules, regulations and laws and with the least environmental impact.

3.06 FENCING

A. Contact all utility service companies prior to planning fence location and post locations for certification of current utilities. Locate pothole posts planned within 5 feet of known utilities. Submit fencing plan and typical details to DIA Project Manager at least seven days before planned execution for review and acceptance.

3.07 SIGNAGE

A. Contractor shall not provide any signage for temporary facilities without prior approval from the DIA Project Manager.

3.08 TEMPORARY FACILITIES AS-BUILT DRAWINGS

A. Provide as-built drawings showing vertical and horizontal location. The location of all regulating and shut off devices along with all branches shall be shown. The as-built drawings shall be based upon the DIA grid coordinate system and benchmark. As-built drawings shall be furnished within 48 hours prior to the Contractor's request for turning on services.

3.09 REMOVAL

A. The Contractor shall locate all temporary facilities including the underground utilities so they can be completely removed without damaging permanent work or the worksite of other contractors.

B. The Contractor shall remove all temporary facilities, including all underground utilities, and restore the site to the condition in which the City initially provided it to the Contractor.

C. The Contractor shall stabilize all areas of disturbance in accordance with State, local, and airport rules and regulations.

D. In accordance with Part 1, an inspection of temporary facilities used by the Contractor is required prior to contract close out.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01500

SECTION 01505

MOBILIZATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section consists of preparatory work and operations including, but not limited to, those necessary for the movement of personnel, equipment, supplies and incidentals to the worksite; for the establishment of all offices, buildings and other facilities necessary for work on the project; and for all other work and operations which must be performed or costs incurred prior to beginning work on the various contract items on the worksite.

1.02 SUBMITTALS

A. Refer to Technical Specifications Sections 01300 and 01340 for submittal procedures.

B. Submit a Mobilization Schedule 15 days prior to first billing for mobilization.

1.03 DELIVERY

A. Delivery to the worksite of construction tools, equipment, materials and supplies shall be accomplished in conformance with local governing regulations.

PART 2 - PRODUCTS

2.01 PRODUCTS

A. Provide construction tools, equipment, materials and supplies of the type and quantities that will facilitate the timely execution of the Work.

PART 3 - EXECUTION

3.01 EXECUTION AND REMOVAL

A. Provide personnel, products, construction materials, equipment, tools and supplies at the worksite at the time they are scheduled to be installed or utilized.

B. Upon completion of the Work, remove construction tools, apparatus, equipment, unused materials and supplies, plant, and personnel from the jobsite.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. The Contractor shall submit for the Project Manager's approval 15 days prior to the first mobilization billing a detailed breakdown of all items, including subcontractor mobilization items that are proposed to be invoiced under Mobilization as part of the Schedule of Values (reference Technical Specifications Section 01370). This breakdown shall be labeled MOBILIZATION SCHEDULE. This schedule will be reviewed by the Project Manager to inform the Contractor what exact types of costs will be approved and paid under Mobilization.

B. All requests for payment for mobilization shall include a detailed Mobilization Schedule which shall identify the nature of each expense item, its delivery date, setup and startup date and the actual invoice amounts inclusive of acquisition, taxes, transportation assembly, and installation less all discounts.

C. The Contractor shall identify a line item in the Mobilization Schedule as "Demobilization" and shall establish the value for this line item, at a minimum, of fifteen percent (15%) of the pay item for mobilization.

D. The initial approved Mobilization Schedule shall determine the basis for all future mobilization payments.

PART 5 - PAYMENT

5.01 MOBILIZATION

A. Payment will be made only for substantiated Mobilization costs in accordance with the approved Mobilization Schedule, and only to the limit of the contract lump sum amount for the pay item Mobilization. In no case will the City pay Mobilization in excess of five percent (5%) of the total Contract amount.

B. Payment for the Contractor's bonds may be included in the Mobilization Schedule to the limits of the actual amount.

C. Payment amounts for personnel involved in mobilization and listed on the approved Mobilization Schedule shall be limited to the Contractor's certified payroll amounts.

D. Payment amounts for materials, supplies and transportation involved in mobilization and listed on the approved Mobilization Schedule shall be for the actual amounts paid as shown on invoices marked paid. No payment will be made under mobilization for the cost of permanent materials to be installed for this contract. See Section 01370 for Stored Materials.

E. No payment under mobilization will be made for rented or leased equipment other than actual transportation cost.

F. No separate payment will be made as part of the Mobilization Schedule for the maintenance and/or use of personnel, equipment, supplies and incidentals after project setup except for demobilization. These costs are to be incorporated in the remaining items of work in the Schedule of Values by multiplier or work request.

G. For any mobilization payment amounts requested by the Contractor that are unsubstantiated or exceed the allowable limit of five percent of the total Contract amount, the Project City, may in its sole discretion reallocate any, all, or none of those amounts to other work items in the Schedule of Values for lump sum contracts or to be disbursed on a prorated basis as determined by the Project Manager for unit price contracts. Any unsubstantiated mobilization payment amounts not reallocated by the Project Manager will not be paid

END OF SECTION 01505

SECTION 01566

ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section consists of avoiding or mitigating adverse environmental impacts caused by construction activities in the areas of air quality, water quality, hazardous and non-hazardous solid waste, natural resources, and noise pollution. Reference the General Contract Conditions 806 (Protection of Drainageways), 807 (Protection of Environment), 808 (Hazardous and Explosive Materials or Substances), and 809 (Archeological and Historical Discoveries).

1. The Contractor, in conducting any activity on airport property or in conducting work for an airport project not on airport property, shall comply with all applicable airport, local, state, and federal rules, regulations, statutes, laws, and orders ("Environmental Requirements"). In addition, these Environmental Requirements include applicable Environmental Guidelines developed for DIA's Environmental Management System (EMS), as summarized in the airport's Rules and Regulations Part 180 (Environmental Management), which can be located on the airport's website at: http://www.flydenver.com/diabiz/info/research/rules/index.htm. Information on DIA's EMS as well as current versions of DIA's Environmental Guidelines and Environmental Policy are also located on the airport's website at: http://www.flydenver.com/diabiz/community/enviro/index.asp. These Environmental Requirements address, but are not limited to, requirements regarding the management of hazardous materials, petroleum products, solid waste, or any other substance; the National Environmental Policy Act (NEPA); and water quality and air quality regulations. Each entity, including subcontractors and subconsultants providing products, goods, and/or services on behalf of DIA, must be aware of the DIA Environmental Policy, the significant environmental aspects for DIA, and which of these aspects are relevant to the activities conducted by the entity.

2. The Contractor shall comply with all Environmental Requirements and accept responsibility for compliance with all environmental quality standards, limitations and permit requirements promulgated there under. The Contractor shall obtain all environmental permits required for implementation of the project. Failure of these specifications to specifically mention any Environmental Requirement does not relieve the Contractor from compliance.

3. If the City, as owner, is determined by any federal, state or local government agency, department, board or commission, or in any judicial proceeding to have violated any such environmental protection rules, laws or regulations as a result of Contractor's acts or omissions, the Contractor agrees to indemnify and hold harmless the City from any and all prosecutions, payment of any and all fines or penalties, and the cost of abatement and remediation, except that the Contractor shall not be required under General Contract Condition 807, to indemnify the City from any amounts which are attributable to the negligence of the City.

4. Work shall not commence on any project until all FAA approvals have been received, applicable permits have been issued and signed by permitee, and all inspection requirements have been satisfied in accordance with State and local permitting requirements.

1.02 SUBMITTALS

A. Refer to Technical Specifications Sections 01300 (Submittals) and 01340 (Shop and Working Drawings, Product Data and Samples) for procedures.

B. Within 10 days after Notice to Proceed on a task order, the Contractor shall submit the following if applicable, unless waived by the DIA Project Manager:

1. Submittals pertaining to water quality management:
    a. Copy of the application completed for the City and County of Denver Construction Activities Stormwater Discharge Permit (CASDP) and the CASDP issued for the project by the Denver Department of Public Works. This submittal consists of three items: the Authorization to Discharge, the Sewer Use & Drainage Permit, and the approved Construction Activities Stormwater Management Plan (CASMP).
        1) Revisions or amendments to the CASMP by the Contractor. At the completion of the project, after final stabilization has been achieved and accepted in accordance with CASDP requirements, the Contractor shall submit a copy of the CASDP Inactivation Request.
    b. Copy of the certification issued by the Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Division (WQCD) under the Colorado Discharge Permit System (CDPS) for discharges associated with construction activities and/or industrial activities. Before obtaining this permit, the Contractor shall submit a **draft** permit application and the final permit application for DIA review and approval PRIOR to submittal to CDPHE. The Contractor need not submit copies of the general permits or the general permit rationales.
        1) At the completion of the project, after final stabilization has been achieved and accepted in accordance with the State of Colorado CDPS requirements, the Contractor shall submit a copy of the CDPS Inactivation Notice or Notice of Termination.
    c. Copy of the certification issued by the State of Colorado CDPS under its General Permit for Construction Dewatering Activities. Before obtaining this permit, the Contractor shall submit a **draft** permit application and the final permit application for DIA review and approval PRIOR to submittal to CDPHE. The Contractor need not submit a copy of the general permit or the general permit rationale.
        1) At the completion of the project, the Contractor shall submit a copy of the CDPS Notice of Termination.
    d. Copies of any certification issued by the State of Colorado under its Industrial Permitting for minimal discharges of process wastewater. Before obtaining a permit, the Contractor shall submit a **draft** permit application and the final permit application for DIA review and approval PRIOR to submittal to CDPHE. The Contractor need not submit a copy of the issued permit or the permit rationale.
        1) The Contractor shall submit copies of Discharge Monitoring Reports (DMRs) and at completion of the project, the CDPS Notice of Termination.
    e. A copy of the well permit from the state Division of Water Resources for every new well that diverts or for the monitoring of groundwater.
    f. A copy of the Notice of Intent for any borehole structure filed with the state Division of Water Resources.
2. Submittals pertaining to sewage holding tanks associated with buildings and trailers. For purposes of this Section 01566, the generic term “sewage holding tank” means “individual sewage disposal system (ISDS)”, “privy vault”, “septic tank”, or “septic system”.
    a. Copy of the permit application for a sewage holding tank.
    b. Copy of the Sewer Use & Drainage Permit issued by the Denver Department of Public Works.

c. Copy of the ISDS permit issued by the Denver Department of Environmental Health.

3. Submittals pertaining to air quality management:
   a. Copy of any permit issued by the CDPHE Air Pollution Control Division (APCD). Before obtaining a permit, the Contractor shall submit a **draft** permit application and the final permit application for DIA review and approval PRIOR to submittal to CDPHE.
      1. In cases where the City has already obtained a dust control permit, the Contractor shall submit a copy of the paperwork transferring the permit over to the Contractor's company name and a copy of the transferred permit.
   b. Dust control plan. For projects where the State of Colorado requires a dust control permit, this submittal is waived. This plan must address appropriate control measures that the Contractor will employ to minimize the release of fugitive dust from the site. In addition, the Contractor must comply with the requirements in Section 3.01 below.
   c. Copies of the Notices of Relocation.
4. Submittals pertaining to storage tanks and containers:
   a. Copy of the permit issued by the State of Colorado, Department of Labor and Employment, Division of Oil and Public Safety, for installation of petroleum (or other regulated substances) storage tanks located on airport property and used for the project.
   b. Copy of permits issued by the Denver Fire Department for storage tank installations, storage tank removals, and hazardous materials use/storage.
   c. Copy of Spill Prevention, Control, and Countermeasure (SPCC) Plan for petroleum storage tanks and containers with capacity of 55 gallons of oil or greater located on airport property and used for the project.
5. Waste Management Plan. This submittal may be waived if DIA Environmental Services, upon consultation with the DIA Project Manager, deems it unnecessary to require such plan. When required, this plan must include, at a minimum, waste management measures listed in Paragraph 3.05.I. below. Because this plan may be required at any point during the project, the Contractor should anticipate making this submittal in its contract bid or proposal.
6. Copies of any other plans, permits, permit applications, correspondence with regulatory agencies (including violations), waste manifests, results of laboratory analyses, or other environmental documentation required for the project not previously identified.

1.03 RELATED DOCUMENTS

A. Code of Federal Regulations (CFR) Publications (including but not limited to):

1. 33 CFR 323 - Permits for discharges of dredged or fill materials into waters of the United States
2. 40 CFR - Protection of Environment
3. 49 CFR 171-180 Hazardous Material Transportation Regulations

B. Colorado Revised Statutes (including but not limited to):

1. Water Quality Control, Title 25, Article 8

2. Air Quality Control, Title 25, Article 7
3. Hazardous Waste, Title 25, Article 15
4. Noise Abatement, Title 25, Article 12
5. Petroleum Storage Tanks, Title 8, Article 20.5
6. Liquified Petroleum Gas (LPG) Storage Tanks, Title 8, Article 20
7. Solid waste regulations

C. City and County of Denver Executive Orders (including but not limited to)

1. Executive Order No. 115
2. Executive Order No. 123

D. Denver Revised Municipal Code, Title II, Sections 48-44 and 48-93

E. City and County of Denver Construction Sites Program

F. City and County of Denver Construction Activities Stormwater Management Plans Information Guide

G. Any other applicable rules, regulations, ordinances, and guidance must be followed as applicable.

PART 2 - PRODUCTS

2.01 PRODUCTS

A. Products required for the work shall meet all Environmental Requirements.

B. At a minimum, products for erosion and sediment control must conform to the technical requirements contained in the *City and County of Denver's Construction Activities Stormwater Management Plan Information Guide* and the current version of the Urban Drainage and Flood Control District's *Urban Storm Drainage Criteria Manual, Volume 3: Best Management Practices.* These documents are posted at http://www.denvergov.org/Portals/528/documents/DftGuide452007.pdf and http://www.udfcd.org/downloads/down_critmanual.htm respectively.

PART 3 - EXECUTION

3.01 AIR POLLUTION CONTROLS

A. The Contractor shall use appropriate control measures to comply with applicable air quality permit requirements. Additionally, the Contractor must be aware of the following procedures and techniques while conducting construction activities on DIA property. NOTE: Application of dust control measures should be discussed in the Dust Control Plan.

1. Apply water as needed to the construction site haul roads, disturbed surface areas and public access roads as needed to suppress dust. The use of chemical stabilizer can be requested by the Contractor. The type of stabilizer to be used and locations of use must be included in the Dust Control Plan, which must be approved by the DIA PM prior to application.

2. The Contractor shall suspend all earthmoving activities if wind speed exceeds 30 mph. For purposes of this Section 01566, the generic term “earthmoving” means clearing, grubbing, excavation, topsoil removal, backfilling, embankment work, grading, trenching, drilling, and installation of borings. Contractors are expected to check wind speeds with the airport’s ramp tower to demonstrate compliance with this requirement. In addition, the project may be shut down if two of three of the Runway Visual Range (RVR) instruments read visibility of 2,400 feet or less. The instruments are used by FAA Control Tower personnel to ensure safe aircraft operations. Costs for shutdowns due to wind velocities or RVR readings shall not be grounds for delay or extra cost claims.

B. Burning of materials is strictly prohibited on DIA property.

3.02 WATER POLLUTION CONTROLS

A. The Contractor shall conduct construction activities in accordance with all applicable permit requirements. In addition, the Contractor shall comply with the following procedures and requirements while conducting activities on DIA property.

1. Water encountered during construction cannot be discharged to the stormwater system or placed onto the ground surface without a permit AND prior written approval by the DIA Project Manager. If groundwater or stormwater is anticipated to be encountered and the Contractor desires to discharge it to the stormwater system or onto the ground surface, then the Contractor must obtain an appropriate CDPS discharge permit in advance of the discharge unless this activity is specifically authorized under the CDPS Construction Stormwater Permit.

2. If water is encountered and the Contractor desires to discharge these waters to the sanitary sewer system, then the Contractor must obtain approval from DIA Environmental Services in advance of the discharge.

3. The Contractor shall ensure that stormwater that comes in contact with storage areas does not become impacted and discharged to the stormwater sewer system or to an impervious surface. Furthermore, any materials in storage areas shall not be stored directly on the ground (refer to DIA Technical Specification 16642 for Cathodic Protection Requirements).

4. The Contractor shall not operate any valves, sluice gates or other drainage appurtenances related to any DIA sewer system without the prior approval of both the DIA Project Manager and DIA Environmental Services. Any violation of this directive may result in the payment of a financial penalty by the Contractor if the State of Colorado assesses such a penalty.

3.03 EROSION CONTROL AND SEDIMENTATION CONTROL

A. This work consists of constructing, installing, maintaining and removing, if required, temporary and permanent control measures during the life of the contract (and possibly afterward) until the Contractor achieves final stabilization of the site to prevent or minimize erosion, sedimentation, and pollution of any state waters in accordance with all Environmental Requirements.

B. The Contractor is responsible for compliance with all requirements in accordance with the CASDP, the City and County of Denver Construction Sites Program, the approved CASMP, and CDPS issued permits.

C. Temporary facilities, including but not limited to, storage areas, laydowns, borrow areas, and contractor offices and work yards shall be managed in accordance with DIA Technical Specification 01500 for Temporary Facilities.

D. Clean soil fill may be stockpiled in any area that has been previously approved and signed off by the DIA Section Manager of Construction, Design and Planning, and Environmental Services. Soil stockpiles are considered a potential pollutant source and must be addressed in the CASMP and/or SWMP.

E. Make immediately available, upon the DIA PM's request, all labor, material and equipment judged appropriate by the Project Manager to maintain suitable erosion and sediment control features. These actions requested by the DIA PM take precedence over all other aspects of project construction that have need of the same labor, material and equipment, except those aspects required to prevent loss of life or severe property damage.

3.04 CONSTRUCTION OF CONTROL MEASURES FOR EROSION AND SEDIMENTATION

A. The Contractor must install control measures in accordance with the most recent version of the Urban Drainage and Flood Control District's *Urban Storm Drainage Criteria Manual, Volume 3: Best Management Practices* and the City and County of Denver's *Construction Activities Stormwater Management Plan information Guide.* These documents are posted at: http://www.udfcd.org/downloads/down_critmanual.htm and http://www.denvergov.org/Portals/528/documents/DftGuide452007.pdf respectively. Deviations from these two documents are allowed with written consent from the City and County of Denver NPDES Inspector.

3.05 SOLID WASTE MANAGEMENT

A. This paragraph applies to solid waste. Solid waste is defined at 40 CFR 261.2 and includes all putrescible and nonputrescible solid, semisolid and liquid wastes, but does not include hazardous waste which is treated as a separate subset of solid waste. Hazardous waste is defined at 40 CFR 261.3, and 6 CCR 1007-2 as a solid, a liquid, or a contained gaseous material that is no longer used or that no longer serves the purpose for which it was produced and meets the definitions of the regulations. Certain types of non-hazardous solid waste may require special handling; such wastes are sometimes called "special waste."

B. Hazardous and non-hazardous solid waste may be generated by the actions of the Contractor including, but not limited to, the direct purchase of hazardous materials, demolition, site preparation, grading, excavation, construction, or maintenance of equipment. If questionable material is encountered during construction activities, the Contractor must immediately notify the DIA Communications Center at (303) 342-4200 and the DIA Project Manager. If the Contractor will utilize any chemicals that will result in the generation of a potentially hazardous waste, the Contractor must prepare and submit a Waste Management Plan (Section 3.05.I)

C. Remove scrap and waste material and dispose of it in accordance with laws, codes, regulations, ordinances, and permits.

D. The Contractor is responsible for the safe management and disposal of all hazardous and non-hazardous solid waste and shall dispose of such waste in accordance with all environmental requirements. Waste disposal options include reuse on the project (with DIA approval only), sale, use for fuel, donation to other public or private projects, or through disposal in approved public or private disposal sites, either free of charge or for a fee. The method of disposal is restricted according to the classification of the waste. Hazardous and non-hazardous solid waste shall not be abandoned, dumped, buried or in any other way disposed on DIA property.

E. City and County of Denver Executive Order No. 115 requires all non-hazardous solid waste generated at DIA to be directed to the Denver Arapahoe Disposal Site (DADS) landfill. This includes all non-hazardous solid waste collected or transported in Denver vehicles, Contractor vehicles, or subcontractor vehicles. Through the DIA Project Manager, the Contractor shall establish accounts in advance for the disposal of non-hazardous solid waste generated on the project. Therefore, this bid shall include costs for transportation to the DADS landfill only and the City is responsible for disposal fees and any applicable State surcharges. The Contractor is responsible for any special handling charge imposed by the transporter or the DADS landfill operator.

NOTE: To establish contractor accounts, the DIA Project Manager shall follow procedures outlined in ES-308-06.03: *Municipal and Special Solid Waste Administrative Management Work Instruction*.

1. In the interest of public relations and to maximize the long-term use of the Site, haul routes adjacent to DADS shall be limited to State Highways 30 or 470 unless these routes are impassable (refer to Exhibit A for preferred haul route). Specifically, Gun Club Road between Interstate Highway 70 (“I-70”) and Mississippi Avenue shall be avoided.

F. Some of the naturally occurring material found by the Contractor, especially tar or oil-impregnated soil, may not be obviously hazardous. Physical and chemical analyses and tests may be required to determine if the material meets the criteria set forth in State of Colorado, CDPHE, Hazardous Materials and Waste Management Division (HMWMD) regulations. The Contractor shall pay for such chemical analyses and will coordinate with local authorities to determine the quantity and origin of samples analyzed for any questionable material. The Contractor will provide the classification of the material to the City.

G. The routes to be followed when transporting solid or hazardous wastes may be subject to the approval of the local agency having jurisdiction.

H. The Contractor shall not wash down equipment in such a manner as to flush grease and oils into the project site or onto airport property unless the waste is properly contained, treated, and disposed.

I. Unless waived, the Contractor shall submit a Waste Management Plan that meets these minimum requirements:

1. Contractor's name and contract number;

2. A list of all materials, products, and wastes for the project; acknowledgment whether any of those materials and products require special handling or storage for environmental, safety, or fire code reasons; and acknowledgment whether any of the wastes will become regulated wastes upon disposal. The list of materials, products, and wastes shall include, at a minimum, trash and unclassified construction debris, asphalt spoils, concrete spoils, pavement sweepings, soils contaminated by chemicals or petroleum products during the project, lime and cement trimmings, scrap metal, and every chemical product used on the project. Reuse of a product on site for its original intended purpose (e.g., cement trimmings from one part of the project used elsewhere on the airport) does not constitute generation of a waste for disposal.

3. For each material and product listed, the Contractor shall identify the storage method, and identify measures to store hazardous waste separately from non-hazardous waste.

4. For each waste listed, the Contractor shall identify the handling/transportation method, the disposal method, and the disposal facility utilized.

5. If the Contractor anticipates generation of hazardous waste, the Contractor shall provide its USEPA (generator) identification number.

6. Recycling measures.

7. Waste minimization measures.

8. Pollution prevention measures.

9. Training measures for management of hazardous materials and hazardous wastes on site.

J. The Contractor shall maintain copies of MSDSs for any and all materials used at the airport project, at its on-site project office or other designated location. DIA Environmental Services may, at any time, request copies of MSDSs and/or waste manifests for any waste shipments from the project site. Any such request must be fulfilled within 1 business day.

K. The Contractor shall require all shipments to the worksite to contain documentation that shows whether the material is hazardous or requires special handling, storage, or disposal; what type of material it is; what hazard(s) it poses; how to treat exposure(s); and the quantity of hazardous material in the shipment. This information must be provided to the DIA PM prior to any hazardous material being allowed on site.

L. Before leaving the site with any hazardous waste or material requiring special handling, disposal, or storage, the Contractor must provide the DIA PM with a detailed description of the material, its source, quantity, who is hauling it off site, and where it is being taken, along with verification that the destination site can legally receive it.

M. The Contractor shall recycle all construction materials to the extent practicable.

3.06 CONSTRUCTION DEBRIS RECYCLING

A. The City and County of Denver encourages recycling applicable materials. Scrap metal, wood, and other construction materials may be eligible for recycling. The Contractor is responsible for coordinating all aspects with regard to recycling. The Contractor can contact DIA Purchasing or DIA Environmental Services for information regarding recycling policies and practices.

B. Dry concrete and asphalt materials are considered solid waste, but may be eligible for recycling. DIA maintains two dry concrete and asphalt recycling yards used for the accumulation and crushing of these materials. The only allowable materials at the recycle yards are dry concrete and asphalt materials derived from construction activities occurring on DIA property. The South Yard is located on 71st Ave just east of Jackson Gap Street. The North Yard is located on the south side of 110th, west of Queensburg Street. The use of these yards must be approved by the DIA Project Manager.

1. Concrete washout activities are prohibited anywhere on DIA property unless a) the activity is specifically authorized under a CDPS permit and included in the SWMP or b) the washwater is collected and hauled offsite for disposal at an appropriately permitted facility. Concrete washout activities authorized by permit are only allowed at a designated concrete washout area as indicated in the approved CASMP and include the washing of the chute and tools ONLY. Concrete washout spoils are eligible for recycling once the washout has been segregated and allowed to dry and harden in accordance with permitted methods.

2. Rejected loads and/or other wet concrete or asphalt materials are prohibited to be placed ANY WHERE on DIA property unless the Contractor holds a permit that authorizes the placement of such material on the site. Unless specifically authorized

in a CDPS permit issued to the Contractor, these materials must be returned to the facility of origination or other permitted facility for proper disposal.

3. The Contractor shall not place any concrete containing welded wire fabric or deformed steel reinforcing bars installed in a crisscross fashion in either of the airport's two construction spoils recycling yards. The Contractor shall remove reinforced concrete from the project site and haul such waste to the DADS landfill.

4. A Recycle Materials Manifest is required to be filled out by the Contractor for each load of concrete or asphalt placed in these areas and given to the responsible Project Manager. It will be the responsibility of the Project Manager to ensure the accuracy and completeness of the manifests. The Project Manger will also be responsible for instituting controls to ensure that only the manifested materials are placed in the approved site. If two or more Project Managers have material going into a site at the same time, they will need to coordinate their efforts to ensure that only approved and manifested materials are allowed on the site.

5. A copy of all manifests must be turned in on a weekly basis to the Assistant Deputy Manager of the Construction Management Section (Michael Steffens). A copy of the Recycled Materials Manifest form is available from the DIA Project Manager.

NOTE: Concrete and asphalt waste materials are considered a potential pollutant source and must be addressed in the CASMP and/or SWMP.

3.07 STORAGE OF OIL, FUELS, OR HAZARDOUS SUBSTANCES

A. The Contractor shall prevent oil or other hazardous substances (as defined in federal and state regulations) from entering the ground, drainage or local bodies of water, and shall provide containment, diversionary structures, or equipment to prevent discharged oil from reaching a watercourse and take immediate action to contain and clean up any spill of oily substances, petroleum products, or hazardous substances. The Contractor shall provide one or more of the following preventive systems at each petroleum storage site:

1. Dikes, berms, or retaining walls capable of containing at least 100% of the volume of the largest single tank and equipped with sufficient freeboard to contain precipitation events. The secondary containment must be "sufficiently impermeable" to prevent a release to the environment.

2. Culverting, curbing, guttering or other similar structures capable of containing at least 100% of the volume of the largest single tank.

B. The provision of such preventive systems shall be subject to acceptance by the DIA PM prior to tank installation and shall follow the SPCC regulations (40 CFR Part 112).

C. Prior to bringing any containers of 55-gallon or above capacity onto DIA property for storage of oil, fuel, or other petroleum substances, the Contractor may be required to prepare an SPCC Plan that conforms to 40 CFR Part 112. The plan must include either a certification from a Professional Engineer or self-certification (if applicable), as well as management approval from the legally responsible Contractor representative.

3.08 SPILL RESPONSE AND NOTIFICATION

A. The Contractor is responsible for all spills that may result from its activities. For ANY suspected or confirmed release or spill of oil, fuel, solid waste, hazardous waste, unknown materials, lavatory waste, or miscellaneous chemicals, etc. that occurs as the result of the Contractor's activities on DIA property, the Contractor is required to take immediate action to mitigate the release or spill and report it to the DIA Project Manager and to the DIA

Communications Center at (303) 342-4200.

B. The Contractor is responsible for notifying the appropriate regulatory agency(ies) in the event suspected and/or confirmed releases are identified, in accordance with regulatory requirements.

3.09 SITE REMEDIATION AND RESTORATION

A. The Contractor shall be required to perform any necessary site assessment and remediation activities required by applicable regulatory agency(ies).

B. During routine construction activities, the Contractor is required to manage soils using typical construction techniques. The Contractor must differentiate between soils and wastes (including contaminated soils versus clean soils) and determine those materials that can remain on DIA property and those that must be transported offsite for disposal.

C. During all construction activities that require the management of soils, the Contractor must notify the Project Manager and DIA Environmental Services (ES) that soils being managed may be impacted by industrial activities conducted at the airport. “Process knowledge” pertaining to previous use and/or impact for the location(s) under construction can be used to determine whether impacted soils are probable. Also, common indices such as soil staining and odor can be used as a determination for the probable condition. If probable contamination conditions are suspected, the Contractor will notify the Project Manager and DIA ES immediately. At that time (which may be before the work is initiated where indicative conditions exist), all work will cease until a sampling and analysis approach is determined and implemented by the proper responder.

D. If the site conditions warrant based on evidence of spillage or contamination, process knowledge, and/or visual or olfactory observations, the Contractor may be required to conduct sampling and analysis to confirm that no remedial action is required. Prior to conducting any removal activities, the Contractor must provide a Scope of Work to the DIA PM describing the proposed site assessment activities.

E. The impacted project will modify its operation to include a segregation area where probable impacted soils can be placed, stored, and sampled for characterization. Should the soil materials be determined to exceed the applicable standards, the Project Manager in conjunction with DIA ES, will be responsible for the proper disposal of these materials. Materials that are determined to contain contamination levels below the applicable standards can be considered clean soils and placed back into the excavation or reused elsewhere on DIA property. In accordance with Section 3.06, materials removed that are suitable for recycling will be placed within areas designated on DIA to store these materials.

F. The Contractor shall restore any area on the Airport which becomes contaminated as a result of its operations. Restoration shall be either to applicable standards under federal and state law or to such other levels as may be required by the Manager of Aviation, at the Manager’s sole discretion. Such restoration shall be completed at the earliest possible time, and the Contractor’s restoration shall be subject to inspection and approval by the Manager of Aviation or her duly authorized representative (see DIA Rules & Regulations – Part 180).

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

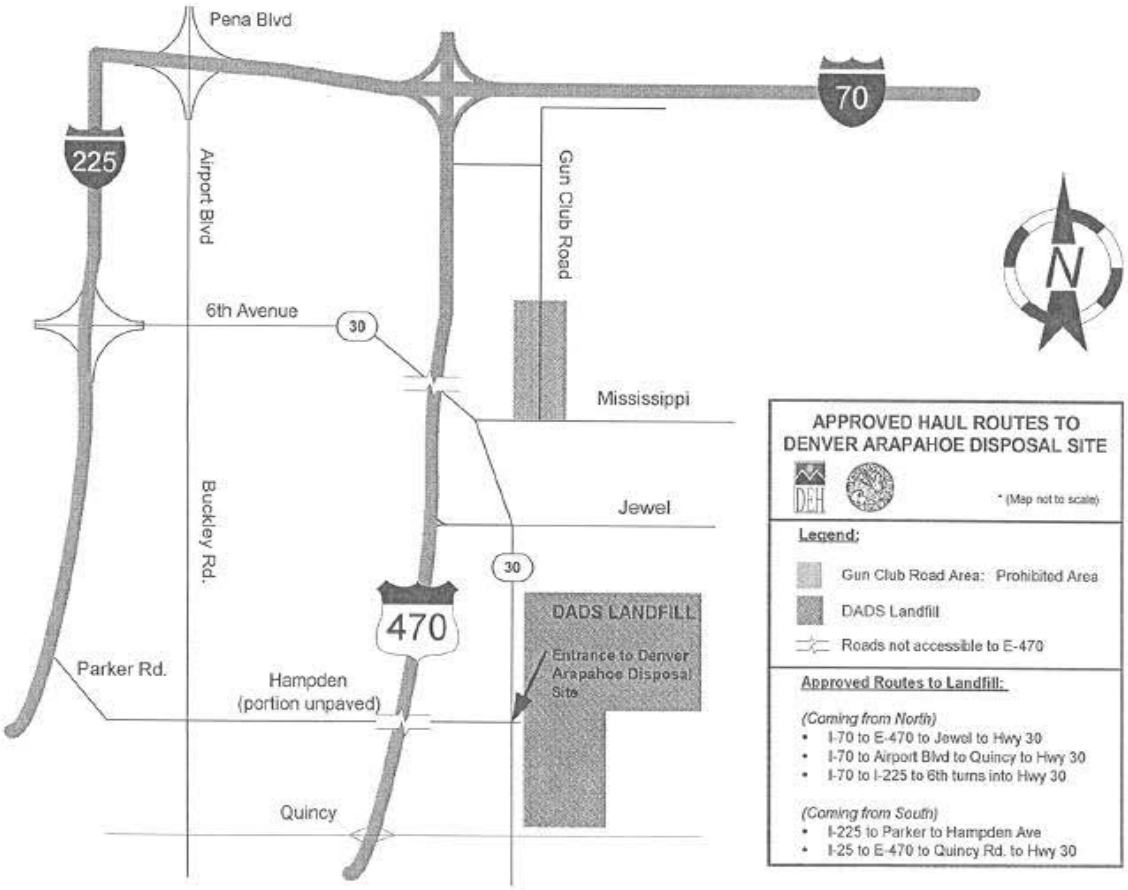
PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid items. The Contractor shall be responsible for payment of all fees associated with review of environmental permit applications and processing of environmental permits.

EXHIBIT A

MAP OF ROUTE TO DADS LANDFILL



END OF SECTION 01566

SECTION 01576

TRAFFIC CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section consists of furnishing plans and designs for traffic control and haul routes, implementing these plans with all necessary personnel and equipment. Installation may require but not be limited to signage, cones, flaggers, signal lights, lighting and temporary roads. All work must be in conformance with the Manual of Uniform Traffic Control Devices (MUTCD), Colorado Department of Highway Standards and SSPWC Specifications. The Contractor must coordinate his proposed traffic control needs with the needs of other contractors on the airport construction site in writing through the Project Manager.

B. Reference Contract General Condition, GC 805.

1.02 QUALITY CONTROL

A. Temporary signal work shall conform to “Standard Specifications for Public Works Construction”.

B. Designate a qualified person to inspect and test traffic control devices daily and to ascertain that those devices are continuously operating, serviceable, in place and clean.

C. Provide trained personnel who will be responsible for design, implementation and inspection of traffic control needs.

1.03 SUBMITTALS

A. Refer to Technical Specifications Sections 01300 and 01340 for submittal procedures.

B. Submit a Traffic Control Plan (TCP) that includes, at a minimum, the following list of items for approval before starting work. Submit an updated TCP when necessary to modify traffic operation or undertake a construction activity that creates a different traffic pattern.

1. Traffic blockade and reductions anticipated to be caused by construction operations.
2. Temporary detours.
3. Show and describe proposed location, dates, hours and duration of detours, vehicular traffic routing and management, traffic control devices for implementing detours and details of barricades.

C. Submit Haul Route Plan for both on- and off-site hauls. The Haul Route Plan shall be submitted 30 days prior to hauling any permanent material. The plan shall be updated as the contractor’s plans change.

D. Specific Traffic Considerations: The Project Manager may require the Contractor to revise the Traffic Control Plan to address traffic considerations not included in the Contractor’s plan.

PART 2 - PRODUCTS

2.01 TRAFFIC CONTROL DEVICES

A. Such devices which include signs, delineators, striping, barriers, barricades and high level warning devices shall conform to the latest revision of the “Manual on Uniform Traffic Control Devices” and the latest revision of the CDOT Supplement thereto.

PART 3 - EXECUTION

3.01 TEMPORARY TRAFFIC CONTROL DEVICES

A. Place temporary control devices in those locations that will enable traffic to traverse the area without hazard or abrupt changes in direction. Place traffic cones or delineators on not more than 35 foot centers. Operate warning lights between sunset and sunrise; place control devices so that approaching traffic is alerted to hazards and variances to normal traffic patterns. Place high rise warning flag units where motorist’s visibility of warning devices, traffic signals, and pedestrian crosswalks will be either limited or obscured. Place barricades, cones and similar protective devices where personnel and equipment will be working within five feet of the edge of a lane bearing traffic. Clean and repair damaged devices or replace them with new devices as required.

3.02 TEMPORARY TRAFFIC STRIPING AND PAVEMENT MARKINGS

A. Stripe and mark bituminous and Portland cement pavement before diverting traffic. Maintain stripes and marks until permanent traffic marking and striping has been provided, or the temporary condition is no longer required. Remove temporary striping and marks when no longer required.

3.03 FLAGGERS

A. Furnish flaggers where construction equipment may intermittently encroach on traffic lanes, already existing haul routes, and where construction operations would affect public or construction safety and convenience and also where active haul roads cross existing access roads.

3.04 CONSTRUCTION VEHICULAR TRAFFIC

A. Restrict construction vehicles to approved haul routes.

3.05 CONTROLLING VEHICULAR AND PEDESTRIAN FLOW ADJACENT TO WORKSITE

A. Ensure that construction operations will not impede normal traffic. Where work is in the area of pedestrian or occupant activity, the Contractor shall erect barriers to prevent pedestrian intrusion into the worksite. The barriers will be a minimum of 42 inches in height and shall not be penetrable from floor or grade to the top of the barrier. Barriers erected in areas where there is a change in grade of over six inches shall meet barrier requirements as defined in the UBC and the DBC.

3.06 SIGNS

A. Coordinate and pay any expense associated with the furnishing and installation of all parking regulatory signs, such as "No Stopping Any Time," etc. at the worksite. The Contractor must contact the Project Manager a minimum of five working days in advance of construction for installation, relocation or removal of regulatory parking signs.

B. Furnish and install any necessary advance detour or guidance signing.

C. Authorize, modify and install regulatory parking controls and vehicle turn restrictions.

D. Implement those traffic control modifications outside of the traffic control zone which are necessary to manage diverted traffic.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. Payment for Traffic Control under these schedules will be for work performed under the applicable work request lump sum bid item.

END OF SECTION 01576

SECTION 01580

TEMPORARY SIGNS

PART 1 - GENERAL

1.01 CONSTRUCTION SIGNAGE VISIBLE TO THE PUBLIC.

1.02 TEMPORARY DIRECTIONAL, INFORMATIONAL OR REGULATORY SIGNAGE.

1.03 QUALITY CONTROL

A. Construction and other temporary signage visible to the public must be commercial grade quality, professionally fabricated and installed for the location of the sign. The contractor is responsible to maintain this signage until it is no longer needed.

PART 2 - PRODUCTS

2.01 GENERAL

A. Interior signs that are visible and not physically accessible to the public may be made of rigid board, such as “Gator Board” with vinyl messages. All edges must be finished and conceal all attachments.

B. Interior signs that are visible and physically accessible by the public must be vandal-proof. Acceptable examples of vandal-proof signs are messages applied second surface with concealed tamperproof fasteners.

C. Exterior signs must be vandal-proof and fabricated of weatherproof materials.

PART 3 - EXECUTION

3.01 HARDWARE

A. Interior Signs: Attach with suitable adhesive and/or tape which may be removed with out damage to finishes.

B. Exterior Signs: Must be secured to withstand site conditions and varying weather conditions.

3.02 SIGN FINISHES, MATERIALS AND PAINT

A. Provide temporary signage to reflect permanent sign design and/or as directed by the Signage Design Project Manager. Submit temporary sign finishes, materials and paint, etc., for review and approval prior to any fabrication.

3.03 MAINTENANCE

A. The Contractor is responsible to maintain temporary signage until it is no longer needed.

3.04 REMOVAL

A. The contractor is responsible to remove all temporary signs, clean and refurbish affected areas to their original (or intended) condition.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01580

SECTION 01620

STORAGE AND PROTECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section consists of providing storage and protection of the materials, products and supplies which are to be incorporated into the construction and indicating such storage areas on the working drawings with the location and dates when such areas will be available for each purpose.

1.02 SUBMITTALS

A. Refer to Technical Specifications Sections 01300 and 01340 for submittal procedures. Submit concurrently with submittals required in Section 01050.

B. Submit working drawings showing locations of storage areas not indicated on the Contract Drawings.

C. Submit descriptions of proposed methods and locations for storing and protecting products.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials required for the storage and protection of the items specified shall be durable, weatherproof and either factory finished or painted to present an appearance acceptable to the City. Storage facilities shall be uniform in appearance with similar materials used to the maximum extent possible.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS OF EXECUTION

A. Palletize materials, products and supplies which are to be incorporated into the construction and stored off the ground. Material and equipment shall be stored only in those areas that are indicated as storage areas on the contract drawings and on the reviewed and accepted working drawings. Store these items in a manner which will prevent damage and which will facilitate inspection. Leave seals, tags and labels intact and legible. Maintain access to products to allow inspection. Protect products that would be affected by adverse environmental conditions.

B. Periodically inspect stored products to ensure that products are being stored as stipulated and that they are free from damage and deterioration.

C. Do not remove items from storage until they are to be incorporated into the Work.

D. The Contractor shall ensure that all protective wrappings and coverings are secure and ballasted to prevent any items from deterioration and/or subsequent dislodgment. All items on the worksite that are subject to becoming windborne shall be ballasted or anchored.

3.02 HANDLING AND TRANSPORTATION

A. Handling

1. Avoid bending, scraping or overstressing products. Protect projecting parts by blocking with wood, by providing bracing or by other approved methods.

2. Protect products from soiling and moisture by wrapping or by other approved means.

3. Package small parts in containers such as boxes, crates or barrels to avoid dispersal and loss. Firmly secure an itemized list and description of contents to each container

B. Transportation

1. Conduct the loading, transporting, unloading and storage of products so that they are kept clean and free from damage.

3.03 STORAGE

A. Store items in a manner that shall prevent damage to the owner's property. Do not store hydraulic fluids, gasoline, liquid petroleum, gases, explosives, diesel fuel and other flammables in excavations, except one day's supply of diesel fuel may be stored in open excavations.

B. Provide sheltered weather-tight or heated weather-tight storage as required for products subject to weather damage.

C. Provide blocking, platforms or skids for products subject to damage by contact with the ground.

D. All material shall be stored according to the manufacturer’s recommendations. Any material that has to be stored within specified temperature or humidity ranges shall have a 24-hour continuously written recording made of the applicable condition. Should the recording show that the material was not stored within the recommended ranges the material shall be considered defective and in nonconformance. If a certification from the manufacturer's engineering design representative is provided stating that the actual variations are acceptable and will in no way harm the material or affect warranties, then the deficiency will be considered corrected.

E. Store hazardous material separately, with all material marked with a label showing the hazard and how to treat exposure to the material.

3.04 LABELS

A. Storage cabinets and sheds that will contain flammable substances and explosive substances shall be labeled FLAMMABLE--KEEP FIRE AWAY and NO SMOKING with conspicuous lettering and conforming to OSHA requirements.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. The cost of the Work described in this Section shall be included in the applicable unit price item, work order, or lump sum bid item. See Technical Specifications Section 01370 for additional requirements for the possible payment of stored material.

END OF SECTION 01620

SECTION 01630

SUBSTITUTIONS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section consists of submitting for the approval of a different material, equipment or process then is described in the Contract Documents. The Contractor is to use the Request for "Or Equal" Approval form found in the Instructions to Bidders before submitting his bid. The Request for Substitution form, found in Section 01999, is used after the Contractor receives his Notice to Proceed.

B. If the substitution changes the scope of work, contract cost or contract time, a change order is required. As-built drawings and specifications must include all substitutions even if a change order is not issued.

1.02 QUALITY CONTROL

A. The substitution must provide the same quality as what it is replacing. The level of quality is defined by:

1. Maintenance and operating cost
2. Reliability
3. Durability
4. Life expectancy
5. Ease of cleaning
6. Ability to be upgraded as needed
7. Ease of interacting with other systems or components
8. Ability to be repaired
9. Availability of replacement parts
10. Established history of use in similar environments
11. Performance equal or superior to that which it is replacing.

1.03 SUBMITTAL

A. Refer to Technical Specifications Sections 01300 and 01340 for submittal procedures.

B. A complete Request for Substitution using the form in Section 01999 must be made at least 60 days prior to when an order needs to be placed or a method needs to be changed.

C. The submittal shall contain, as appropriate, detailed product data sheets for the specified items and the substitution. Samples and shop drawings shall also be submitted of the substitution as applicable. The submittal shall contain all the data required to be submitted for acceptance of the originally specified item or process.

D. The submittal shall contain all the applicable information required in Technical Specifications

Section 01630, paragraph 2.01 below.

E. A signed statement as outlined in Technical Specifications Section 01630, paragraph 2.03.B below must accompany the Request for Substitution.

PART 2 - EXECUTION

2.01 INFORMATION

A. Provide the following information as applicable with the Request for Substitution on the item or process that is being requested to be substituted:

1. A complete description of the item or process
2. Utility connections including electrical, plumbing, HVAC, fire protection and controls
3. The physical dimensions and clearances
4. A parts list with prices
5. Samples of color and texture
6. Detailed cost comparisons of the substitution and the contract specified item or process
7. Manufacturer warranties
8. Energy consumption over a one-year period
9. What local organization is certified to maintain the item
10. Performance characteristics and production rates
11. A list of any license fees or royalties that must be paid
12. A list of all variations for the item or method specified
13. A list of at least three other projects of similar nature to this contract where the products or methods have been in use for at least one year including telephone number and name of the person to contact at these other projects
14. An analysis of the effect of the substitution on the schedule and contract cost and on the overall project as it relates to adjoining work.

2.02 SUBSTITUTION REQUEST

A. The formal Request for Substitution will be evaluated by the Project Manager and the Designer of Record based on the following criteria:

1. Compatibility with the rest of the project
2. Reliability, ease of use and maintenance
3. Both initial and long term cost
4. Schedule impact
5. The willingness of the Contractor to share equally in any cost savings
6. The ability of the item or process to meet all applicable governing regulations, rules and laws along with funding agency requirements
7. The cost of evaluating the substitution.

B. Based upon the above evaluation the Deputy Manager of Aviation will make a final

determination of what is in the best interest of the City and either approve, disapprove or approve as noted the requested substitution.

2.03 CONDITIONS

A. As a condition for submitting a Request for Substitution the Contractor waives all rights to claim for extra cost or change in contract time other than those outlined in the request and approved by the Deputy Manager of Aviation. The Contractor, by submitting a Request for Substitution, also accepts all liability for cost and scheduling impact on other contractors or the City due to the substitution.

B. Included with the Request for Substitution shall be the following statement:

1. "The substitution being submitted is equal to or superior in all respects to the contract-required item or process. All differences between the substitution and the contract-required item or process are described in this request along with all cost and scheduling data."

C. The statement shall be signed and dated by the Contractor's Superintendent.

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or the lump bid item.

END OF SECTION 01630

SECTION 01650

SYSTEM STARTUP, TESTING AND TRAINING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Provide complete startup, testing and operator training services to ensure operability of all electrical and electronic equipment supplied.

1.02 SUBMITTAL

A. Refer to Technical Specifications Sections 01300 and 01340 for submittal procedures.

1. Test procedures
2. Test report
3. Training outline.

1.03 FIELD TESTS AND ADJUSTMENTS

A. All electrical and mechanical equipment including the interfaces with control systems and the communication system, and all alarm and operating modes for each piece of equipment shall be tested by the Contractor to the satisfaction of the Project Manager before any facility is put into operation. Tests shall be as specified herein and shall be made to determine whether the equipment has been properly assembled, aligned and connected. Any changes, adjustments or replacements required to make the equipment operate as specified shall be carried out by the Contractor as part of the work.

1. At least 30 days before the time allowed in the construction schedule for commencing startup and testing procedures, the Contractor shall submit to the Project Manager six copies of the detailed procedures he proposes for testing and startup of all electrical and mechanical equipment. These procedures are submitted for review and acceptance.
2. The Contractor's startup and testing procedures shall include detailed descriptions of all pre-operational hardware, electrical, mechanical and instrumentation used for testing work. Each control device, item of electrical, mechanical and instrumentation equipment, and all control circuits shall be considered in the testing procedures which shall be designed in a logical sequence to ensure that all equipment has been properly serviced, aligned, connected, wired, calibrated and adjusted prior to operation. Motors shall be tested in accordance with ANSI/IEEE Publication 112. The Contractor is advised that failure to observe these precautions may place the acceptability of the subject equipment in question, and he may either be required to demonstrate that the equipment has not been damaged, or replace it as determined by the Project Manager.
3. Testing procedures shall be designed to duplicate as nearly as possible all conditions of operations and shall be carefully selected to ensure that the equipment is not damaged. All filters shall be in place during startup and testing. Once the Project Manager has accepted the testing procedures, the Contractor shall provide checkout, alignment, adjustment and calibration signoff forms for each item of equipment and each system that will be used. The Contractor and the Project Manager shall use the signoff forms in the field jointly to ensure that each item of electrical, mechanical and instrumentation equipment and each system has been properly installed and tested. The Contractor shall cooperate with project wide systems contractors where startup and testing is to be

conducted concurrently.

4. Any special equipment needed to test equipment shall be provided to the City at no cost for a period of 30 days during startup.

B. Before starting up the equipment, the Contractor shall properly service it and other items, which normally require service in accordance with the maintenance instructions. The Contractor shall be responsible for lubrication and maintenance of equipment and filters throughout the entire equipment “break-in” period described by the manufacturer.

1. The Contractor shall be responsible for the startup, adjustment, preliminary maintenance and checkout of all equipment and instrumentation. All systems shall be carefully checked for conformance with the design criteria.

2. If any equipment or system does not operate as specified in the contract, the Contractor shall immediately replace or repair components until it operates properly.

3. The Contractor shall submit a test report to the Project Manager within 30 days after completion of the system startup period.

1.04 SYSTEMS STARTUP AND TESTING

A. The Contractor shall be responsible for a 30-day startup period during which time all hardware, electrical and mechanical equipment, communications, alarm systems and associated devices shall be energized and operated under local and automatic controls. The Contractor shall be present during the startup period with adequate labor and support personnel to adjust equipment and troubleshoot system failures that might arise.

B. When a piece of electrical or mechanical equipment is found to be in conflict with specific criteria, an experienced representative of the manufacturer shall make an adjustment to the item.

C. If adjustments fail to correct the operation of a piece of equipment or fixture, the Contractor shall remove the equipment or fixture from the project site and replace it with a workable replacement that meets the specification requirements.

D. The 30-day startup period shall commence 30 days prior to the contract completion date and shall be completed prior to final payment. If, during the startup, any system fails to operate in accordance with contract requirements, the failure shall be corrected and the startup period shall begin again. At the end of the startup period, all filters shall be replaced with new ones. The City may, at its option, provide a Commissioning Representative to observe or participate in the startup and testing of any system. The Contractor shall coordinate with the Commissioning Representative relating to scheduling, reporting, forms, methods and procedures of the startup and testing.

1.05 FINAL INSTRUCTIONS AND OPERATION TRAINING

A. After startup and testing is completed, the Contractor shall demonstrate to the City's personnel the proper manner of operating the equipment, programming messages, making adjustments, responding to alarms and emergency signals, and maintaining the system.

B. The Contractor shall provide on-the-job training by a suitably qualified instructor to designated personnel and shall instruct them in the operation and maintenance of the systems. In the event qualified instructors on the Contractor’s staff are not available, the Contractor shall arrange with the equipment manufacturer for such instruction at no additional cost to the City.

C. The Contractor shall provide a minimum of 16 hours of maintenance training to the Airport. Classes shall accommodate up to five people at a time.

D. The Contractor shall provide a minimum of 8 hours of operator training to the Airport. Classes shall accommodate up to five people at a time with up to two separate courses (one for each shift).

E. The Contractor shall provide a syllabus to the Project Manager at least seven calendar days prior to the start of each course that outlines topics to be covered, the proposed time allotted to each topic, and the target audience of the training session (technical, casual operator, overview, etc.). The Contractor shall not commence any training courses until the syllabus has been reviewed and approved by the Project Manager.

F. The Contractor shall videotape all training sessions and provide labeled digital video disks (DVD) to the Project Manager. The Contractor shall provide three copies of the DVD to the Project Manager in DVD+R format. All disks shall be labeled using the LightScribe technology.

G. The Contractor shall provide an annotated syllabus to the Project Manager that indicates topics contained on each tape.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or the lump bid item. No contractual item requiring startup or testing will be paid until the conditions of this Section are completely satisfied.

END OF SECTION 01650

SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work specified in this Section includes procedures required prior to Final Acceptance of the Work in addition to those specified in General Conditions Title 20 and Technical Specifications Section 01720.

1.02 PREPARATION FOR FINAL INSPECTION

A. Before requesting inspection for Final Acceptance of the Work by the City, inspect, clean and repair the Work as required.

1.03 FINAL INSPECTION

A. When the Contractor considers that the Work is complete, he shall submit written certification that:

1. Work has been inspected by the Contractor for compliance with contract documents.
2. Work has been completed in accordance with contract documents.
3. Work is ready for final inspection by the City.
4. All as-built required documents have been submitted and accepted.
5. All damaged or destroyed real, personnel, public or private property has been repaired or replaced.
6. All operation and maintenance manuals have been submitted and accepted and all training has been completed.
7. All personnel badges and vehicle permits have been returned to DIA Airport Security.

B. The Project Manager will inspect to verify the status of completion with reasonable promptness after receipt of such certifications. The inspection of the work will be done in accordance with the General Conditions.

C. If the Project Manager finds incomplete or defective work:

1. The Project Manager may, at the Project Manager's sole discretion, either terminate the inspection or prepare a punch list and notify the Contractor in writing, listing incomplete or defective work.
2. The Contractor shall take immediate steps to remedy stated deficiencies and send a second written certification to the Project Manager that Work is complete.
3. The Project Manager will then reinspect the Work.

1.04 REINSPECTION FEES

A. Should the Project Manager perform reinspection due to failure of the Work to comply with the claims of status of completion made by the Contractor:

1. The Contractor shall compensate the City for such additional services at the rate of $75.00 per man-hour.
2. The City shall deduct the amount of such compensation from the final payment to the Contractor.

1.05 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a Final Statement of Accounting to the Project Manager.

B. The Final Statement of Accounting shall reflect all adjustments to the contract amount and shall include the following:
   1. The original contract amount.
   2. Additions and deductions resulting from:
      a. Previous change orders.
      b. Allowances.
      c. Final quantities for unit price items. Along with this statement shall be detailed backup for the quantities.
      d. Deductions or corrected work.
      e. Penalties.
      f. Deductions for liquidated damages.
      g. Deductions for reinspection payments.
      h. City resurveys required due to the Contractor.
      i. Other adjustments.
   3. Total contract amount, as adjusted.
   4. Previous payments.
   5. Sum remaining due.

C. If required, the Project Manager will prepare a final change order, reflecting approved adjustments to the Contract sum which were not previously made by change orders.

1.06 FINAL APPLICATION FOR PAYMENT

A. The Contractor shall submit the final application for payment in accordance with the procedures and requirements stated in the General Conditions Title 20.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work

described in this Section shall be included in the applicable unit price item, work order, or lump sum bid item.

END OF SECTION 01700

SECTION 01710

CLEANING

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this section consists of maintaining a clean, orderly, hazard free worksite during construction, and final cleaning for the City's Final Acceptance. Failure to maintain the worksite will be grounds for withholding monthly payments until corrected to the satisfaction of the Project Manager.

1.02 JOB CONDITIONS

A. Safety Requirements

1. Maintain the worksite in a neat, orderly and hazard-free manner in conformance with all federal, state and local rules, codes, regulations and orders, including all OSHA requirements, until Final Acceptance of the Work. Keep catwalks, underground structures, worksite walks, sidewalks, roadways and streets, along with public and private walkways adjacent to the worksite, free from hazards caused by construction activities. Inspect those facilities regularly for hazardous conditions caused by construction activities.

B. Hazards Control

1. Store volatile wastes in covered metal containers and remove those wastes from worksite daily.
2. Do not accumulate wastes which create hazardous conditions.
3. If volatile and noxious substances are being used in spaces that are not naturally ventilated, provide artificial ventilation.
4. Hazard controls shall conform to the applicable federal, state and local rules and regulations.
5. Provide appropriate waste receptacles in all areas in which employees are working. Waste receptacles shall be kept covered at all times. All materials on site shall be anchored and covered to prevent any objects from becoming wind-borne.

C. Access

1. Maintain the worksite to permit access by other City contractors as required and to allow access by emergency personnel.

1.03 SUBMITTALS

A. Washing Plan. The Contractor shall prepare a plan describing the specific procedures and materials to be utilized for any equipment, vehicle, etc. washing activities. The plan must be submitted to the PM and also approved by the PM and Environmental Services. Outdoor washing at DIA is not allowed unless the materials will be collected or managed in a manner to ensure that they will not enter the municipally-owned separate storm sewer system (MS4). The materials can only be disposed at a location pre-approved by DIA Environmental Services (refer to DIA SWMP). Failure to comply with this requirement would result in the

discharge of non-stormwater. Indoor washing must be conducted in accordance with the Best Management Practices (BMPs) detailed in the DIA SWMP. Refer to Technical Specification 01566. In addition, all indoor washing must be conducted in a manner that ensures that there are no prohibited discharges to the sanitary sewer system.

PART 2 - PRODUCTS

2.01 CLEANING MATERIALS

A. Utilize the type of cleaning materials recommended by the manufacturer for the surfaces to be cleaned.

B. Maintain current Material Safety Data Sheets (MSDS) on site for all chemicals. DIA Environmental Services must approve the chemicals used prior to discharge to the sanitary sewer system.

C. Ensure proper disposal of all wastes generated from the use of these materials. Must ensure compliance with all environmental regulations. No wastes can be disposed on DIA property.

PART 3 - EXECUTION

3.01 INTERIM CLEANING

A. Clean the worksite every shift/workday for the duration of the construction contract. Maintain structures, grounds, storage areas and other areas of worksite, including public and private properties immediately adjacent to worksite, free from accumulations of waste materials caused by construction operations. Place waste materials in covered metal containers. All hard concrete, steel, wood and finished walking surfaces shall be swept clean daily.

B. Remove or secure loose material on open decks and on other exposed surfaces at the end of each workday or more often in a manner that will maintain the worksite hazard free. Secure material in a manner that will prevent dislodgment by wind and other forces.

C. Sprinkle waste materials with water or acceptable chemical palliative to prevent blowing of dust.

D. Promptly empty waste containers when they become full and legally dispose of the contents at dumping areas off the City's property.

E. Control the handling of waste materials. Do not permit materials to be dropped or thrown from structures.

F. Immediately remove spillage of construction related materials from haul routes, work site, private property, public rights of way, or on the Denver International Airport site.

G. Clean only when dust and other contaminants will not precipitate upon newly painted surfaces.

H. Cleaning shall be done in accordance with manufacturer's recommendation.

I. Cleaning shall be done in a manner and using such materials as to not damage the Work.

J. Clean areas prior to painting or applying adhesive.

K. Clean all heating and cooling systems prior to operations. If the contractor is allowed to use the heating and cooling system it shall be cleaned prior to testing.

L. Clean all areas that will be concealed prior to concealment.

M. Dispose of all fluids according to the approved Washing Plan.

3.02 FINAL CLEANING

A. Inspect interior and exterior surfaces, including concealed spaces, in preparation for completion and acceptance.

B. Remove dirt, dust, litter, corrosion, solvents, discursive paint, stains and extraneous markings.

C. Remove surplus materials, except those materials intended for maintenance.

D. Remove all tools, appliances, equipment and temporary facilities used in the construction.

E. Remove detachable labels and tags. File them with the manufacturer's specifications for that specific material for the City's records.

F. Repair damaged materials to the specified finish or remove and replace.

G. After all trades have completed their work and just before Final Acceptance, all catch basins, manholes, drains, strainers and filters shall be cleaned; roadway, driveways, floors, steps and walks shall be swept. Interior building areas shall be vacuum cleaned and mopped.

H. Final cleanup applies to all areas, whether previously occupied and operational or not.

I. Dispose of all fluids according to the approved Washing Plan.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01710

SECTION 01720

CONTRACT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section consists of maintaining, marking, recording and submitting contract record documents which include shop drawings, warranties, contract documents and contractor records.

1.02 SUBMITTALS

A. Each submittal of record documents shall contain the following information:

1. Date
2. Project title and numbers
3. Contractor's name and address
4. Title and number of each record document
5. Certification that each document as submitted is complete and accurate
6. Signature of the Contractor or his authorized representative.

B. At the completion of this contract, deliver all record documents including the following:

1. As-built shop drawings, diagrams, illustrations, schedules, charts, brochures and other similar data
2. Warranties, guarantees and bonds
3. Contract documents
4. Contractor records.

C. As-built contract drawings shall be submitted with each monthly progress payment application, and a complete set shall be submitted prior to final payment.

1. The Contractor shall provide a single electronic copy of each contract drawing sheet which has been used to produce work during the payment period or work that payment is being requested on, which records the current as-built conditions of work, including the posting of any change orders or change directives not shown on the contract documents at the time of contract signing.
    a. The Contractor must show as-built work completed through the payment application date including but not limited to utilities, empty conduit, conduit for actual electrical lines, plumbing, HVAC, location of anchor bolts and support points for use by others.
    b. The Contractor shall be liable for any costs incurred by the City or a third party due to errors or lack of information provided on the as-built drawings.
    c. All markings on drawings shall be legible to identify the portion of work completed.

1.03 QUALITY CONTROL

A. Record documents shall be prepared to a high standard of quality, such as that set forth in

MIL STD 100, ANSI Standard Drafting Manual Y14 or other relevant lower tier specification defining equal drafting quality for microfilming, except for daily reports.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 MAINTENANCE OF DOCUMENTS

A. The Contractor shall maintain at the worksite on a current basis one record copy of all drawings, specifications, addenda, change orders, approved shop drawings, working drawings, product data and samples in good order and marked currently to record all changes made during construction.

B. Maintain at the field office one copy of the following record documents:

1. Contract Documents
    a. Contract drawings with all clarifications, requests for information, directives, changes and as-built conditions clearly posted.
    b. Contract specifications with all clarifications, requests for information, changes, directives and record of manufacturer actually used along with product trade name.
    c. Reference Standards in accordance with Technical Specifications Section 01091.
    d. Affirmative Action Plan and documents.
    e. One set of drawings to record the following:
        1) Horizontal and vertical location of underground utilities affected by the Work.
        2) Location of internal utilities; include valves, controls, conduit, duct work, switches, pressure reducers, size reducers, transitions, crosses, tees, filters, motors, heaters, dampers, regulators, safety devices, sensors, access doors and appurtenances that are concealed in the construction shall be shown with dimensions given from a visible and recognizable reference to the item being located in all three dimensions. The drawing shall also reference the applicable submittal for the item being located.
        3) Field changes of dimensions and details including as-built elevations and location (station and offset).
        4) Details not on original contract drawings but obtained through requests for information or by other communications with the City.

2. Contractor Records
    a. Daily QC Reports
    b. Certificates of compliance for materials used in construction
    c. Nonconformance Reports (NCRs)
    d. Remedial Action Requests (RARs)
    e. Completed inspection list
    f. Inspection and test reports
    g. Test procedures
    h. Qualification of personnel
    i. Approved submittals
    j. Material and equipment storage records
    k. Safety Plan
    l. Erosion, sediment, hazardous and quality plans
    m. Hazardous material records

n. First report of injuries.

3.02 RECORDING

A. Label each document page or article "PROJECT RECORD" in two inch high letters.

B. Keep record documents current daily.

C. Legibly mark copies of the contract drawings to record actual construction.

D. Legibly mark up each Section of the technical specifications and contract drawings to record:

1. Manufacturer, trade name, catalog number and supplier of each product and item actually installed

2. Changes made by change orders, requests for information, substitutions and variations approved by submittals.

3.03 DOCUMENT MAINTENANCE

A. Provide files and racks for storage of documents to maintain in clean, dry and legible condition, which shall be turned over to the City prior to final acceptance.

B. Do not use record documents for construction purposes.

C. Make documents available for inspection by the Project Manager and any others having jurisdiction.

3.04 BUILDING INFORMATION MANAGEMENT (REVIT)

A. Contact Mark Hughes at Mark.Hughes@flydenver.com (Ph: 303.214.5620) to coordinate all BIM “Project Record” requirements.

3.05 MONTHLY REVIEW

A. Prior to any application for payment, the Project Manager or his designated representative will inspect the record documents to ensure that they are being maintained and contain the most current correct data with particular attention to as-built drawings.

B. If, during the inspection, the Project Manager determines that the documents are not being maintained and kept current as to as-built conditions, an amount may be withheld from the payment request and deducted from the contract value to cover the City's cost of collecting and recording the as-built contract data. This cost will be determined on the basis of $75.00 per man-hour of effort.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01720

SECTION 01730

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section consists of preparing and submitting operation and maintenance data for mechanical, electrical and other specified equipment.

1.02 SUBMITTALS

A. Refer to Technical Specifications Section 01300 and 01340 for submittal procedures.

B. Submit one (1) electronic copy and one (1) bound hard copy of the proposed Operation and Maintenance Data Manual format including a table of contents not less than 90 days prior to acceptance tests and final inspection.

C. Submit one (1) electronic copy and one (1) bound hard copy of the complete Operation and Maintenance Data Manuals in final form 30 days prior to system startup.

D. Submit one (1) electronic copy and one (1) bound hard copy of Operation and Maintenance Data Manual within ten days after system startup is complete. These copies shall incorporate any comments made on the previous submittals, along with final readings on all settings and gauges taken while the system is in fully satisfactory operation.

E. Contact Mark Hughes at Mark.Hughes@flydenver.com (Ph: 303.214.5620) to coordinate all Building Information Management (BIM) submittal requirements.

1.03 CONTINUOUS UPDATING PROGRAM

A. Furnish one electronic copy of the Contractor's letter indicating that suppliers have been notified to provide updated operation and maintenance data, service bulletins and other information pertinent to the equipment, as it becomes available.

PART 2 - PRODUCTS

A. The following products are the requirements of hard copies:

B. PAPER SIZE 8-½ inches x 11 inches.

C. PAPER White bond, at least 20 pound weight.

D. TEXT typewritten.

E. PRINTED DATA Manufacturer's catalog cuts, brochures, operation and maintenance data. Clear reproductions thereof will be acceptable. If this data is in color, all final manuals must contain color data.

F. DRAWINGS 8-½ inches x 11inches, bound with the text. Larger drawings are acceptable provided they are folded to fit into a pocket inside the rear cover of the manual. Reinforce edges of large drawings.

G. PRINTS OF DRAWINGS black ink on white paper, sharp in detail and suitable for making reproductions.

H. FLYSHEETS Separate each portion of the manual with colored, neatly prepared flysheets briefly describing the contents of the ensuing portion.

I. COVERS Provide 40 to 50 mil, clear plastic, front and plain back covers for each manual. The front covers shall contain the information required in paragraph 3.02 below.

J. BINDINGS Conceal the binding mechanism inside the manual; lockable 3 ring binders shall be provided.

PART 3 - EXECUTION

3.01 GENERAL

A. Assemble each operation and maintenance manual using the manufacturer's latest standard commercial data.

3.02 COVER

A. Include the following information on the front cover and on the inside cover sheet:

1. OPERATION AND MAINTENANCE INSTRUCTIONS
2. (TITLE OF STRUCTURE OR FACILITY)
3. (TITLE AND NUMBER OF CONTRACT)
4. (CONTRACTOR’S NAME AND ADDRESS)
5. (GENERAL SUBJECT OF THE MANUAL)
6. (Leave spaces for signatures of the City representatives and acceptance date)

3.03 CONTENTS OF THE MANUAL

A. An index of all volumes in each volume of multiple volume systems.

B. An index in front of each volume. List and combine the literature for each system in the sequence of operation.

C. Name, address and telephone numbers of Contractor, suppliers and installers along with the manufacturer's order number and description of the order.

D. Name, address and telephone numbers of manufacturer's nearest service representatives.

E. Name, address and telephone number of nearest parts vendor and service agency.

F. Copy of guaranties and warranties issued to, and executed in the name of, the City.

G. Anticipated date City assumes responsibility for maintenance.

H. Description of system and component parts including theory of operation.

I. Pre operation check or inspection list.

J. Procedures for starting, operating and stopping equipment.

K. Post operation check or shutdown list.

L. Inspection and adjustment procedures.

M. Troubleshooting and fault isolation procedures for on-site level of repair.

N. Emergency operating instructions.

O. Accepted test data.

P. Maintenance schedules and procedures.

Q. Test procedures to verify the adequacy of repairs.

R. One copy of each wiring diagram.

S. One copy of each piping diagram.

T. Location where all measurements are to be made.

U. One copy of each duct diagram.

V. One copy of control diagram.

W. One copy of each accepted shop drawing.

X. One copy of software programs imputable or changeable on site.

Y. Manufacturer's parts list with catalog names, numbers and illustrations.

Z. A list of components which are replaceable by the City.

AA. An exploded view of each piece of the equipment with part designations.

BB. List of manufacturer's recommended spare parts, current prices and recommended quantities for two years of operation.

CC. List of special tools and test equipment required for the operation, maintenance, adjustment, testing and repair of the equipment, instruments and components.

DD. Scale and corrosion control procedures.

EE. Disassembly and re-assembly instructions.

FF. Troubleshooting and repair instructions.

GG. Calibration procedures.

HH. Ordering information.

II. Training course material used to train City staff, including slides and other presentation

material.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order, or lump sum bid item.

END OF SECTION 01730

SECTION 01740

WARRANTIES AND BONDS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work specified in this Section consists of preparing and submitting warranties and bonds required by these specifications.

1.02 SUBMITTALS

A. Refer to Technical Specifications Section 01300 for submittal procedures.

B. Submit executed warranties and bonds.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 WARRANTIES AND BONDS

A. Execute the warranties and bonds required by the Contract Documents. Prepare and submit a list of all warranties and bonds on the form provided by the City. Reference Technical Specifications Section 01999.

B. Provide warranties or bonds for the materials, labor and time period set forth in the sections of these specifications requiring such documents. All warranties shall be for a minimum period of one year unless the technical specifications for a specific item require a greater period of time.

C. Provide all warranties and bonds that the manufacturer or supplier furnishes at no additional cost in regular commercial trade. All warranties shall be for a minimum period of one year unless the technical specifications for a specific item require a greater period of time.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01740

SECTION 01999

STANDARD FORMS

1.01 FORMS

A. The forms listed below and appended to this Section will be used for performance of the Work as indicated. This is not a complete listing of all required forms. The Contractor shall properly complete all forms required by the contract or the Project Manager. The Project Manager shall review and approve all submitted forms. If submitted forms are not acceptable the Contractor shall resubmit forms in an acceptable format.

1.02 APPENDICES

A. Attached to this Technical Specifications Section are the following forms:

1. Daily Quality Control Report (Form CM-13) (1 Page)
2. Request for Information (Form CM-17) (1 Page)
3. Submittal Transmittal Form (Form CM-30) (Page 1 of 2)
4. Submittal Transmittal Form (Form CM-30) (Page 2 of 2)
5. Contractor Warranty (Form CM-10) (4 Pages)
6. Contractor/Subcontractor Warranty (Form CM-11) (4 Pages)
7. Contractors Certification of Payment (Form CM-19) (this form shall be completed and submitted with each pay application) (1 Page)
8. Pay Application Form (CM-18) (1 Page)
9. Certificate of Current Cost or Pricing Data (Form CM-69) (1 Page)
10. Subcontractor Partial Lien Release Form (Form CM-26) (1 Page)
11. Subcontractor Final Lien Release Form (Form CM-70) (1 Page)
12. Request for Substitution (Form CM-09) (5 pages)
13. System Shutdown Request Forms:
    a. AGTS and Baggage Systems
    b. Airfield Systems
    c. CCTV Security Systems
    d. Electrical Power and Lighting
    e. Elevator, Escalator and Autowalk
    f. Fire Protection Plumbing
    g. HVAC Systems
    h. Temperature Control Systems
    i. Life Safety/ Fire Alarm Systems
    j. Plumbing
    k. Roadways
    l. Security
    m. Sterile Public Areas
    n. X-Ray

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 COMPLETING FORMS

A. All documents are to be filled digitally by the Contractor using the format provided by the Project Manager or using Adobe Acrobat 6 or newer. It is at the discretion of the Project Manager if other forms or formats will be accepted.

3.02 SIGNING FORMS

A. Original hand written signatures are acceptable for all documents. The Contractor is to fill out the document as indicated above prior to signing the hard copy. If the form is to be submitted digitally to the Project Manager the document shall be scanned and saved as an Adobe Acrobat 6 or newer file.

B. Digital signatures are acceptable for all documents. The Contractor is to fill out the document digitally in the format provided by the Project Manager or Adobe Acrobat 6 or newer. The file must be signed using Adobe Acrobat 6 or newer and submitted digitally to the Project Manager.

1. Add digital signatures must contain the name of signer in plain text and the time and date the signature is executed.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 01999

DIVISION 03 – CONCRETE

SECTION 03301

CAST-IN-PLACE CONCRETE (LIMITED APPLICATIONS)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section specifies cast-in-place concrete, including reinforcement, concrete materials, mix design, placement procedures, and finishes.

1.03 SUBMITTALS

A. General: In addition to the following, comply with submittal requirements in ACI 301.

B. Product Data: For each type of manufactured material and product indicated.

C. Design Mixes: For each concrete mix.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

C. Source Limitations: Obtain each type of cement of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

D. Comply with ACI 301, "Specification for Structural Concrete," including the following, unless modified by the requirements of the Contract Documents.

1. General requirements, including submittals, quality assurance, acceptance of structure, and protection of in-place concrete.
2.
3. Steel reinforcement and supports.
4. Concrete mixtures.
5. Handling, placing, and constructing concrete.
6.

PART 2 - PRODUCTS

2.01 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Plain-Steel Wire: ASTM A 82, as drawn.

C. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

D.

2.02 CONCRETE MATERIALS

A.

B.

C. Portland Cement: ASTM C 150, Types I or II or Type I/II.

D. Normal-Weight Aggregate: ASTM C 33, uniformly graded, not exceeding 3/4-inch nominal size.

E. Water: Potable and complying with ASTM C 94.

2.03 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures. Do not use admixtures containing calcium chloride.

B. Air-Entraining Admixture: ASTM C 260.

C. Water-Reducing Admixture: ASTM C 494, Type A.

D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.

F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.04 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E.

F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.05 CONCRETE MIXES

A. Comply with ACI 301 requirements for concrete mixtures.

B. Prepare design mixes, proportioned according to ACI 301, for normal-weight concrete determined by either laboratory trial mix or field test data bases, as follows:

1. Compressive Strength (28 Days): 3500 psi.
2. Slump: 4 inches.
   a. Slump Limit for Concrete Containing High-Range Water-Reducing Admixture: Not more than 8 inches after adding admixture to plant- or site-verified, 2- to 3-inch slump.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 6.0 percent within a tolerance of plus 1.0 or minus 1.5 percent.

D. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd..

2.06 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with ASTM C 94.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.02 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Locate and install so as not to impair strength or appearance of concrete, at locations indicated or as approved by Architect.

3.03 CONCRETE PLACEMENT

A. Comply with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.

B. Consolidate concrete with mechanical vibrating equipment.

3.04 FINISHING UNFORMED SURFACES

A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on the surface.

1. Do not further disturb surfaces before starting finishing operations.

C. Nonslip Broom Finish: Apply a nonslip broom finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.05 TOLERANCES

A. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

3.06 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection, and follow recommendations in ACI 305R for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure formed and unformed concrete for at least seven days by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.07 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article. Perform tests according to ACI 301.

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.

3.08 REPAIRS

A. Remove and replace concrete that does not comply with requirements in this Section.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the lump sum contract price.

END OF SECTION 03301

DIVISION 4 - MASONRY

SECTION 04200

UNIT MASONRY

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Extent of each type of masonry work is indicated on the contract drawings.

B. Types of masonry work required include:

1. Concrete unit masonry.

1.02 RELATED DOCUMENTS

A. Drawings, general and special conditions, general requirements and other applicable technical specifications apply to work of this Section.

B. Section 03310 - "Concrete Work".

C. Section 07900, "Sealants".

1.03 REFERENCES

A. ASTM: American Society for Testing and Materials: Refer to specific tests and standards referred to throughout this section.

B. U.L.: Underwriters laboratories fire ratings. Refer to drawings for specific fire ratings.

C. Masonry Building Code, 530.1, revised 1988.

1.04 QUALITY ASSURANCE

A. Fire Performance Characteristics: Where indicated, provide materials and construction which are identical to those of assemblies whose fire endurance has been determined by testing in compliance with ASTM E 119 by a recognized testing and inspecting organization or by another means, as acceptable to authority having jurisdiction.

B. Single Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.

C. Single Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.

D. Masonry Preconstruction Testing Service: Contractor shall employ and pay for the services of a testing laboratory acceptable to Resident Engineer and experienced in performing types of preconstruction masonry tests indicated.

1. Engage a testing laboratory complying with ASTM E 329.

E. Preconstruction Tests by Unit Test Methods: Test the following materials by methods indicated:

1. Concrete Masonry Units: Test each type, class and grade of concrete masonry unit per ASTM C 140.

2. Mortar Tests: Test each mortar type per ASTM C 780. Include compression and absorption data.

3.

F. Fabricate concrete masonry prisms with height-to-thickness ratio of no less than 1.33 nor more than 3.0.

G. Manufacturer of sealer shall:

1. Pre-approve CMU substrate condition. Submit letter to Resident Engineer accepting substrate.

2. Be present at job-site when sealer is initially installed.

3. Certify that sealer has been applied per manufacturers recommendations.

H. Warranty: Installer to warrant installation masonry units, grout and accessories for 2 years.

I. Net area compressive strength of concrete masonry units shall meet or exceed 1900 psi. Mortar strength shall be 1350 psi or greater.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's product data for each type of masonry unit, flashing, cleaners, accessory, sealer and other manufactured products, including certifications that each type complies with specified requirements.

B. Samples for Verification Purposes: Submit the following samples:

1. Unit masonry samples for each type of exposed masonry unit required; include in each set the full range of exposed color and texture to be expected in completed work. Sample of flashings, accessories, fasteners, every type and color matching mortar for split-faced CMU.

2. Certificate from the manufacturer stating that all materials are per contract requirements and proof of minimum 5 years experience manufacturing same.

3. Certificate from installer evidencing minimum 3 years experience successfully installing this type of work.

C. Mock-up: Provide a mock-up of components of this section as described by the mock-up required in section 07410, "Preformed Siding". Coordinate all work. Cost of components of this section incorporated into mock-up shall be by this contractor.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver masonry materials to project in undamaged condition.

B. Store and handle masonry units to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion or other causes.

1. Limit moisture absorption of concrete masonry units during delivery and until time of installation to the maximum percentage specified for Type I units for the average annual relative humidity as reported by the U.S. Weather Bureau Station nearest project site.

C. Store cementitious materials off the ground, under cover and in dry location.

D. Store aggregates where grading and other required characteristics can be maintained.

E. Store masonry accessories including metal items to prevent deterioration by corrosion and accumulation of dirt.

1.07 PROJECT CONDITIONS

A. Protection of Work: During erection, cover top of walls with waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress.

B. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

C. Do not apply uniform floor or roof loading for at least 12 hours after building masonry walls or columns.

D. Do not apply concentrated loads for at least 3 days after building masonry walls or columns.

E. Staining: Prevent grout or mortar or soil from staining the face of masonry to be left exposed or painted. Remove immediately grout or mortar in contact with such masonry.

F. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.

G. Protect sills, ledges and projections from droppings of mortar.
a)

PART 2 - PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. General: Comply with referenced standards and other requirements indicated below applicable to each form of concrete masonry unit required.

1. Provide special shapes where required for lintels, corners, jambs, sash, control joints, headers, bonding and other special conditions.
   a. Provide bullnose units for outside corners at doors, windows, wall corners unless otherwise indicated.

B. Concrete Block: Provide units complying with characteristics indicated below for Grade, Type, face size, exposed face and, under each form of block included, for weight classification.

1. Grade N.

2. Class: D-2 at fire rated conditions.
   a. Comply with listed U.L. design standards.

3. Size: Manufacturer's standard units with nominal face dimensions of 16" long x 8" high (15-5/8" x 7-5/8" actual) x thicknesses indicated.

4. Type I, moisture-controlled units. Cure units by autoclone treatment at a minimum temperature of 350°F and a minimum pressure of 125 P.S.I.

5. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.

6. Hollow Loadbearing Block: ASTM C 90 and as follows:

7. Split-face CMU: Pigmented, colored aggregate, as selected by Resident Engineer.
   a. Weight Classification: Lightweight.
   b. Resident Engineer's Selection: Match Valley Block split face Brown Granite, Sample #150.
   c. Smooth-faced blocks can also be used at DIA.

2.02 MORTAR AND GROUT MATERIALS

A. Masonry Cement: ASTM C 91.

1. For colored pigmented mortar at split-faced CMU only, use colored masonry cements of formulation required to produce color matching split-faced CMU color.

B. Strength: 3,000 p.s.i. after 28 days, plus or minus 400 p.s.i.

C. Hydrated Lime: ASTM C 207, Type S.

D. Aggregate for Mortar: ASTM C 144, except for joints less than 1/4" use aggregate graded with 100% passing the No. 16 sieve.

E. Aggregate for Grout: ASTM C 404.

F. Water: Clean, potable, drinkable.

2.03 JOINT REINFORCEMENT, TIES AND ANCHORING DEVICES

A. Materials: Comply with requirements indicated below for basic materials and with requirements indicated under each form of joint reinforcement, tie and anchor for size and other characteristics:

B. Hot-Dip Galvanized Steel Wire: ASTM A 82 for uncoated wire and with ASTM A 123, Class B-2 (1.5 oz. per sq. ft. of wire surface) for zinc coating applied after prefabrication into units.

C. Joint Reinforcement: Provide welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10', with prefabricated corner and tee units, and complying with requirements indicated below:

1. Width: Fabricate joint reinforcement in units with widths of approximately 2" less than nominal width of walls and partitions as required to provide mortar coverage of not less than 5/8" on joint faces exposed to exterior and 1/2" elsewhere.

2. Wire Size for Side Rods: 0.1875" diameter.

3. Wire Size for Cross Rods: 0.1875" diameter.
   a. For single-wythe masonry provide type as follows with single pair of side rods:
      1) Ladder design with perpendicular cross rods spaced not more than 16" o.c.
      2) Truss design with continuous diagonal cross rods spaced not more than 16" o.c.

D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
   a. AA Wire Products Co.
   b. Dur-O-Wall, Inc.
   c. Heckman Building Products, Inc.
   d. Hohmann & Barnard, Inc.
   e. Masonry Reinforcing Corp. of America.
   f. National Wire Products Corp.

2.04 CONCEALED FLASHING MATERIALS

A. Vinyl Sheet Flashing: Flexible sheet flashings especially formulated from virgin polyvinyl chloride with plasticizers and other modifiers to remain flexible and waterproof in concealed masonry applications, black in color and of thickness indicated below:
   1. Thickness: 56 mils.

B. Solder and Sealants for Sheet Metal Flashings: As specified in Division-7 section "Flashing and Sheet Metal".

C. Adhesive for Flashings: Of type recommended by manufacturer of flashing material for use indicated.

D. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
   1. Vinyl Sheet Flashing:
      a. "Vi-Seal Plastic Flashing"; Afco Products Inc.
      b. "BFG" Vinyl Water Barrier; B.F. Goodrich Co.
      c. "Nuflex"; Sandell Manufacturing Co., Inc.
      d. "Wascoseal"; York Manufacturing, Inc.

2.05 MISCELLANEOUS MASONRY ACCESSORIES

A. Reinforcing Bars: Deformed steel, ASTM A 615, Grade 60 for bars No. 3 to No. 18.

B. Bond Breaker Strips: Asphalt-saturated organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

C. Weepholes: Provide the following for weepholes:
   1. Weephole/Ventilators: One-piece offset T-shaped units formed to fit in a vertical mortar joint by injection molding of flexible polyvinyl chloride and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and top flap; in color approved by Architect to match that of mortar.
      a. Available Products: Subject to compliance with requirements, weephole/ventilators which may be incorporated in the work include, but are not limited to, the following:
         1) "Wilko" (Aluminum) Weephole Ventilators"; AA Wire Products Co.
         2) "Williams-Goodco" (Vinyl) Brick Vent; Williams Products, Inc.

2.06 MASONRY CLEANERS

A. Acidic Cleaner: Manufacturer's standard strength general purpose cleaner designed for

new masonry surfaces of type indicated; composed of blended organic and inorganic acids combined with special wetting systems and inhibitors; expressly approved for intended use by manufacturer of masonry units being cleaned. Clean CMU laces exposed to view.

1. Available Products: Subject to compliance with requirements, a product which may be used to clean unit masonry surfaces includes, but is not limited to, the following:
   a. "Sure Klean" No. 600 Detergent; ProSoCo, Inc.

2.07 MASONRY SEALER

A. Okon W-2, or performance equal meeting the following minimum criteria.
   1. Minimal darkening of concrete surface.
   2. Minimum 10% chemical solids consisting of a siloxane/acrylic emulsion solution.

2.08 MORTAR AND GROUT MIXES

A. General: Use Chemistar-Dolomitic Hydrated Lime. Do not add admixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.

B. Mixing: Combine and thoroughly mix cementitious, water and aggregates in a mechanical batch mixer; comply with referenced ASTM standards for mixing time and water content.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for types of mortar required, unless otherwise indicated.
   1. Use Type S mortar for exterior, above-grade loadbearing and non-loadbearing walls; for interior loadbearing walls; and for other applications where another type is not indicated.

D. Grout for Unit Masonry: Comply with ASTM C 476 for grout for use in construction of reinforced and nonreinforced unit masonry. Use grout of consistency indicated or if not otherwise indicated, of consistency (fine or coarse) at time of placement which will completely fill all spaces intended to receive grout.
   1. Use fine grout in grout spaces less than 2" in horizontal direction, unless otherwise indicated.
   2. Use coarse grout in grout spaces 2" or more in least horizontal dimension, unless otherwise indicated.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Do not wet concrete masonry units.

B. Cleaning Reinforcing: Before placing, remove loose rust, ice and other coatings from reinforcing.

C. Thickness: Build cavity and composite walls, floors and other masonry construction to the full thickness shown. Build single-wythe walls (if any) to the actual thickness of the masonry units, using units of nominal thickness indicated.

D. Build chases and recesses as shown or required for the work of other trades. Provide not less than 8" of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

E. Leave openings for equipment to be installed before completion of masonry work. After installation of equipment, complete masonry work to match work immediately adjacent to the opening.

F. Cut masonry units using motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining work. Use full-size units without cutting where possible. Cut masonry as required to allow passage of utilities.

1. Use dry or wet cutting saws to cut concrete masonry units.

G. At Split-Faced CMU: Provide color matching non-split face units where indicated and at light fixtures attached directly to the CMU. Provide special shapes or sizes when indicated.

3.02 CONSTRUCTION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4" in 10', or 3/8" in a story height not to exceed 20', nor 1/2" in 40' or more. For external corners, expansion joints, control joints and other conspicuous lines, do not exceed 1/4" in any story or 20' maximum, nor 1/2" in 40' or more. For vertical alignment of head joints do not exceed plus or minus 1/4" in 10', 1/2" maximum.

B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/4" in any bay or 20' maximum, nor 1/2" in 40' or more. For top surface of bearing walls do not exceed 1/8" between adjacent floor elements in 10' or 1/16" within width of a single unit.

C. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 1/2" in any bay or 20' maximum, nor 3/4" in 40' or more.

D. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4" nor plus 1/2".

E. Variation in Mortar Joint Thickness: Do not exceed bed joint thickness indicated by more than plus or minus 1/8", with a maximum thickness limited to 1/2". Do not exceed head joint thickness indicated by more than plus or minus 1/8".

3.03 LAYING MASONRY WALLS

A. Layout walls in advance for accurate spacing of surface bond patterns with uniform joint widths and to accurately locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half-size units at corners, jambs and wherever possible at other locations.

B. Lay-up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other work.

C. Pattern Bond: Lay exposed masonry in the bond pattern shown or, if not shown, lay in running bond with vertical joint in each course centered on units in courses above and below. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2". Bond and interlock each course of each wythe at corners. Do not use units with less that nominal 4" horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Rack back 1/2-unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly (if required) and remove loose masonry units and mortar prior to laying fresh masonry.

E. Built-in Work: As the work progresses, build-in items specified under this and other sections of these specifications. Fill in solidly with masonry around built-in items.

1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

2. Remove any rust from frame and prime prior to filling solid.

3. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

4. Fill cores in hollow concrete masonry units with grout 3 courses (24") under bearing plates, beams, lintels, posts and similar items, unless otherwise indicated.

3.04 MORTAR BEDDING AND JOINTING

A. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course on footings and in all courses of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

B. Maintain joint widths shown, except for minor variations required to maintain bond alignment. If not shown, lay walls with 3/8" joints.

C. Cut joints flush for masonry walls which are to be concealed or to be covered by other materials, unless otherwise indicated.

D. Tool exposed joints slightly concave using a jointer larger than joint thickness, unless otherwise indicated tool unexposed joints concave, where possible.

E. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners or jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

F. Collar Joints: After each course is laid, fill the vertical longitudinal joint between wythes solidly and with mortar for the following masonry work:

1. Exterior walls, except cavity walls.

3.05 HORIZONTAL JOINT REINFORCEMENT

A. General: Provide continuous horizontal joint reinforcement as indicated. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8" on exterior side of walls, 1/2" elsewhere. Lap reinforcing a minimum of 6".

B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Reinforce walls with continuous horizontal joint reinforcing unless specifically noted to be omitted.

D. Reinforce the following walls with continuous horizontal joint reinforcement:

1. Hollow concrete masonry walls.

E. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.

1. Space continuous horizontal reinforcement as follows:
   a. For single-wythe walls, space reinforcement at 16" o.c. vertically, unless otherwise indicated.
   b. Reinforce masonry openings greater than 2'-0" wide, with horizontal joint reinforcement placed in 2 horizontal joints approximately 8" apart, immediately above the lintel and immediately below the sill. Extend reinforcement a minimum of 2'-0" beyond jambs of the opening except at control joints.
      1) In addition to wall reinforcement, provide additional reinforcement at openings as required to comply with the above.

3.06 ANCHORING MASONRY WORK

A. General: Provide anchor devices of type indicated.

B. Anchor masonry to floor slab 36" o.c. unless otherwise noted on drawings.

C. Anchor masonry to structural members as indicated.

3.07 CONTROL JOINTS

A. General: Provide vertical control and isolation joints in masonry minimum 20'-0" O.C. unless indicated more often. Build-in related items as the masonry work progresses.

B. Construct joint equal to mortar joint width. Seal joint with sealer matching mortar color. Seal both sides of joint. Provide a compressible filler.

C. Grout each CMU cell either side of control joint full height with number 4 re-bar or provide continuous tee shaped PVC control joint with CMU shaped to accept control joint.

D. At exterior walls align control joint with a preformed siding joint.

E. Horizontal joint reinforcement is not to extend thru control joint.

3.08 LINTELS

A. Install steel lintels where indicated.

3.09 FLASHING OF MASONRY WORK

A. General: Provide concealed flashing in masonry work at, or above, shelf angles, lintels, ledges and other obstructions to the downward flow of water in the wall so as to divert such water to the exterior. Prepare masonry surfaces smooth and free from projections which could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing or laps watertight with mastic before covering with mortar. Extend flashings through exterior face of masonry and turn down to form drip, cut excess. Flashing shall lead to weeps.

B. Extend flashing the full length of lintels and shelf angles and minimum of 4" into masonry each end. Extend flashing from exterior face of outer wythe of masonry, through the outer

wythe, turned up a minimum of 4", and through the inner wythe to within 1/2" of the interior face of the wall in exposed work. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2". At heads and sills turn up ends not less than 2" to form a pan.

C. Install flashing to comply with manufacturer's instructions.

D. Provide weep holes in the head joints of the first course of masonry immediately above concealed flashings unless otherwise detailed. Space 24" o.c., unless otherwise indicated.

E. Install reglets and nailers for flashing and other related work where shown to be built into masonry work.

3.10 INSTALLATION OF REINFORCED UNIT MASONRY

A. FIELD QUALITY CONTROL:

1. Contractor shall employ separate testing laboratory to perform all field quality control testing. The Owner will employ a laboratory to perform quality assurance to assure that the contractor and his laboratory are performing in accordance with contract documents.

2. Prism Test Method:

a. Compression Test: For each type of wall construction indicated for testing, test masonry prisms by methods of sampling and testing of ASTM E 447, Method B, including absorption testing, and as follows:

1) Prepare one set of prisms for testing at 7 days and one set for testing at 28 days.

2) For concrete masonry prisms provide same height-to-thickness ratio (h/t) as specified under preconstruction testing.

3) Conduct tests no less frequently than that required to provide sets of prisms from each 5000 sq. ft. of wall area installed.

3. Report test results in writing and in form requested by the Resident Engineer to Resident Engineer and Contractor, on same day tests are made. Include on form or plan location of test, name of contractor and person performing test, laboratory performing test.

4. Evaluation of Quality Control Tests: Masonry work, in absence of other indications of noncompliance with requirements, will be considered satisfactory if results from construction quality control tests comply with minimum requirements indicated.

3.11 REPAIR, POINTING AND CLEANING

A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings and adjacent work to provide a neat, uniform appearance, prepared for application of sealants.

C. Final Cleaning: After mortar is thoroughly set and cured, clean masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and non-metallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave 1/2 panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film or waterproof masking tape.

4. Saturate wall surfaces with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clear water.

5. Clean concrete unit masonry to comply with masonry manufacturer's directions and applicable NCMA "Tek" bulletins.

D. Sealer: Provide sealer at all CMU exposed to the exterior, and on all split face CMU, on the side exposed. Two coats. Install per Manufacturer's recommendations, after cleaning. Do not install over wet or damp masonry.

E. Protection: Provide final protection and maintain conditions in a manner acceptable to Installer, which ensures unit masonry work being without damage and deterioration at time of substantial completion.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the lump sum contract price.

END OF SECTION 0420

DIVISION 5 – METALS

SECTION 05120

STRUCTURAL STEEL

PART 1 -GENERAL

1.01 SUMMARY

A. Extent of structural steel work is shown on drawings, including schedules, notes and details to show size and location of members, typical connections, and type of steel required.

B. Structural steel is that work defined in American Institute of Steel Construction (AISC) "Code of Standard Practice" and as otherwise shown on drawings.

C. Members in a structure that carries an imposed load in addition to their own weight.

1.02 RELATED DOCUMENTS

A. Drawings, general and special conditions, general requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Refer to Section 05500, "Metal Fabrications," for miscellaneous metals.

B. Division 5 Section 05999 “Welding”. Contractor shall comply with requirements of 05999 Welding in addition to requirements of this section. In the case of a conflict between Section 05999 and this section, the more stringent shall apply.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1.05 SUBMITTALS

A. Product Data: Submit producer's or manufacturer's specifications and installation instructions for the following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).

1. Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.
2. High-strength bolts (each type), including nuts and washers.
3. Structural steel primer paint.
4. Shrinkage-resistant grout.
5. Welding Electrodes: per Section 05999 Welding
6. Provide fully traceable certificates of compliance with ASTM.

B. Submit shop drawings as specified under Section 01300 for all work specified herein, including complete details and schedules for fabrication and assembly of structural steel members, procedures and diagrams. Submit design calculations and drawings prepared under the supervision and sealed by a professional engineer registered in Colorado for all standard shear connections moment connections, and fabricated truss member connections as shown on drawings. Submit non-standard connections for design review. Design construction drawings shall not be re-used as bases for submitted shop drawings. Shop drawings that use reproductions of design plans or details may not be reviewed. Erection and piece drawings shall be submitted in complete units. Do not submit partial sets. Calculations shall be submitted only with relevant erection plans with clear references between each.

1. Shop drawings shall clearly indicate profiles, sizes, and locations of structural members, connections, attachments, anchorage's, framed openings, size and type of fasteners, and clearances. Indicate welded connections using standard AWS welding symbols. Clearly indicate net weld lengths and sizes, root openings, bevel angles and other information required to satisfactorily complete welding operations.

2. Calculations shall show all pertinent members and pieces. Calculations shall be submitted prior to, or with, relevant shop drawing submittals. It is contractor's responsibility to insure that field construction uses connection design as submitted and reviewed.

C. Test Reports: Submit copies of all test reports conducted on shop and field bolted and welded connections. Include data on type(s) of tests conducted and test results. Reports must be sequentially numbered and submitted to the Project Manager within 48 hours of completion.

D. Surveys: Submit certified copies of each survey conducted by a registered professional engineer, showing elevations and locations of all base plates and anchor bolts to receive structural steel, and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.

E. Submit WPS (Welding Procedure Specifications) and WPQR (Welder performance Qualification Records) in accordance with Specification 05999 Welding.

F. Submit Quality Control Plan for approval by DIA Project Manager and Designer of Record.

1.06 QUALITY CONTROL

A. Codes and Standards: Comply with provisions of following, except as otherwise indicated:

1. AISC "Code of Standard Practice for Steel Buildings and Bridges", 1986 except as modified by the below comments:

1.2 Definitions: Owner - as pertains to this Code shall be interpreted as the Contractor.

2.2 Delete.

3.2 Delete "provided all requirements for the structural steel are noted on the structural plans."

3.3 Delete "in case of discrepancies between the structural steel plans and plans for other trades, the structural steel plans govern."

4.2 In the second sentence, change "fourteen (14) calendar days" to "thirty (30) calendar days from receipt of complete shop drawings by the owner." Delete the last two sentences, beginning with "Return of shop drawings...." Delete this sentence from 4.2.1, "This approval constitutes the owner's acceptance of all responsibility for the design adequacy of any connections designed by the fabricator as a part of his preparation of these shop drawings."

7.3 Delete.

7.5.4 Delete.

7.6 Add to the end of this section, "The survey notes from the checking of lines and grades shall be furnished to the owner in an acceptable form at least 48 hours prior to grouting."

7.8 Delete.

7.9.1 Delete from the last sentence, "but not the loads resulting from the performance of work by or the acts of others."

7.9.6 Delete.

7.11.1 Add to the end of this section, "The variances allowed shall be the lesser of the values specified below or those required by the standards of the industry whose work is attaching to the steel."

7.11.3.3 Add after the first sentence, "For purposes of bidding, the contractor should assume that adjustable connections should be supplied where needed to accommodate other trades." Delete the second sentence, which begins "When adjustable connections."

7.11.4 Delete.

7.12 All cutting by heat must be approved by the Project Manager.

8.5.4 Delete the last sentence, which begins "However, this provision..."

8.5.5 Delete.

9.2.2 (c, d & e) Delete.

9.3 Delete whole section.

9.4 Delete whole section.

9.5 Delete whole section.

2. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", including "Commentary" and Supplements thereto as issued.

3. AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts" approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.

4. American Welding Society (AWS) D1.1 "Structural Welding Code Steel" and all other applicable A.W.S codes (latest editions).

5. ASTM A 6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use".

6. Specification Section 05999 Welding.

B. The erection sequence indicated on the drawing is the basis for bidding the work. The contractor may submit alternate method(s) for the erection sequence. The alternate method(s) shall be priced as a separate line item and shall be inclusive of cost of the work complete including:

C. All engineering required for the alternate design.

D. Design of connections: Standard shear connections moment connections, and fabricated truss member connections shall be designed by the fabricator for loads indicated in drawings. Calculations shall be prepared by or under the direct supervision of a Colorado registered engineer and submitted to the Project Manager for review prior to fabrication.

E. An allowance of $15,000.00 for the Engineer of Record to review the alternate proposal, fabricator-designed connections, and related engineering calculations.

F. Qualifications for welding work shall be in accordance with Specification Section 05999 Welding and applicable welding and inspection codes.

1. The Contractor shall periodically review each welder’s work quality and take any steps required to endure high quality work. This is in addition to Quality Control requirements.

G. Fabricator Qualifications: Minimum of three years experience specializing in fabrication of structural steel for similar projects and be an AISC Class III shop.

H. Fabricator shall provide full traceability of all steel used in the fabrication of this project. Procedures for providing traceability shall be included in the Quality Control Plan.

I. Source Quality Control: Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field, conducted by a qualified independent inspection agency furnished and paid for by contractor.

1. Promptly remove and replace materials or fabricated components which do not comply.

J. Design of Members and Connections: Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site whenever possible without causing delay in the work.

1. Promptly notify Project Manager whenever design of members and connections for any portion of structure are not clearly indicated.

K. Paint testing: Provide certification that factory applied paint complies with specified requirements. Submit copy to Project Manager prior to steel erection.

L. Independent Testing Agency or Project Manager’s Quality Control Inspector will have authority to reject weldments. Such rejection may be based on visual inspection where, in his opinion, weldment would not pass more detailed investigation.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to site at such intervals to insure uninterrupted progress of work. All material shall bear easily readable identification mark numbers as noted on shop drawings. Deliveries to the jobsite shall be made in the order that material is being erected. The direction of camber shall be clearly shown.

B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time to not to delay work.

C. Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Metal Surfaces, General: For fabrication of exposed to view steel, use only materials which are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names and roughness.

B. Structural Steel Shapes, Plates and Bars: ASTM A 36, ASTM A 572 grade 50, as shown on drawings.

C. Cold-Formed Steel Tubing: ASTM A 500, Grade B.

D. Hot-Formed Steel Tubing: ASTM A 501.

E. Steel Pipe: ASTM A 53, Type E or S, Grade B; or ASTM A 501.

1. Finish: Black, except where indicated to be galvanized.

F. Steel Castings: ASTM A 27, Grade 65-35, medium-strength carbon steel.

G. Headed Stud-Type Shear Connectors: ASTM A 108, Grade 1015 or 1020, cold finished carbon steel; with dimensions complying with AISC Specifications.

H. Anchor Bolts: ASTM A 307, nonheaded type unless otherwise indicated.

I. Unfinished Threaded Fasteners: ASTM A 307, Grade A, regular low-carbon steel bolts and nuts.

1. Provide hexagonal heads and nuts for all connections.

J. High-Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers, as follows:

1. Quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM A 325.

2. Quenched and tempered alloy steel bolts, nuts and washers, complying with ASTM A

490.

3. High strength bolted connections will use one of the following tension control systems.
   a. Direct tension indicator washers for A325 and A490 bolts. Washers and installation shall comply with ASTM F959-89.
   b. Torque control bolt assembly using splined bolt shank for A325 and A490 bolts. Fastener shall be ICBO approved and shown to result in uniform clamping and tension forces not less than AISC specifications.

K. Electrodes for Welding: Comply with Specifications Section 05999 Welding and applicable welding codes and specifications.

L. Structural steel primer paint: As specified in Division 9 sections.

M. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean, uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum water required for placement and hydration.

N. Non-metallic Shrinkage-Resistant Grout: Pre-mixed, non-metallic, non-corrosive, non-staining product containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
   a. Euco N.S.; Euclid Chemical Co.
   b. Crystex; L&M Construction Chemicals
   c. Masterflow 713; Master Builders
   d. Five Star Grout; U.S. Grout Corp.
   e. Upcon; Upco Chem. Div., USM Corp.
   f. Propak; Protex Industries, Inc.
   g. Sure Grip High Performance; Dayton Superior Corp.

2.02 FABRICATION

A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated.

1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize field handling of materials.

2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.

B. Connections: Weld or bolt shop connections, as indicated.

1. Bolt field connections, except where welded connections or other connections are indicated.
   a. Provide high-strength threaded fasteners for all bolted connections, except where unfinished bolts are indicated.
   b. Provide unfinished threaded fasteners for only bolted connections of secondary framing members to primary members (including girts, small angle bracing) and

for temporary bracing to facilitate erection.

C. High-Strength Bolted Construction: Install high-strength threaded fasteners in accordance with AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts", including direction tension indicator tightening procedures.

D. Welding: Comply with AISC Specifications and applicable welding codes per Specification Section 05999 Welding.

E. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Shop weld shear connectors, spaced as shown, to beams and girders in composite construction. Use automatic end welding of headed stud shear connectors in accordance with manufacturer's printed instructions, Specification Section 05999 Welding, and AWS D1.1.

F. Holes for Other Work: Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on final shop drawings.

1. Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.

2. Cut, drill, or punch holes perpendicular to metal surfaces. Any enlarging of holes by flame cutting shall be approved by the Project Manager. Drill holes in bearing plates.

G. Reference Specification Section 01401 and Section 05120 4.01 for Independent Testing Agency Requirements.

2.03 SHOP CLEANING AND PAINTING

A. Steel to be primed is as shown on the drawings.

1. Do not paint surfaces that are to be welded or high strength bolted with friction type connections. Touch up paint.

B. Surface Preparation: After inspection and before shipping, clean all steelwork, including steelwork to be painted or not to be painted. Remove loose rust, loose mill scale, and spatter, slag or flux deposits. Clean steel in accordance with Steel Structures Painting Council (SSPC) as follows:

1. SP-3, Power Tool Cleaning.

C. Painting: Immediately after surface preparation, apply structural steel primer paint in accordance with manufacturer's instructions and at a rate to provide dry film thickness of not less than 2.0 mils. Use painting methods that result in full coverage of joints, corners, edges and exposed surfaces.

PART 3 - EXECUTION

3.01 ERECTION

A. Surveys: Employ a registered professional engineer or land surveyor for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar devices, before erection work proceeds, and report discrepancies to Project Manager along with a suggested plan on how to correct the

discrepancy. Do not proceed with erection until corrections have been made, or until compensating adjustments to structural steel work have been agreed upon with Project Manager.

B. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and all final connections are made. Provide temporary guide lines to achieve proper alignment of structures as erection proceeds. Temporary shoring and bracing shall be designed by a Licensed Colorado Professional Engineer. The Engineer shall inspect finished shoring and bracing and document compliance with the design plans.

C. Temporary Planking: Provide temporary planking handrails, nets, anchorages and working platforms as necessary to effectively and safely complete work.

D. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.

1. Set loose and attached base plates and bearing plates for structural members on wedges or other adjusting devices.

E. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.

F. Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.

1. For proprietary grout materials, comply with manufacturer's instructions.

G. Field Assembly: Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure within specified AISC tolerances and as follows:
   a. At all slab edge conditions, provide a maximum deviation from grid line (or dimensioned point from grid line), to beam or column center, on the exterior or open side, of 1/2" at any given point. Grid line shall be considered a theoretically perfect plane.
   b. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.
2. Splice members only where indicated and accepted on shop drawings.

H. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.

I. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds. Where welding to

existing steel, clean existing steel surfaces prior to welding.

1. Do not enlarge misaligned or undersized holes in members by burning or by use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

J. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members that are not under stress, as acceptable to Project Manager. Finish gas-cut sections equal to a sheared appearance when permitted.

K. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.

L. Beam Members: Deviation of member working point horizontal location and elevation with respect to the supporting member shall not exceed +_/- 1/16” from the location and elevation shown on the drawings.

1. Leveling and Plumbing: Based on mean temperature of 70 degrees F.

2. Compensate for difference in temperature at time of erection.

M. Headed Stud Shear Connectors: Automatically end weld in accordance with Specification Section 05999, AWS D1.1 and manufacturer’s printed instructions.

N. Reference Specification Section 01401 and Section 05999 Welding, Part 4 Independent Testing Agency Requirements for welding inspection.

3.02 INDEPENDENT TESTING AGENCY

A. Contractor will engage an independent testing and inspection agency to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports. The Contractor's Quality Control Structural Inspector will coordinate the inspections and tests performed by the testing lab inspectors and testing personnel.

1. The Contractor’s Independent Testing Agency and Project Manager’s staff shall conduct and interpret tests and state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom. All reports shall be delivered to the Project Manager. Results not complying with requirements are to be brought to the Project Manager’s attention within 24 hours of discovery. All reports shall be sequentially numbered.

2. Provide access for testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.

3. The Contractor’s Independent Testing Agency shall inspect structural steel at plant before shipment; however, Project Manager reserves right, at any time before final acceptance, to reject material not complying with specified requirements.

B. The Contractor shall furnish such facilities and provide such assistance as may be required for carrying out the inspection prescribed herein. He shall notify the independent inspection agency and the DIA Project Manager at least two weeks in advance of the start of any qualification testing for welding.

C. The Testing Agency's Inspector will perform his duties in such a way that neither fabrication nor erection is unnecessarily delayed or impeded. The testing agency shall notify the

Project Manager of any scheduled inspections at least 48 hours prior to such time. The Project Manager shall also be notified as soon as possible prior to any unscheduled inspections. In no case will the inspector recommend or prescribe the method of repair of a defect.

D. Shop Inspection for all columns and 20 percent of beams will include examination of steel for straightness and alignment, fissures, mill scale, and other defects and deformities, as described in ASTM A6, and examination of fabricated pieces for conformity with connections as required.

E. Field Inspection will include examination of erected steel for proper fitting, tensioning of bolts, alignment, and compliance with tolerances required. Inspector shall check mill certificates for all steel for compliance with contract requirements. Inspect all steel members for loose rust, scale, and corrosion which may impair the application of fireproofing, painting, or other coatings, or which may impair the structural properties of the member. Submit written reports of deviations within 48 hours of erection.

F. Welding: Inspection of welding shall be in accordance with Specifications Section 05999 Welding and applicable AWS codes.

G. Bolting

1. Bolt tension quality control (Self-indicating) - inspection of installed high strength fasteners shall insure that the requirements of Section 6 inspection of the "Specification for structural joints using ASTM A325 or A490 bolts" of the American Institute of Steel Construction are met by inspection.
2. For direct tension indicator washers the following shall be used:
    a. A visual inspection thereafter shall insure that all washer nubs have been flattened per ASTM F959.
    b. When nubs are not flattened, the testing agency will determine that proper bolt tension requirements exist by the application of a properly calibrated testing torque. All cost of any torque inspection will be borne by the Contractor.
    c. A minimum of 2 percent of each batch or shipment of high strength bolts shall be tested for compliance with ASTM A325 or A490 as appropriate.
3. For torque control bolts the following shall be used:
    a. A visual inspection shall ensure that all spline shanks have been cleanly broken without excessive distortion.
    b. If distortion is encountered, the bolts should be tightened to a snug connection, followed by final tightening with the manufacturer's approved installation tool until the splines are sheared. Each such bolt shall then be torque tested. All cost of torque inspection will be borne by the Contractor.
    c. A minimum of 0.5% of each batch or shipment of bolts shall be tested for tension and ductility values and for compliance with ASTM A325 or A490.

H. Correct deficiencies in structural steel work that inspections and laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as may be necessary to reconfirm any non-compliance of original work, and as may be necessary to show compliance of corrected work.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 05120

SECTION 05500

METAL FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Work

1. Provide miscellaneous metal fabrications manufactured or fabricated to special, conventional, or standard details, as shown on the drawings and specified herein. Work includes, but is not necessarily limited to:
   a. Anchor plates, weld plates, and other embedments.
   b. Steel ladders.
   c. Steel handrails and guardrails which are not part of or associated with steel stairs.
   d. Overhead supports and bracing for toilet partitions and other suspended work.
   e. Equipment supports.
   f. Equipment screen framing.
   g. Pipe bollards.
   h. Steel lintels at masonry openings.
   i. Formed steel channel support (unistrut) framing.
   j. Grating and grilles.
   k. Other miscellaneous, non-structural framing as shown on the drawings or required for the bracing or support of the work of other Sections.
   l. Anchors, fasteners, and related hardware or accessories required for the installation of work specified herein.
2. Carefully examine the drawings and other sections of these specifications for metal fabrications and miscellaneous non-structural framing or support items which may not be specifically shown or specified herein. Avoid duplications and assume responsibility for providing all necessary items required for completion of the work.

1.02 RELATED WORK

A. Ornamental metal fabrications are specified in Section 05700.

B. Field painting of exposed metal fabrications is specified in Section 09900.

1.03 RELATED DOCUMENTS

A. Drawings, General and Supplementary Conditions, and applicable provisions of Division 1 Sections apply to this Section.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1.05 SUBMITTALS

A. Submittal Procedures: Refer to Section 01300.

B. Product Data: Submit copies of manufacturer's printed descriptive data and specifications for manufactured products specified herein.

C. Shop Drawings: Submit complete shop drawings for all shop or field fabricated items specified herein. Identify materials, thicknesses, and gauges; detail connections and methods of joining; and show coordination with adjacent work.

1.06 QUALITY ASSURANCE

A. Welding: Perform shop and field welding in accordance with applicable recommendations of the American Welding Society. Use only welders who have been certified by AWS D1.1 testing procedures within one year of Contract Date.

B. Structural Criteria

1. Handrails and Guardrails: Rails must be capable of resisting a uniform lateral load of 50 plf applied horizontally to the top rail, plus a concentrated load of 200 lbs applied at any point in any direction.

2. Structural Design: Provide the services of a professional engineer registered in the State of Colorado to design all handrails and guardrails.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Storage: Store materials and fabrications in protected areas. Protect from rusting or other damage.

B. Identification: Properly identify all items or components, including bolts or other loose materials and accessories. Leave manufacturer's labels or tags intact on manufactured products.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Steel Plates and Shapes: ASTM A36.

B. Steel Plates for Cold-Forming: ASTM A283, Grade C.

C. Steel Tubing: ASTM A501.

D. Steel Bars: ASTM A663 or ASTM A36.

E. Steel Sheets: ASTM A366

F. Welding Materials: Conform to AWS Code and AWS filler metal specifications.

G. Fasteners

1. Use same material and finish as parts being joined, except use stainless steel between dissimilar metals and non-corrosive fasteners at exterior connections or joints.

2. Provide fasteners of sufficient strength to support connected members and loads, and to develop full strength of parts fastened or connected.

H. Primer: Provide the following primer types

1. Metal Fabrications Receiving High Performance Finish Coatings: Zinc-rich, organic, rust-inhibitive primer with metallic zinc content not less than 75% of the total non-volatile content. Acceptable products include:
   a. ICI/Devoe #310 "Catha-Coat"
   b. Tnemec 90-97 "Tneme-Zinc"
   c. Approved substitution.
2. Other Metal Fabrications: Modified alkyd rust-inhibitive primer containing less than 3.5 lbs/gal volatile organic compounds (VOC). Acceptable products include:
   a. ICI/Devoe "Devshield 4130"
   b. Tnemec Series 10 Primers
   c. Approved substitution.

I. Galvanizing Repair Compound: ZRC Products Co. "Z.R.C. Cold Galvanizing Compound", or approved substitute, liquid organic zinc compound containing not less than 95% pure zinc metal.

2.02 MANUFACTURED PRODUCTS

A. Formed Steel Channel Support Framing System

1. "Unistrut" or similar manufactured system consisting of roll-formed steel channels fabricated from structural grade steel complying with ASTM A653, Grade 33, minimum 12 gage, weighing 190 lbs per 100 lineal feet. Provide channels with manufacturer's "Permagreen II" finish consisting of thermally-cured, rust inhibiting acrylic enamel applied by electrodeposition after cleaning and phosphating, color No. 14109 per Federal Standard 595a.
2. Unless otherwise indicated, provide channels with dimensions of 1-5/8" x 1-5/8", with 7/8" clear opening between lip returns.
3. Provide all required fittings, anchors, and accessories or incidental materials.

B. Gratings: McNichols Co. Type GW welded steel bar grates, consisting of continuous steel bearing bars spaced approximately 1-3/16" o.c. and cross bars spaced 4" o.c., with standard saddle clip fasteners. Unless otherwise noted, provide 1" x 3/16" bearing bars of the following types and finishes:

1. Exterior Gratings: Serrated bars, galvanized finish
2. Interior Gratings: Plain bars, shop prime coat finish

2.03 FABRICATION

A. Workmanship

1. Fabricate work to sizes, shapes, and profiles shown, and in accordance with approved shop drawings. Verify all dimensions prior to fabrication.
2. Fabricate equipment supports and other items penetrating through roof from square, rectangular, or round tubing; angle, channel, or H-shapes will not be permitted.

3. Do all punching, shearing, cutting, and forming so as to produce clean, true lines, and surfaces with a constant width on each face. Form straight and true edge arises and uniform contours as detailed. Make stampings and perforations with uniformly spaced and sized openings in alignment in both directions. Dress all cuts smooth; make corners square and joints tight. Ease sharp edges.

4. Uniformly space and align members. Provide sleeves, inserts, anchors, and other built-in and auxiliary work. Provide welded connections at all joints and intersections; use continuous welds and grind smooth.

5. Cut, drill, and tap units to receive hardware. Provide all necessary brackets, anchors, fasteners, and other accessory items required for complete installation.

B. Exposed-to-Public-View Members

1. Fabricate items which will be exposed to public view with smooth, flat surfaces, free from embedded scale, marks, gouges, or other irregularities.

2. Fill depressions with weld metal of same composition as parent metal. Grind welds and raised marks flush with adjacent surfaces. Fill small pit marks with metallic compound and grind smooth.

C. Galvanizing: Where miscellaneous steel fabrications are indicated to be galvanized or zinc-coated, apply coating by hot-dip process after items are assembled or fabricated in accordance with ASTM A386.

D. Shop Cleaning

1. Metal Fabrications Receiving High-Performance Finish Coatings: Completely remove oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint, or other foreign matter from surface of steel in accordance with SSPC-SP6, "Commercial Blast Cleaning".

2. Other Metal Fabrications: Remove rust, loose mill scale, oil, and foreign material. Clean surfaces just prior to shop painting by use of power tools and solvents in accordance with SSPC-SP3, "Power Tool Cleaning".

E. Shop Painting: Immediately after cleaning, apply primer to a minimum dry film thickness as recommended by paint manufacturer, but not less than 2.0 mils per coat.

2.04 DESCRIPTION OF FABRICATED ITEMS

A. Steel Ladders

1. Refer to Drawings for ladder details.

2. Unless otherwise indicated, fabricate ladders with 1" square bar rungs welded to minimum 3/8" x 2" flat plate side rails or stringers. Rungs shall be capable of carrying a load of 1000 pounds each without failing or permanently deforming. Side rails shall be capable of carrying the load of a single rung.

3. Bolt or weld all anchors and connections; grind welds smooth.

4. Ladder shall not deflect horizontally or vertically more than 1/240 of its span between anchorage points.

B. Handrails and Guardrails

1. Unless otherwise indicated, fabricate handrails and guardrails from 1-1/2" outside

diameter smooth steel pipe or round tubing as indicated. Uniformly space posts and rails as shown, and provide rounded safety caps at all exposed rail terminations. Weld all connections.

2. Fabricate intermediate guardrail pickets from steel bars of size and configuration indicated on the Drawings. Space intermediate rails or pickets with clear dimension not exceeding 3-15/16", as required by UBC or applicable local code.

3. Provide all necessary brackets, escutcheons or cover plates, and anchors required for anchoring to substrates indicated.

C. Screen Framing

1. Provide welded steel frames in accordance with detailed drawings.

2. Fabricate from angles and tubular or bar shapes as indicated. Punch or drill for bolts and other attachments, and provide any additional internal bracing required to resist wind or other imposed loads.

3. Provide minimum 12 gauge steel flashing collars at all members penetrating roof; furnish collars loose for field welding after erection.

D. Equipment Supports

1. Provide welded steel supports in accordance with Detailed Drawings. Verify dimensions and sizes with manufacturer of equipment to be supported.

2. Fabricate from angles, tubes, or shapes as indicated. Punch or drill for bolts or other attachment, and provide all required internal bracing to prevent deflection or racking under load.

3. Provide minimum 12 gauge steel flashing collars at all members penetrating roof; furnish collars loose for field welding after erection.

E. Steel Lintels: Refer to Structural Drawings for lintel sizes.

F. Embedments: Provide miscellaneous weld plates and anchor plates as indicated or required for embedding in concrete or building into masonry for attachment of the work of other trades.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work of this Section will be performed. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

3.02 INSTALLATION

A. General

1. Install metal fabrications in accordance with approved shop drawings.

a. Set work accurately into position, plumb, level, true, and free from racking. Bring each member into alignment with mating members and set in correct relationship to adjacent work with tight joints.

2. Provide fasteners of proper size and type and in sufficient quantity to develop full

strength of parts being joined and to safely support and transfer all loads. Provide all necessary concealed clips and fasteners to hold work securely and rigidly.

3. Remove all temporary braces or erection clips when no longer needed and restore affected surface finishes.

4. Insulate between dissimilar metals at connections.

5. Install flashing collars at members penetrating roofing. Coordinate installation with roofing trades.

3.03 FIELD QUALITY CONTROL

A. Visual Inspection: The testing and inspection agency will visually inspect shop and field welding and bolting of handrails, ladders, and other items requiring structural connections. Welds or bolts which do not pass visual inspection will be tested as specified herein at the Contractor's expense.

B. Welding Materials and Procedures

1. Verify that electrodes used for manual shielded metal-arc welding conform to requirements of the Contract Documents, and that welding procedures and welding sequences are followed without deviation.

2. Verify certification of welding operators under AWS qualification procedures within previous 12 months.

3. Verify that fit up, joint preparation, size, contour, extent of reinforcement, and length and location of welds conform to specified requirements.

4. Inspect and test field welds as follows:
   a. Visually inspect all (100%) welds.
   b. If more than 10% of the tested welds of any type are rejected, an additional 10% of all such welds will be re-tested using the same test method. This 10% additional testing procedure will be continued until the rejection rate drops below 10%.
   c. In addition, the Resident Engineer reserves the right to require additional ultrasonic or magnetic testing of uninspected welds of the same type.
      1) All costs of additional testing shall be borne by the Contractor.
   d. Radiographic (X-ray) testing (ASTM E94 and E390) may be substituted for ultrasonic testing at the option of the testing agency and with the approval of the Resident Engineer.
   e. Authority for Rejection: The testing and inspections agency is authorized to reject welding materials and procedures. Rejection may be based on visual inspection if, in the opinion of the inspector, the weld would not pass a more detailed investigation.

3.04 PROTECTION

A. Protection of Work in Place: Protect all work in place, and replace damaged finished work without cost to Owner.

B. Touch-up and Repair of Galvanized Coating

1. Welds: Wire brush to remove slag residue, weld splatter, and similar deleterious materials. If surface is oily, clean with phosphoric acid base compound as recommended by galvanizing repair compound manufacturer. Apply galvanizing repair

compound in accordance with manufacturer's instructions.

2. Scratches and Other Surface Damage: Thoroughly wash damaged area with water or mild detergent to remove any zinc oxides that may have formed. Apply galvanizing repair compound in accordance with manufacturer's instructions.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 05500

SECTION 05999

WELDING

PART 1 -GENERAL

1.01 SUMMARY

A. Welding is that work defined in American Welding Society (AWS) "Standard Welding Terms and Definitions - AWS A2.4" and as otherwise shown on drawings.

1. All welding on this project shall comply with requirement of specification, Section 05999 “Welding”, and other documents such as but not limited to drawings. If there is a conflict between Project Drawings, codes, and specifications, the more stringent shall apply.

B. Extent of welding work is shown on drawings, including schedules, notes and details to show size and location of welds. Welding Symbols shall be in accordance with AWS/A2.4-Standard Symbols for Welding, Brazing, and Nondestructive Examination.

C. Nothing stated in this Section shall be interpreted as diminishing or eliminating requirements stated in other Sections.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special conditions, general requirements and other applicable Technical Specifications apply to work of this Section.

B. IEEE-1992. Only welding machines that have been tested and comply with harmonic distortion requirements of IEEE-1992 shall be allowed to operate off of DIA electrical power system.

1.03 RELATED SECTIONS

A. This section “Section 05999 Welding” will apply to all welding performed under all other sections of this specification.

B. Division 15 sections.

1.04 REFERENCE STANDARDS

A. Welding shall comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1. AISC - American Institute of Steel Construction
2. AWS - American Welding Society
3. ASME - American Society of Mechanical Engineers.
4. ASTM - American Society for Testing and Materials
5. ASNT - American Society for Nondestructive Testing

1.05 SUBMITTALS

A. Product Data: Submit producers or manufacturer's specifications and installation instructions for all products, including, but not limited to those listed below. Include laboratory test reports and other data to show compliance with specifications (including specified standards).

1. Welding Electrodes: Submit manufactures specifications, to include recommended parameters and technique, for each electrode to be used on this project.

B. Submittal Requirements for Steel Studs

1. Stud manufacturer¹s certification that the studs, as delivered, conform to the applicable requirements of AWS D1.1-2000, sections 7.2 and & 7.3.

2. Certified copies of the stud manufacturer¹s test reports covering the last completed set of in-plant quality control mechanical tests, required by AWS D1.1-2000, 7.3 for each diameter delivered. The quality control test shall have been made within the six month period before delivery of the studs.

3. Certified material test reports (CMTR) from the steel supplier indicating diameter, chemical properties, and grade on each heat number delivered.

4. In the absence of Quality Control tests the provisions of AWS D1.1-2000, 7.3.4and 7.3.5 shall apply with the exception that DIA Project Manager or his representative will replace engineer in the process. All costs shall be at contractor¹s expense.

C. Submit shop drawings as specified under Section 01300 for all work specified herein, including complete details and schedules for fabrication and assembly of members, procedures and diagrams. Shop drawings shall indicate how each and every component shall be welded. If another company manufactures a component to be welded to another part(s) or piece(s) to form a larger assembly, then the shop drawings shall include that manufacturer¹s recommended welding procedures for that component. Design construction drawings shall not be re-used as bases for submitted shop drawings. Shop drawings, which use reproductions of design plans or details, will not be reviewed. Drawings shall be submitted in complete units. Do not submit partial sets.

D. Shop drawings shall clearly indicate profiles, sizes and locations of structural members, connections, attachments, anchorage’s, framed openings, size and type of fasteners, and clearances. Indicate welded connections using standard AWS welding symbols, per AWS A2.4. Clearly indicate net weld lengths and sizes, root openings, bevel angles and other information required to satisfactorily complete welding operations.

E. Contractor shall submit fully dimensioned Isometric drawings (spool drawings) for all welded piping work. Drawings shall indicate all weld types, sizes and materials to be used. The spool drawing size shall match the full size contract documents of either 24x36 or 34x44. Spool drawings shall be submitted in either the latest version of AutoCAD (dwg) or the latest version of Adobe Acrobat (pdf). Adobe Acrobat files shall not contain security. Other file formats will not be accepted.

F. Calculations required in other Sections shall show all pertinent members and pieces. Calculations shall be submitted prior to, or with, relevant shop drawing submittals. It is contractor's responsibility to insure that field construction uses connection design as submitted and reviewed.

G. Test Reports: Submit copies of all test reports conducted on shop and field welded

connections. Include data on type(s) of tests conducted and test results. Reports must be sequentially numbered and submitted to the DIA Project Manager within 48 hours of completion.

H. Individual Welder Qualifications: Submit Welding Performance Qualification Records (WPQR) for all welders, shop and field, prior to any welding per Specification Paragraph 05999 1.06 B.

I. Procedures: Submit Welding Procedure Specifications for all shop and field welding prior to any welding per Specification Paragraph 05999 1.06 B

1.06 QUALITY REQUIREMENTS

A. Codes and Standards: Comply with provisions of following, as applicable

1. AISC American Institute of Steel Construction
   a. AISC "Code of Standard Practice for Steel Buildings and Bridges", 1986.
   b. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", including "Commentary" and Supplements thereto as issued.
2. American Welding Society (AWS) D1.1 "Structural Welding Code Steel" and all other applicable A.W.S codes (latest editions).
3. ASTM A 6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use".
4. All welding shall be performed in accordance with the latest addition of applicable AWS, API, ASME code and ASTM Standards.

B. Qualifications for Welding Work

1. All Welders shall have been qualified through welding tests in accordance with applicable AWS code per Specification paragraph 05999 1.04 A within one year prior to welding taking place. Evidence of qualification shall be through Welding Performance Qualification Records (WPQR).
2. All welder qualifications test shall be or shall have been administered and witnessed by an Independent Testing Agency (ITA), AWS Certified Welding Inspector, (CWI).
3. If recertification of welders is required, delay costs and retesting costs shall be borne by the Contractor.
4. Welding that is to take place at each and every type of joint shall be per approved AWS procedure for that type of joint. Evidence of intended procedure shall be through written Welding Procedure Specifications.
5. Any welding done without submission to and approval by the DIA Project Manager of Welding Performance Qualification Records of the individual welder(s) doing the welding and Procedure Specifications for the actual welding shall be considered defective and subject to the provisions of Title 17 of the General Conditions.
6. All WPS and WPQR qualification testing shall be in accordance with this specification and the applicable welding code requirements.

C. The Contractor shall periodically review each welders work quality and take any steps required to insure high quality work. This is in addition to Quality Control requirements.

D. Fabricator Qualifications: Minimum of three years experience specializing in fabrication for

similar projects.

E. Design of Members and Connections: Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site whenever possible without causing delay in the work.

1. Promptly notify DIA Project Manager whenever design of members and connections for any portion of structure are not clearly indicated.

F. Welding and materials shall be inspected and tested by an Independent Testing Agency furnished and paid for by the Contractor. The Independent Testing Agency will have authority to reject weldments and materials. Such rejection may be based on visual inspection where, in the Inspector¹s opinion, the weldment or material would not pass more detailed investigation. Reference Specification Section 05999 4.01 for inspection and testing requirements. DIA's Quality Assurance Inspector(s), per the provisions of General Conditions Title 17, will also inspect welding and materials. Inspections by either the Independent Testing Agency or DIA's Quality Assurance Inspector may take place in the mill, shop and field.

1. Promptly remove and replace materials or fabricated components that do not comply with requirements as set forth in the Contract Documents.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Electrodes for Welding: Comply with AWS Code. Use E70 grade minimum unless otherwise approved. Store all electrodes and welding materials inside and protect from moisture, corrosion, and any other damage. Damaged electrodes shall not be used.

2.02 FABRICATION

A. Shop Fabrication and Assembly: Fabricate and assemble components in shop to greatest extent possible.

1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.

2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.

B. Holes for Other Work: Provide holes required for securing other work to components, and for passage of other work through components, as shown on final shop drawings.

1. Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.

2. Cut, drill, or punch holes perpendicular to metal surfaces. The DIA Project Manager shall approve any enlarging of holes by flame cutting

C. Contractor will notify DIA Project Manager or his representative at least 48 hours prior to any commencing fabrication. Notification to include starting date and duration of work.

2.03 SHOP CLEANING AND PAINTING

A. Components to be painted are as shown on the drawings.

1. Do not paint surfaces, which are to be welded.

2. Do not paint over welded joints until after Independent Testing Agency and DIA Quality Assurance Inspector have approved them.

PART 3 - EXECUTION

3.01 ERECTION

A. Do not enlarge misaligned or undersized holes in members by burning or by use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

B. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members, which are not under stress, as acceptable to DIA Project Manager. Finish gas-cut sections equal to a sheared appearance when permitted.

C. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Once Independent Testing Agency and DIA Quality Assurance Inspector have approved welds, apply paint to exposed areas using same material as used for shop painting.

D. No welding machines are to be operated off of DIA power until such machines have been tested for harmonic distortion per IEEE-1992 and approved by DIA Project Manager.

E. Contractor will notify DIA Project Manager or his representative at least 48 hours prior to any inspections to be performed by ITA.

PART 4 - TESTING AND INSPECTION

4.01 INDEPENDENT TESTING AGENCY (ITA)

A. See Division 1 for Independent Testing Agency requirements.

B. The General Contractor shall provide the ITA for all subcontractors. Subcontractors shall not contract with a separate ITA.

C. Contractor will engage an Independent Testing Agency to inspect welded connections and to perform tests and prepare test reports. The Contractor's Quality Control Inspector will coordinate the inspections and tests performed by the testing lab inspectors and testing personnel.

1. The Contractor’s Independent Testing Agency and DIA Project Manager’s staff shall conduct and interpret tests and state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom. All reports shall be delivered to the Project Manager. Results not complying with requirements are to be brought to the Project Manager[1]s attention within 24 hours of discovery. All reports shall be sequentially numbered.

2. Provide access for Independent Testing Agency to places where work is being fabricated or produced so that required inspection and testing can be accomplished.

3. The Independent Testing Agency shall inspect work at the plant before shipment;

however, DIA Project Manager reserves right, at any time before final acceptance, to reject material not complying with specified requirements.

a. Inspections and tests conducted by the ITA or DIA shall not in any way relieve the Contractor of his responsibility and obligation to meet all specifications and referenced standards. Employment of the ITA does not relieve the Contractor of providing the required Quality Control Program.

4. Welding Inspection Personnel Qualifications: All visual welding inspections shall be performed by AWS Certified Welding Inspectors CWI, qualified in accordance with AWS QC1. Inspectors qualified in accordance with the most current edition of the American Society for Nondestructive Testing Recommended Practice No. SNT-TC 1A, shall perform all non-destructive inspections other than visual inspections

5. Independent Testing Agency Inspectors working for the Contractor shall identify with a distinguishing mark all parts and joints they have inspected and accepted. Marks to be visible from at least 50 feet. DIA Project Manager and the Quality Control Inspectors shall mutually agree upon identifying marks.

6. Independent Testing Agency welding inspector shall be on job site however much time it takes to guaranty that all requirements of Project Specifications and codes are being met and provide written reports showing specific requirements have been met. Shop inspections by ITA welding inspector shall be performed in such a manor as to guaranty that all provisions of Project Specifications and codes are being met and provide written reports showing specific requirements have been met.

D. The Contractor shall furnish such facilities and provide such assistance as may be required for carrying out the inspection prescribed herein. He shall notify the Independent Testing Agency and the DIA Project Manager at least two weeks in advance of the start of any qualification testing for welding.

E. The Testing Agency's Inspector will perform his duties in such a way that neither fabrication nor erection is unnecessarily delayed or impeded. The Testing Agency shall notify the DIA Project Manager of any scheduled inspections at least 48 hours prior to such time. The Project Manager shall also be notified as soon as possible prior to any unscheduled inspections. In no case will the inspector recommend or prescribe the method of repair of a defect.

F. Inspection of welding will be such as to assure that all requirements of Project Specifications AWS D1.1, and other applicable welding codes are being complied with. Reports shall show the following items as being in conformance, but not be limited to just the items shown:

1. Verify that electrodes used for welding conform to the requirements Manufacturer, AWS, and other applicable Welding Codes and Standards.

2. Verify that the approved Welding Procedure Specifications and the approved welding sequence are followed without deviation.

3. Verify that only welding operators and welders who have been properly qualified will perform the welding. The inspection agency will witness such qualification testing of welding operations and welders, as may be required. Reference Specification Section 05999 1.06 B for Welder Qualification and Welding Procedure requirements.

4. Verify that the fit up, joint preparation, size, contour, extent of reinforcement, and length and location of welds conform to specified requirements such as but not limited to applicable welding codes, Welding Procedure Specifications, and drawings.

5. Review Mill Test Reports of material for compliance with Project Specifications, all

applicable Codes, and Drawings.

6. ITA inspection reports shall list all inspected, nonconforming, repaired, and accepted welds.

G. DIA Project Manager shall be informed at least 48 hours prior to shop and field welding so random inspections can be performed as stipulated in these specifications and General Conditions, TITLE 17.

H. All welders shall mark their welds with identifying marks. Contractor shall furnish DIA Project Manager with list of welders and their marks. List shall be updated each time a welder is added or subtracted.

4.02 STRUCTURAL STEEL

A. The Independent Testing Agency will test shop and field welds per ASTM E 543 and applicable welding code requirements as follows:

1. All welds: 100% visual.
2. All full penetration or partial penetration groove welds require 100% ultrasonic testing:
3. Studs on all embed assemblies: 100% of studs tested by hammer method and visual inspection.
4. Wall and roof deck connections
   a. 10% Magnetic Particle
5. All other welded connections: 10% Magnetic Particle.
6. Additional Testing shall be performed by the Independent Testing Agency as noted in paragraph 4.02, B below.

B. Additional Field Weld Testing

1. In addition, if defective welds are discovered, the remaining un-inspected welds shall receive such ultrasonic or magnetic particle inspection as may be required by the DIA Project Manager. If more than 10 percent of a welder's welds fail or when a CWI (Certified Welding Inspector) feels that the quality of the qualified welder's work appears to be below the requirements of the applicable AWS Code, he/she shall be removed from the job and retested to demonstrate compliance with AWS D1.1 (Latest Edition) or other applicable AWS codes and all other applicable AWS codes.
2. Additional testing shall be required if more than 10% of the Magnetic Particle tested welds are rejected. Then an additional 10% will be tested using either Magnetic Particle or Dye Penetrant Testing. This 10% additional testing shall be repeated until rejection rate drops below one in 10.
3. When ultrasonic indications arising from the weld root can be interpreted as either a weld defect or the backing strip, the backing strip shall be removed at the expense of the contractor, and if no root defect is indicated on this retest, and no significant amount of the base and weld metal have been removed, the joint needs no further repair or welding. If a defect is still indicated, it shall be repaired.
4. The welding inspector will have the authority to reject weldments. Such rejection may be based on visual inspection where in his opinion the weldment would not pass a more detailed investigation.
5. Reports by the Independent Testing Agency inspector will contain, as a minimum, an adequate description of each weld tested, the identifying mark of the welder

responsible for the weld, a critique of any defects noted by visual inspection or testing, and a statement regarding the acceptability of the weld tested, as judged by current A.W.S. standards. A copy of all tests results, including ultrasonic and x-ray, shall be provided to the DIA Project Manager within 48 hours of the test occurrence. This requirement includes all failed tests. Any test that shows work not in conformance with the contract requirement shall be retaken after the non-conformity is corrected. The retest shall refer to the failed test. Radiographic testing may be substituted for ultrasonic.

C. Stud Connectors

1. Stud connectors - the testing agency will inspect headed stud connectors as follows:
   a. All studs shall be acoustically inspected. Studs, which do not ring when struck with a hammer, shall be bent 15 degrees. If no fracture occurs, stud is considered acceptable and left bent.
   b. In addition to the above, not less than one of each 50 studs shall be tested by bending 15 degrees. If no fracture occurs, stud is considered acceptable and left bent.
   c. If at any time the number of rejectable studs on any level of structural steel framing exceeds 3% additional testing in accordance with paragraph above shall be performed on one of each 25 studs at this level and this increased frequency of testing shall be continued on all succeeding levels until the number of rejectable studs at a level is 3% or less. All cost of additional testing required by this paragraph shall be borne by the Contractor.
   d. 100% visual inspection to be performed in accordance with AWS D1.1 acceptance criteria.

D. Correct deficiencies in structural steel work, which inspections and laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor[1]s expense, as may be necessary to reconfirm any non-compliance of original work, and as may be necessary to show compliance of corrected work.

4.03 METAL DECKING

A. Welding shall be performed in accordance with AWS D1.3 and this specification.

B. 100 % visual inspection of all welds, per AWS D1.3 Structural Welding Code Sheet Steel.

1. Requires the removal of all slag from welds.

C. 10% Magnetic Particle testing of all welds.

1. Additional testing shall be required if more than 10% of the Magnetic Particle tested welds are rejected. Then an additional 10% will be tested using either Magnetic Particle or Dye Penetrant Testing. This 10% additional testing shall be repeated until rejection rate drops below one in 10.

D. All weld areas shall be repaired after inspection. Repair painted decking per Section 05300.

4.04 METAL FABRICATIONS

A. Welding shall be performed in accordance with applicable AWS welding code and these specifications.

B. 100% visual inspection of all welds.

C. 10% Magnetic Particle testing of all welds.

1. Additional testing shall be required if more than 10% of the Magnetic Particle tested welds are rejected. Then an additional 10% will be tested using either Magnetic Particle or Dye Penetrant Testing. This 10% additional testing shall be repeated until rejection rate drops below one in 10.

D. Applicable sections of “4.02 Structural Steel” shall be met also.

4.05 SHEET STEEL

A. Welding shall be in accordance with AWS D1.3 Structural Welding Code- Sheet Steel.

B. Inspection

1. 100 % visual in accordance with acceptance criteria of AWS D1.3.
2. 10% Magnetic Particle testing of all welds.
3. Additional testing shall be required if more than 10% of the Magnetic Particle tested welds are rejected. Then an additional 10% will be tested using either Magnetic Particle or Dye Penetrant Testing. This 10% additional testing shall be repeated until rejection rate drops below one in 10.

4.06 DIVISION 15 BASIC MECHANICAL MATERIALS AND METHODS

A. All welding in Division 15 Mechanical shall comply with the applicable AWS, ASME, AWWA, and API codes, latest editions.

B. All shop and field welds will be inspected per these specifications and applicable code for work being performed.

C. All welds shall be 100% visually inspected by ITA supplied by Contractor. Additional testing shall be as required by other parts of 05999, applicable codes, DIA Project Manager and Designer of Record.

1. Hot and chilled water piping/Hydronic Piping: ASME B31.9
   a. 100% visual inspection per acceptance criteria of ASME B31.9.
   b. All other requirements of ASME B31.9 as required for the application.
2. Hot water piping (in excess of 200ºF) /Hydronic Piping: ASME B31.3
   a. 100% visual inspection per acceptance criteria of ASME B31.3.
   b. All other requirements of ASME B31.1 as required for the application.
3. Water Lines: Per AWWA, AWS D1.1 latest edition, and Denver Water Board Specifications. If there is a conflict the more stringent shall apply.
   a. 100% visual inspection per AWS D1.1 visual acceptance criteria.
   b. AWWA requires that welds be 100% Dye Penetrant Tested in place of Magnetic Particle testing.

PART 5 -MEASUREMENT

5.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 6 - PAYMENT

6.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 05999

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

SECTION 07250

SPRAYED-ON FIREPROOFING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Concealed sprayed-on fireproofing.
2. Exposed sprayed-on fireproofing.
3. Includes all of this Concourse and Central Core sprayed-on fireproofing.

1.02 RELATED DOCUMENTS

A. Drawings, general and special conditions, general requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Section 05120, "Structural Steel".

B. Section 05210, Steel Joists and Joist Girders".

C. Section 05310, "Steel Deck".

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Section 01091.

1.05 DEFINITIONS

A. Concealed sprayed-on fireproofing refers to applications where sprayed-on materials are applied to surfaces which will be concealed from view behind other construction when the Work is completed.

B. Exposed sprayed-on fireproofing refers to applications where sprayed-on materials are applied to surfaces which are exposed to view when the Work is completed.

1.06 SUBMITTALS

A. Product data for each sprayed-on fireproofing product indicated including laboratory test reports for the performance criteria specified herein.

B. Test reports containing the following information:

1. Test results from an independent testing laboratory indicating compliance of sprayed-on fireproofing products with performance requirements indicated, including

asbestos content and mineral wool content. Include copy of each design selected.

C. Thickness: W/D values will be used for the thickness adjustment for members less than the minimum in the U.L. designs. Submit calculations for the thickness for each condition.

D. Job-site Mock-up: of 100 sq. ft. for each product specified.

E. Certificates from fireproofing manufacturer, for each fireproofing product required, indicating that:

1. Supplier has a minimum 5 years experience manufacturing products required.

2. Each fireproofing product required complies with specified product requirements and is suitable for the use indicated.

F. Certificate from installer evidencing a minimum 3 years of successful experience installing type of product specified on projects of similar scale and that installer has been approved by the manufacturer to install the types of products required.

G. Warranty.

1.07 QUALITY ASSURANCE

A. Testing Laboratory Qualifications: To qualify for acceptance, an independent testing laboratory must demonstrate to Resident Engineer's satisfaction, based on evaluation of laboratory-submitted criteria conforming to ASTM E 605, that it has the experience and capability to conduct satisfactorily the testing indicated without delaying the progress of the Work and that it complies with Section 01400, "Quality Control Requirements".

B. Single Source Responsibility: Obtain sprayed-on fireproofing materials from a single manufacturer for each different product required.

C. Fire Performance Characteristics: Provide materials and construction which are identical to those tested for the following fire performance characteristics, per test method indicated, by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction.

1. Fire Resistance Ratings: As indicated by reference to design designation in UL "Fire Resistance Directory" for fire-resistance-rated assemblies in which sprayed-on fireproofing serves as direct-applied protection, tested per ASTM E 119.

2. Surface Burning Characteristics: As indicated for each sprayed-on fireproofing product required, tested per ASTM E 84 and listed in UL "Building Materials Directory".

D. Warranty: Installer to warrant material and installation for 2 years.

E. Prior to the start of the application of the sprayed fireproofing a meeting will be held with the Resident Engineer, General Contractor, City Inspector, Third Party Inspector, Fireproofing Applicator, Fireproofing Manufacturer and other parties as deemed necessary to review submittals, sequencing, project conditions and scheduling.

F. Manufacturer shall submit a certificate that all products specified by the section are 100% asbestos or mineral wool free.

G. Submit a certificate that each UL design will provide the required fire resistance rating in accordance with building code requirements.

1.08 FIREPROOFING OF STEEL

A. Required U.L. Fire Ratings:

1. Floors:
   a. Secondary beams, 2 hr., UL D-916, restrained or unrestrained as noted on the drawings at unexposed conditions and N-720 at exposed conditions (not noted on drawings).
   b. Primary beams, 3 hr., UL N-708, restrained or unrestrained as noted on the drawings at unexposed conditions and N-720 at exposed conditions (not noted on drawings).
2. Steel columns:
   a. Unexposed: 3 hr., UL X-772 or UL X-771.
   b. Exposed: 3 hr., UL X-738.
3. Roofs:
   a. Secondary beams and deck, 2 hr., P-711, restrained or unrestrained as noted on the drawings.
   b. Primary beams, 3 hr., S-715, restrained or unrestrained as noted on the drawings.
4. Refer to Appendix A at the end of this section and drawings for areas to be fireproofed.

B. Field-Constructed Mock-Up: Prior to installation of exposed sprayed-on fireproofing, apply each product indicated for exposed applications, in locations indicated or selected by Resident Engineer, to represent completed work for qualities of appearance, materials and application.

1. Extent of Mock-Ups: Approximately 100 sq. ft. of surface for each product indicated.
2. Retain mock-ups during construction as standard for judging completed work.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project site in original, unopened packages with manufacturers' labels identifying products legible and intact. Include on labels names of products and manufacturers, date of manufacture and shelf life, where applicable. Also include UL labels for fire-resistance ratings applicable to project.

B. Use materials with limited shelf life within period indicated. Remove from project site and discard any materials whose shelf life has expired.

C. Store materials inside, under cover, above ground and in a manner to keep them dry until ready to use. Remove from project site and discard any materials that have been exposed to moisture or have otherwise deteriorated.

1.10 PROJECT CONDITIONS

A. Environmental Conditions: Do not install sprayed-on fireproofing when substrate temperatures are 40 deg F (4.4 deg C) and falling, unless temporary protection and heat can be provided to maintain temperatures of both at or above this temperature level for a minimum of 24 hours before, during, and for 24 hours after application of sprayed fireproofing.

B. Ventilation: Ventilate spray fireproofing by means of natural or, where this is inadequate, of forced air circulation during and after application until it dries thoroughly.

1.11 SEQUENCING

A. Sequence and coordinate application of sprayed-on fireproofing with other, related work specified in other sections to comply with the following requirements:

1. Provide temporary enclosures to prevent deterioration of sprayed-on fireproofing for interior applications due to exposure to unfavorable environmental conditions.
2. Avoid unnecessary exposure of sprayed-on fireproofing to abrasion and other damage likely to occur during construction operations subsequent to its application.
3. Do not apply fireproofing to metal roof decking substrates until application of roofing has been completed; prohibit roof traffic during application and drying of fireproofing.
4. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, tested, and corrections made to any defective fireproofing.

PART 2 - PRODUCTS

2.01 PRODUCTS

A. Products manufactured by the Construction Products Division of W.R. Grace and Co., or its approved processing distributors are specified to establish a standard of material and quality.

B. Acceptable manufacturers: Subject to compliance with requirements, manufacturers whose products may be incorporated in the work include, but are not limited to the following:

1. W.R. Grace and Co.
   a. Manufacturers not listed, who request approval, shall submit a completed Request for "Or Equal" approval form, contained in Part 1, Instructions to Bidders.
   b. Listed manufacturers other than the company whose products are specified, W.R. Grace Co., shall submit in addition to requirements of this section, the following:
      1) Proposed U.L. numbers, W/D calculations.
      2) A complete description of the process.
      3) Samples of each product.
      4) A list of at least (3) other projects of similar nature to this project where product has been in use.
      5) Certificate stating that all materials comply with specified requirements, signed by the manufacturer.

2.02 CONCEALED SPRAYED-ON FIREPROOFING MATERIALS

A. General: For concealed applications of sprayed-on fireproofing provide manufacturer's standard products complying with requirements indicated below for material composition and physical properties representative of installed products.

B. Material Composition: As indicated below:

1. Factory blended, plaster-based cementitious mix for spray application with integral mold inhibitors.

C. Physical Properties: Minimum values, unless otherwise indicated, measured per standard test methods referenced with each property, as follows:

1. Bond Strength: 300 lbf per sq. ft. per ASTM E 736.
2. Compressive Strength: Maximum deformation of 10% when subjected to 1500 psf per square foot per ASTM E 761.
3. Corrosion Resistance: No evidence of corrosion per ASTM E 937.
4. Deflection: No cracking, spalling, delamination or the like per ASTM E 759.
5. Effect of Impact on Bonding: No cracking, spalling, delamination or the like per ASTM E 760.
6. Air Erosion: Maximum weight loss of 0.002 grams per sq. ft. per ASTM E 859.
7. Asbestos and mineral wool fibers are not allowed.

D. Dry Density: Values for average and individual densities as required for fire-resistance rating indicated, per ASTM E 605, but not less than the following:

1. For cementitious fireproofing: 14 lb per cu. ft., 15 lbs. per cu. ft. average.
2. Hardness: 0.50 inch maximum penetration per ASTM C 569.
3. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 0 and 0, respectively, per ASTM E-84.

E. Available Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:

1. Cementitious Fireproofing:
   a. "Monokote MK6 CBF"; Grace Construction Products Div., W.R. Grace & Co.

2.03 EXPOSED FIREPROOFING

A. General: For exposed applications of sprayed-on fireproofing provide manufacturer's standard products complying with requirements indicated for material composition and for minimum physical properties of each product type listed, measured by standard test methods referenced with each property.

B. Medium Density Cementitious Fireproofing: Type 106, Grace Construction Products Division, W.R. Grace, or approved equal. Factory-mixed dry formulation mixed with water at project site to form a slurry for pumping and for dispersal by compressed air introduced at spray nozzle, complying with the following requirements:

1. Material Composition: As indicated below:
   a. Cement-aggregate formulation, chloride free, of portland cement, additives, and synthetic aggregates with integral mold inhibitors.
2. Bond Strength: 1000 lbf per sq. ft. per ASTM E 736.
3. Compressive Strength: Maximum deformation of 10% when subjected to 80 psi, per ASTM E 761.
4. Corrosion Resistance: No evidence of corrosion per ASTM E 937.
5. Deflection: No cracking, spalling, delamination or the like per ASTM E 759.
6. Dry Density: Values for average and individual densities as required for fire-resistance ratings indicated, per ASTM E 605, but not less than that indicated below:

a. 22 lb per cu. ft.

7. Air Erosion: Maximum weight loss of 0.025 grams per sq. ft. per ASTM E 859.

8. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 0 and 0, respectively, per ASTM E-84.

9. Asbestos and mineral wool fibers are not allowed.

2.04 EXPOSED COLUMNS

A. General: Fireproofed exposed steel columns up to 8'-0" height, shall be coated to a minimum 1/4" thickness with Topkrete type 610 as manufactured by the Construction Products Division: W.R. Grace & Co. or approved equal unless the column is to be encased in concrete as noted on the drawings.

B. Product: Factory-mixed formulation, a latex-modified plaster that is compatible to the base material with integral mold inhibitors.

C. Performance Criteria:

1. Dry density minimum 60 PCF when tested in accordance with ASTM E-605.

2. Compressive strength of greater than 440 psi when tested in accordance with ASTM C-354.

3. Hardness of the material shall be determined by testing in accordance with ASTM D-2240. The material shall have a minimum hardness of 50.

4. When tested in accordance with ASTM C-569 the material shall have a penetration resistance of 750 psi.

D. Asbestos and mineral wool fibers are not allowed.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, with Installer present, to determine if they are in satisfactory condition to receive sprayed-on fireproofing. A substrate is in satisfactory condition if it complies with the following:

1. Substrate complies with requirements of the section in which the substrate and related work is specified and is free of oil, grease, rolling compounds in quantities that would impair bond, incompatible primers, loose mill scale, dirt or other foreign substances capable of impairing bond of fireproofing with substrate under conditions of normal use or fire exposure.

2. Objects which will penetrate fireproofing, including clips, hangers, support sleeves and similar items have been securely attached to substrates.

3. Substrates are not obstructed by ducts, piping, equipment and other suspended construction that could interfere with application of fireproofing.

B. For steel, sheet metal ducts and other substrates suspected of being coated with oil, rolling compounds or other substances not readily identifiable but potentially capable of impairing bond, conduct tests recommended by fireproofing manufacturer to determine their presence and effect on adhesion of fireproofing.

C. Do not proceed with installation of fireproofing until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean substrates of substances which could impair bond of fireproofing, including oil, grease, rolling compounds, incompatible primers, and loose mill scale.

B. For exposed sprayed-on fireproofing applications repair substrates to remove any surface imperfections that could affect uniformity of texture and thickness in finished surface of fireproofing. Remove minor projections and fill voids which would telegraph through.

C. Cover other work which might be damaged by fall-out or overspray of fireproofing materials during application. Provide temporary enclosure as required to confine spraying operations, protect the environment, and to ensure adequate ambient conditions for temperature and ventilation.

3.03 INSTALLATION, GENERAL

A. General: Comply with fireproofing manufacturer's instructions for mixing materials, for application procedures and for types of equipment used to convey and spray-on fireproofing materials; as applicable to the particular conditions of installation and as required to achieve fire-resistance ratings indicated.

B. Extend fireproofing full thickness over entire area of each substrate to be protected. Unless otherwise recommended by fireproofing manufacturer, install body of fireproof covering in a single course.

C. Apply fireproofing in thicknesses and densities indicated but not less than that required to achieve fire resistance ratings designated for each condition, unless greater thicknesses and densities are indicated. Thickness to be as required by the specific U.L. Design Number.

D. Apply fireproofing materials by sprayed-on method to maximum extent possible.

3.04 INSTALLATION OF EXPOSED FIREPROOFING

A. Provide a uniform finish complying with description indicated for each type of material and matching Resident Engineer's sample, or if none, finish approved for field-erected mock-up.

B. Apply cement based cementitious fireproofing to produce the following finish:

1. Spray texture with no further treatment. Use trowel-on only in small areas for patching.

3.05 FIELD QUALITY CONTROL

A. Testing Laboratory: Contractor shall employ and pay a qualified independent testing laboratory to perform field quality control testing. Owner will randomly test areas for quality assurance purposes.

B. Extent and Testing Methodology: Arrange for testing of completed fireproofing in successive stages in areas of extent described below; do not proceed with fireproofing of next area until test results for previously completed work evidence compliance with requirements.

1. Extent of Each Test Area: Not greater than one floor or 10,000 sq. ft., whichever produces the greatest number of test areas.
2. Within each area, testing laboratory shall randomly select a typical bay, and test each fireproofed structural element within it for thickness and density per ASTM E 605.
3. Within each area, testing laboratory shall randomly select one typical structural element of each type and test fireproofing for cohesion/adhesion per ASTM E 736.

C. Testing Laboratory shall report test results within 48 hours of test in writing to Contractor and Resident Engineer.

D. Repair or replace fireproofing within areas where test results indicate fireproofing does not comply with requirements.

3.06 CLEANING, REPAIR, AND PROTECTION

A. Cleaning: In exposed surface areas, at the floor, provide masking, drop cloths or other satisfactory coverings so as to prevent overspray of sprayed fireproofing.

1. In unexposed surface areas, at the floor, surfaces are to be left in a scraped clean condition.
2. In exposed or unexposed areas remove all overspray and fall-out material from surfaces of other work including all areas not to be spray fireproofed.

B. Protect fireproofing according to advice of fireproofing manufacturer and Installer from damage resulting from construction operations or other causes so that fireproofing will be without damage or deterioration at time of Substantial Completion.

C. Coordinate installation of fireproofing with other work in order to minimize the need for other trades to cut or remove fireproofing. As other trades successively complete installation of their work, maintain protection of structure afforded by fireproofing by patching any areas which have been removed or damaged prior to concealment of fireproofing by other work.

D. All patching and repairing of sprayed fireproofing, due to damage by other trades, shall be performed under this section and paid for by the trade(s) responsible for the damage through the General Contractor.

E. Repair or replace work which has not been successfully protected.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the lump sum contract price.

APPENDIX A:
FIREPROOFING (PRIMED/NOT TO BE PRIMED) STEEL SCHEDULE

FLOOR	CENTRAL CORE F.P. (REMARK)	HOLDROOM END HOLDROOM F.P. (REMARK)	SUBCORE F.P. (REMARK)
ROOF of 5TH FLOOR			
ROOF F.P.	2 Hr (a)	--	--
COLUMN F.P.	3 Hr (a)	--	--
ROOF/5TH FLOOR			
FLOOR/ROOF F.P.	2 Hr	2 Hr (c)	2 Hr (e)
COLUMN F.P.	3 Hr	3 Hr (b)	3 Hr
4TH FLOOR/MECH./ROOF			
FLOOR/ROOF F.P.	2 Hr	2 Hr (c)	2 Hr
COLUMN F.P.	3 Hr	3 Hr (b)	3 Hr (d)
MEZZANINE LEVEL			
FLOOR/ROOF F.P.	2 Hr	O(f)	2 Hr
COLUMN	3 Hr	3 Hr (b)	3 Hr
CONCOURSE LEVEL			
FLOOR/F.P.	2 Hr	2 Hr	2 Hr
COLUMN F.P.	3 Hr	3 Hr (b)	3 Hr
APRON LEVEL			
FLOOR/F.P.	2 Hr	2 Hr	2 Hr
COLUMN F.P.	3 Hr	3 Hr	3 Hr
BASEMENT LEVEL			
FLOOR/F.P.	2 Hr	0	0
COLUMN F.P.	3 Hr	3 Hr	3 Hr

B. ABBREVIATIONS/SYMBOLS

1. F.P.: Fireproofing in hours per U.L. ratings listed, refer to Section "07250", 1.08.
   a. Remark, see remarks schedule.

C. REMARKS TO SCHEDULE:

1. Roof and columns over the elevator machine room, the stair vestibule and the stairs are to be fireproofed.
   a. Exposed to view structure consists of "Hero" columns, "Hero" trusses and structure shown on drawing S3.112. These areas are not to be fireproofed.
2. Columns supporting mechanical space floor and roof are to be fireproofed. All other areas are non-rated, not to be fireproofed.
3. Mechanical space floor, columns, and roof are to be fireproofed. All other areas are non-rated, not to be fireproofed.
4. All columns are to be fireproofed except the columns supporting the clerestory roof.
5. All roofs to be fireproofed except the clerestory roof.
6. Unless otherwise indicated on the drawings.

D. GENERAL NOTES:

1. Refer to drawings for areas defined as Central Core, Holdroom, End Holdroom and Subcore.
2. All steel to receive fireproofing is not to be primed except steel per Section 05210. All other steel to be primed including steel per Section 05210.
3. Refer to structural drawings and Section 07250, 1.08 for members requiring fireproofing.

4. Galvanized metal deck is not to be primed.
5. Refer to drawings for other areas to be fireproofed.
6. Primary beams at roof or floors requiring a 2 hour firerating, require a 3 hour firerating, refer to structural drawings general notes sheet for locations of primary beams.
7. Fireproof supplementary steel where required by the Denver Building Code.
8. At Concourse and Mezzanine level only, at rooms denoted as "Tenant", concealed type sprayed-on fireproofing may be used. Not allowed at other spaces labeled "Tenant".

END OF SECTION 07250

SECTION 07270

FIRESTOPPING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes firestop sealant and safing insulation for the following locations:

1. Openings between exterior walls and connecting floors.
2. All pipes, ductwork or conduit penetrating a fire rated wall, floor assembly or roof assembly.
3. Head of wall firestopping at fire rated full height partitions.

B. Fire stop mortar not allowed.

1.02 RELATED DOCUMENTS

A. Drawings, general and special conditions, general requirements and other applicable technical specifications apply to work of this Section:

1.03 RELATED SECTIONS

A. Section 07200 "Insulation" specifies non-firestopping insulation.

B. Section 07410, "Preformed Siding", for the Single Source Responsibility "required for components of this section installed by the "exterior skin installer".

C. Section 07900 "Joint Sealers" specifies non-firestopping joint sealers.

D. Section 07250 "Spray-on Fireproofing" specifies assembly fire ratings.

1.04 SUBMITTALS

A. Product Data from manufacturers for each joint firestop sealer grout or safing insulation product required, including instructions for joint preparation and joint sealer application and insulation installation instructions.

B. Certified Test Reports: With product data, submit copies of certified test reports showing compliance with specified performance values, including r-values (aged values for plastic insulations), densities, compression strengths, fire performance characteristics, perm ratings, water absorption ratings and similar properties.

C. Certificates from manufacturers of joint firestop sealers and safing insulation attesting that their products comply with specification requirements and are suitable for the use indicated.

D. Samples of each product.

E. Certificates: Submit certificates from manufacturer and installer.

F. Product test reports for each type of joint firestop sealer evidencing compliance with

requirements.

1.05 QUALITY ASSURANCE

A. Manufacturers Certificate: Not less than 5 years experience manufacturing types of product specified.

B. Installer Certificate: Engage an Installer who has successfully completed within the last 3 years at least 3 sealer applications similar in type and size to that of this Project and is approved by manufacturer for this type of installation.

C. Pre-installation conference to be attended by installer, contractor and Resident Engineer and representatives from affected trades.

D. Warranty: Installer to warrant that the firestopping system will provide a permanent installation.

E. Install firestopping materials to comply with the following:

1. Openings between walls and connecting floors shall be per ASTM E 119 and comply with Underwriters laboratories designs J-900, U-900.
2. Openings around all pipes, ductwork, conduit or similar penetrating a rated wall, floor or roof assembly shall comply with ASTM E 814.
3. Head of wall firestopping at fire rated full height partitions shall comply with ASTM E 119 and Underwriters laboratories design U.
4. The Denver Building Code.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

C. General Protection: Protect insulations from physical damage and from becoming wet, soiled, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storage and protection during installation.

1.07 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of firestop joint sealers under the following conditions:

1. When ambient and substrate temperature conditions are outside the limits permitted by manufacturers.
2. When substrates are wet due to rain, frost, condensation, or other causes.

B. Joint Substrate Conditions: Do not proceed with installation of firestop joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.

1.08 OVERSTOCK

A. Provide minimum two gallons of each type of sealant. Store as directed by Resident Engineer.

PART 2 - PRODUCTS

2.01 FIRE-RESISTANT JOINT SEALERS

A. General: Provide manufacturer's standard fire-stopping sealant, with accessory materials, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

B. Foamed-In-Place Fire-Stopping Sealant: Two-part, foamed-in-place, silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around cables, conduit, pipes and similar penetrations through walls and floors.

C. One-Part Fire-Stopping Sealant: One part elastomeric sealant formulated for use in a through-penetration fire-stop system for sealing openings around cables, conduit, pipes and similar penetrations through walls and floors.

D. Available Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:

1. Foamed-In-Place Fire-Stopping Sealant:
   a. "Dow Corning Fire Stop Foam"; Dow Corning Corp.
   b. "Pensil 851"; General Electric Co.
2. One-Part Fire-Stopping Sealant:
   a. "Dow Corning Fire Stop Sealant"; Dow Corning Corp.
   b. "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.
   c. "RTV 7403"; General Electric Co.
   d. "Fyre Putty"; Standard Oil Engineered Materials Co.
   e. "Fyre Shield"; Tremco
   f. "Fyre-Sil"; Tremco (High Movement)
   g. "Metalcaulk 950"; Metalines

E. Accessory Materials for Fire-Stopping Sealants: Provide forming, joint fillers, packing and other accessory materials required for installation of fire-stopping sealants as applicable to installation conditions indicated.

2.02 FIRESTOPPING INSULATING MATERIALS

A. General: Provide insulating materials which comply with requirements indicated for materials, compliance with referenced standards, and other characteristics.

B. Semi-Refractory Fiber Board Safing Insulation: Semi-rigid boards designed for use as a firestop at openings between edge of slab and exterior wall panels at tops of rated walls and as shown, produced by combining semi-refractory mineral fiber manufactured from slag with thermosetting resin binders to comply with ASTM C 612, Class 1 and 2; nominal density of 4.0 lbs. per cu. ft.; passing ASTM E 136 for combustion characteristics; r-value of 4.0 at 75 deg. F (23.9 deg. C), meeting point exceeding 2000 deg. F. Supports to be 26 gauge galvanized steel.

C. Manufacturers of Semi-Refractory Fiber Insulation:

1. United States Gypsum Co.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces indicated to receive joint sealers, with Installer present, for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance. Do not proceed with installation of joint sealers until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements:

1. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust; paints, except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer; old joint sealers; oil; grease; waterproofing; water repellents; water; surface dirt; and frost.

2. Clean concrete, masonry, unglazed surfaces of ceramic tile and similar porous joint substrate surfaces, by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.

3. Remove laitance and form release agents from concrete.

B. Joint Priming: Prime joint substrates where recommended by joint sealer manufacturer based on preconstruction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond, do not allow spillage or migration onto adjoining surfaces.

3.03 INSTALLATION

A. General: Comply with manufacturers' printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials to fill openings around mechanical and electrical services penetrating floors and walls to provide fire-stops with fire resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

C. At full height fire rated walls: Install firesafing insulation as shown on the drawings at wall head condition and as required to meet Denver Building Code requirements.

D. Protect all fire safing insulation by installing 22 gage galvanized sheet metal closure at top and bottom, which complies with the DBC for protection of fire safing insulation.

E. Tool exposed surfaces of mortar or sealants.

F. At plastic pipes penetrating floors provide a gauge galvanized steel sleeve around pipes, fire stop sealant within sleeve.

G. At opening between exterior walls and floors/roofs install firesafing insulation per DBC requirements and in accordance with AAMA Tir-A3

3.04 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

3.05 PROTECTION

A. Protect joint sealers and insulation from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and installations with repaired areas indistinguishable from original work.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the lump sum contract price.

END OF SECTION 07270

SECTION 07841

THROUGH-PENETRATION FIRESTOP SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:

1. Floors.
2. Walls and partitions.
3. Construction enclosing compartmentalized areas.

B. Related Sections include the following:

1. Division 7 Section "Sprayed-On Fireproofing."
2. Division 15 Sections specifying duct and piping penetrations.
3. Division 16 Sections specifying cable and conduit penetrations.

1.03 PERFORMANCE REQUIREMENTS

A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.

1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.
2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
3. Fire-resistance-rated floor assemblies.

B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that after curing do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor

loads involved either by installing floor plates or by other means.

3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

D. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-developed ratings of less than 450, as determined per ASTM E 84.

1.04 SUBMITTALS

A. Product Data: For each type of through-penetration firestop system product indicated.

B. Shop Drawings: For each through-penetration firestop system, show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating item. Include firestop design designation of testing and inspecting agency acceptable to authorities having jurisdiction that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.

2. Where Project conditions require modification of qualified testing and inspecting agency's illustration to suit a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

D. Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.

E. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

C. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:

1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.

2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:
   a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
   b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
      1) UL in "Fire Resistance Directory."

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.08 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. A/D Fire Protection Systems Inc.
2. DAP Inc.
3. Firestop Systems Inc.
4. Hilti Construction Chemicals, Inc.
5. Instant Firestop Mfg. Inc.
6. International Protective Coatings Corp.
7. Isolatek International.

8. Nelson Firestop Products.
9. NUCO Industries.
10. RectorSeal Corporation (The).
11. Specified Technologies Inc.
12. 3M Fire Protection Products.
13. Tremco.
14. United States Gypsum Company.

2.02 FIRESTOPPING, GENERAL

A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:
   a. Slag-/rock-wool-fiber insulation.
   b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   c. Fire-rated form board.
   d. Fillers for sealants.
2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.03 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.03 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION

A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on la-

bels:

1. The words: "Warning--Through-Penetration Firestop System--Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Through-penetration firestop system designation of applicable testing and inspecting agency.
4. Date of installation.
5. Through-penetration firestop system manufacturer's name.
6. Installer's name.

3.05 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

3.06 THROUGH-PENETRATION FIRESTOP SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to the alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Firestop Systems for Metallic Pipes, Conduit, or Tubing FS-1: Comply with the following:

1. Available UL-Classified Systems: C-BJ- 1001-1999.
2. Type of Fill Materials: One or more of the following:
   a. Latex sealant.
   b. Silicone sealant.
   c. Intumescent putty.
   d. Mortar.

C. Firestop Systems for Electrical Cables FS-2: Comply with the following:

1. Available UL-Classified Systems: C-BJ- 3001-3999.
2. Type of Fill Materials: One or more of the following:
   a. Latex sealant.
   b. Silicone sealant.
   c. Intumescent putty.
   d. Silicone foam.

D. Firestop Systems for Insulated Pipes FS-3: Comply with the following:

1. Available UL-Classified Systems: C-BJ- 5001-5999.
2. Type of Fill Materials: One or more of the following:

a. Latex sealant.
b. Intumescent putty.
c. Silicone foam.
d. Intumescent wrap strips.

E. Firestop Systems for Miscellaneous Electrical Penetrants FS-4: Comply with the following:

1. Available UL-Classified Systems: C-AJ- 6001-6999.

2. Type of Fill Materials: One or more of the following:
   a. Latex sealant.
   b. Intumescent putty.
   c. Mortar.

F. Firestop Systems for Miscellaneous Mechanical Penetrations FS-5: Comply with the following:

1. Available UL-Classified Systems: C-AJ- 7001-7999.

2. Type of Fill Materials: One or both of the following:
   a. Latex sealant.
   b. Mortar.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the lump sum contract price.

END OF SECTION 07841

SECTION 07900

JOINT SEALERS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes joint sealers for the following locations:

1. Interior joints in vertical surfaces and horizontal surfaces as indicated below:
   a. Control joints on exposed interior surfaces of exterior walls and slabs-on-grade.
   b. Perimeter joints of exterior openings.
   c. Vertical control joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
   d. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
   e. Perimeter joints of toilet fixtures.
   f. Control and expansion joints in finish flooring.
   g. Other joints as indicated.
2. Other joints not specified elsewhere.

1.02 RELATED DOCUMENTS

A. Drawings, general and special conditions, general requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. For gypsum board assemblies: Section 09255

1.04 SYSTEM PERFORMANCES

A. Provide joint sealers that have been produced and installed to establish and maintain watertight and airtight continuous seals.

1.05 SUBMITTALS

A. Product Data from manufacturers for each joint sealer product required, including instructions for joint preparation and joint sealer application.

B. Samples for Initial Selection Purposes: Manufacturer's standard bead samples consisting of strips of actual products showing full range of colors available, for each product exposed to view.

C. Other Samples: Samples of joint fillers, cleaners, primer, bond breaker tape and backer rod.

D. Samples for verification purposes of each type and color of joint sealer required. Install joint sealer samples in 1/2 inch wide joints formed between two 6 inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealers.

E. Certificates from manufacturers of joint sealers attesting that their products comply with specification requirements and are suitable for the use indicated and that manufacturer has a minimum 10 years experience manufacturing types of products specified.

F. Certificate from installer.

G. Qualification data complying with requirements specified in "Quality Assurance" article. Include list of completed projects with project name, addresses, names of Architects and Owners, plus other information specified.

H. Compatibility and adhesion test reports from elastomeric sealant manufacturer indicating that materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants. Include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed to obtain adhesion.

I. Product test reports for each type of joint sealers indicated, evidencing compliance with requirements specified.

J. Preconstruction field test reports indicating which products and joint preparation methods demonstrated acceptable adhesion to joint substrates.

1.06 QUALITY ASSURANCE

A. Installer Certificate: Installer who has successfully completed within the last 5 years at least 3 joint sealer applications similar in type and size to that of this Project.

B. Testing Laboratory Qualifications: To qualify for acceptance, an independent testing laboratory must demonstrate to Resident Engineers's satisfaction, based on evaluation of laboratory-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated without delaying progress of the Work.

C. Single Source Responsibility for Joint Sealer Materials: Obtain joint sealer materials from a single manufacturer for each different product required.

D. Preconstruction Compatibility and Adhesion Testing: Submit samples of all materials that will contact or affect joint sealers to joint sealer manufacturers for compatibility and adhesion testing, as indicated below:

1. Use test methods standard with manufacturer to determine if priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealers to joint substrates.
    a. Perform tests under normal environmental conditions that will exist during actual installation.
2. Submit not less than 9 pieces of each type of material, including joint substrates, shims, joint sealant backings, secondary seals, and miscellaneous materials.
3. Schedule 30 days for testing and analysis of results to prevent delay in the progress of the Work.
4. Investigate materials failing compatibility or adhesion tests and obtain joint sealer manufacturer's written recommendations for corrective measures, including use of specially formulated primers.
5. Testing will not be required when joint sealer manufacturer is able to submit joint

preparation data required above which is acceptable to Resident Engineer and is based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

E. Product Testing: Provide comprehensive test data for each type of joint sealer based on tests conducted by a qualified independent testing laboratory on current product formulations within a 24-month period preceding date of Contractor's submittal of test results to Resident Engineer.

1. Test elastomeric sealants for compliance with requirements specified by reference to ASTM C 920. Include test results for hardness, stain resistance, adhesion and cohesion under cyclic movement (per ASTM C 719), low-temperature flexibility, modulus of elasticity at 100 percent strain, effects of heat aging, and effects of accelerated weathering.
   a. Include test results performed on joint sealers after they have cured 1 year.

F. Preconstruction Field Testing: Prior to installation of joint sealants, field-test their adhesion to joint substrates as follows:

1. Locate test joints where indicated or, if not indicated, as directed by Resident Engineer.
2. Conduct field tests for each application indicated below:
   a. Each type of elastomeric sealant and joint substrate indicated.
   b. Each type of non-elastomeric sealant and joint substrate indicated.
3. Arrange for tests to take place with both Resident Engineer and joint sealer manufacturer's technical representative present.
4. Test Method: Test joint sealers by hand pull method described below:
   a. Install joint sealants in 5-feet joint lengths using same materials and methods for joint preparation and joint sealant installation required for completed Work. Allow sealants to cure fully before testing.
   b. Make knife cuts as follows: A horizontal cut from one side of joint to the other followed by 2 vertical cuts approximately 2 inches long at side of joint and meeting horizontal cut at top of 2 inch cuts. Place a mark 1 inch from top of 2 inch piece.
   c. Use fingers to grasp 2 inch piece of sealant just above 1 inch mark; pull firmly down at a 90 degree angle or more while holding a ruler along side of sealant. Pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than that equaling specified maximum movement capability in extension; hold this position for 10 seconds.
5. Submit report whether or not sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.
6. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants which fail to adhere to joint substrates during testing.

G. Field-Constructed Mock-Ups: Prior to installation of joint sealers, apply elastomeric sealants to the following selected building joints as indicated below for further verification of colors selected from sample submittals and to represent completed work for qualities of appearance, materials, and application:

1. Joints in field-constructed mock-ups of assemblies specified in other sections which

are indicated to receive elastomeric joint sealants specified in this section.

2. Retain mock-ups during construction as standard for judging completed construction.

H. Pre-Installation Conference: Conduct conference at Project site to comply with requirements of the Division-1 section covering this activity.

I. Manufacturer shall submit evidence that material will maintain its specified movement range, and experience no visible change in color after one year.

J. Warranty: Installer to provide a 5 year warranty to replace any failing joints.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.08 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of joint sealers under the following conditions:

1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturers.

2. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturer or below 40 deg F (4.4 deg C).

3. When joint substrates are wet due to rain, frost, condensation, or other causes.

B. Joint Width Conditions: Do not proceed with installation of joint sealers where joint widths are less than allowed by joint sealer manufacturer for application indicated.

C. Joint Substrate Conditions: Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.

1.09 SEQUENCING AND SCHEDULING

A. Sequence installation of joint sealers to occur not less than 21 nor more than 30 days after completion of waterproofing, unless otherwise indicated.

1.10 OVERSTOCK

A. Provide a minimum 2 gallons of each type or color sealant used. Store as directed by Resident Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

A. Compatibility: Provide joint sealers, joint fillers and other related materials that are

compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

B. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by Resident Engineer from manufacturer's standard colors. A minimum of 12 colors for each type must be available for selection purposes.

2.02 SCHEDULE

A. Extreme Movement Sealants (+100% or -50% movement capability)

1. Vertical/horizontal unexposed joints.
   a. Sealant Type: S-6

B. Significant Movement Sealants (+25% or -25% movement capability)

1. Vertical or inclined joints such as panel, coping, expansion, precast planks, and prestressed concrete joints pavement.
   a. Sealant Type: S-3 or S-6
2. Horizontal joints exposed to fuel or gas spillage including concrete pavement joints if noted on drawings. Use sonneborn sonomeric
   a. Sealant Type: S-10
3. Horizontal joints not exposed to fuel or gas spillage.
   a. Sealant Type: S-3 or S-6

C. Exterior Minimal Movement Sealants (+25% or -25% movement capability)

1. Vertical or inclined joints such as perimeters of doors, windows, wall penetrations.
   a. Sealant Type: S-3, S-6 or S-7
2. Horizontal joints not exposed to fuel or gas spillage. Use Sonneborn sonolastic. 1 1/2" horizontal expansion Jt. at elevation 95-2".
   a. Sealant Type: S-2, or 5

D. Glazing Sealants

1. Structural Glazing (Requires pre-testing and prior written approval from the sealant manufacturer before using).
   a. Sealant Type: S-7, or 8
2. Non-structural
   a. Sealant Type: S-7, or 8

E. Interior Sealants and Caulking

1. General, use Sonneborn sonolastic NP-1 black.
   a. Sealant Type: C-1
2. Special
   a. Exposed acoustical
      1) Sealant Type: S-9, C-2
   b. Non-exposed acoustical
      1) Sealant Type: S-9, C-2

F. Hidden from view, metal to metal curtainwall or preformed siding joints expected to undergo minimal movement.

1. Sealant Type: C-4

G. Slab-on-grade joints: Use Sonneborn Sonolastic NP-2

1. Sealant Type: S-1, 2, 3, 4, 6 or 7

2.03 SEALANT TYPES

NO.	ASTM	FEDERAL	DESCRIPTION
S-1	C-920-79 Type M Class 25 Grade NS	TT-S-227(e) Class A Type II	-Multi component, non-sag, polyurethane sealant -Shore A hardness of 20-40 -Joint movement range of +/-25% as tested after 1 year
S-2	C-920-79 Type M Class 25 Grade P	TT-S-227(e) Class A Type I	-Multi component, self leveling, polyurethane sealant -Shore A hardness of 25-40 -Joint movement range of +/-25% after 1 year
S-3	C-920-79 Type S Class 25 Grade NS	TT-S-230(c) Class A Type II	-Low modulus, one component, non-sag, polyurethane sealant -Shore A hardness of 15-25 -Joint movement range of +/-50% after 1 year -Minimum elongation of 700%
S-4	C-920-79 Type S Class 25 Grade NS	TT-S-230(c) Class A Type I	-One component, non-sag, polyurethane sealant -Shore A hardness of 25-40 -Joint movement of +/-25% after 1 year
S-5	C-920-79 Type S Class 25 Grade P	TT-S-230(c) Class A Type I	-One component, self leveling,polyurethane sealant -Shore A hardness of 15-45 -Joint movement of +/-25% after 1 year
S-6	C-920-79 Type S Class 25 Grade NS	TT-S-1543(a) Class A	-Low modulus, one component, non-sag, neutral cure, silicone sealant -Shore A hardness of 15-20 -Joint movement range of +100% to -50% after 1 year -Joint size may be as little as two times joint movement -Minimum elongation of 1200%
S-7	C-920-79 Type S Class 25 Grade NS	TT-S-1543(a) Class A	-One component, neutral cure, non-sag, silicone sealant -Shore A hardness of 25-30 -Joint movement range of +/-25% after 1 year
S-8	C-920-79 Type S Class 25 Grade NS	TT-S-1543(a) Class A	-One silicone, acetoxy cure, non-sag, silicone sealant -Shore A hardness of 25-30
S-9	C-920-79 Type S Class 25 Grade NS	TT-S-1543(a) Class A	-One component, non-sag, mildew resistant silicone sealant -Shore A hardness of 25-30
S-10	C-920-79 Type M/S Class 25	SS-S-200(d) Type H	-One or two component, coal tar extended, fuel resistant polyurethane sealant -Shore A hardness of 15-35

	Grade P/NS		
C-1	C-834-76	N/A	-Component acrylic latex caulking minimum 75% recovery per ASTM C-736-82
C-2	N/A/	TT-S-1657	-One component, butyl rubber caulking -Maximum joint movement of +/-5% after 1 year
C-3	N/A	N/A	-One component, acoustical caulking -Non-drying, non-hardening, synthetic rubber, normally not paintable
C-4	N/A	N/A	-One part, non-skinning, non-drying sealing compound meeting AAMA Spec. 809.1

Notes:

1. S = Sealant Type
2. C = Caulking Type

2.04 JOINT SEALANT BACKING

A. General: Provide sealant backings of material and type which are nonstaining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Plastic Foam Joint Fillers: Preformed, compressible, resilient, nonwaxing, nonextruding strips of flexible, nongassing plastic foam of material indicated below; nonabsorbent to water and gas; and of size, shape and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

1. Either open-cell polyurethane foam or closed-cell polyethylene foam, unless otherwise indicated, subject to approval of sealant manufacturer, for cold-applied sealants only.

C. Elastomeric Tubing Joint Fillers: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, capable of remaining resilient at temperatures down to -26 deg F (-15 deg C). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.

D. Bond-Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.05 MISCELLANEOUS MATERIALS

A. Primer: Provide type recommended by joint sealer manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealer-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Provide nonstaining, chemical cleaners of type which are acceptable to manufacturers of sealants and sealant backing materials, which are not harmful to substrates and adjacent nonporous materials, and which do not leave oily residues or otherwise have a detrimental effect on sealant adhesion or in-service performance.

C. Masking Tape: Provide nonstaining, nonabsorbent type compatible with joint sealants and

to surfaces adjacent to joints.

D. Accessory Materials for Fire-Stopping Sealants: Provide forming, joint fillers, packing and other accessory materials required for installation of fire-stopping sealants as applicable to installation conditions indicated.

2.06 JOINT FILLERS FOR CONCRETE PAVING

A. General: Provide joint fillers of thickness and widths indicated.

B. Bituminous Fiber Joint Filler: Preformed strips of composition below, complying with ASTM D 1751:

1. Asphalt saturated fiberboard.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine joints indicated to receive joint sealers, with Installer present, for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance. Do not proceed with installation of joint sealers until unsatisfactory conditions have been corrected. If the examination by the installer shows that conditions are not satisfactory, then the Resident Engineer is to be notified within 48 hours in writing of the unsatisfactory condition.

3.02 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements:

1. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust; paints, except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer; old joint sealers; oil; grease; waterproofing; water repellents; water; surface dirt; and frost.

2. Clean concrete, masonry, unglazed surfaces of ceramic tile and similar porous joint substrate surfaces, by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.

3. Remove laitance and form release agents from concrete.

4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile; and other nonporous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.

B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealer manufacturer based on preconstruction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond, do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such

contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Elastomeric Sealant Installation Standard: Comply with recommendations of ASTM C 962 for use of joint sealants as applicable to materials, applications and conditions indicated.

C. Latex Sealant Installation Standard: Comply with requirements of ASTM C 790 for use of latex sealants.

D. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:

E. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint fillers.
2. Do not stretch, twist, puncture, or tear joint fillers.
3. Remove absorbent joint fillers which have become wet prior to sealant application and replace with dry material.

F. Install bond breaker tape between sealants and joint fillers, compression seals, or back of joints where adhesion of sealant to surfaces at back of joints would result in sealant failure.

G. Install compressible seals serving as sealant backings to comply with requirements indicated above for joint fillers.

H. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.

I. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

J. Provide concave joint configuration per Figure 6A in ASTM C 962, unless otherwise indicated.

K. Provide flush joint configuration per Figure 6B in ASTM C 962, where indicated.

1. Use masking tape to protect adjacent surfaces of recessed tooled joints.

L. Provide Recessed joint configuration per Figure 6C in ASTM C 962, of recess depth and at locations indicated.

3.04 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

3.05 PROTECTION

A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and installations with repaired areas indistinguishable from original work.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the lump sum contract price.

END OF SECTION 07900

DIVISION 08 – OPENINGS

SECTION 08110

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes hollow metal doors and welded frames.

1. The integration of a security system into the hollow metal door and frame work is required. The Contractor shall be responsible for the total and complete coordination of the security system components into the Work.

1.2 ACTION SUBMITTALS

A. Product Data: Submit product data for each product indicated. Include material descriptions, core descriptions, label compliance, sound and fire-resistance ratings, and finishes for each type of door and frame specified.

B. Shop Drawings: Submit door and frame schedule using same reference designations indicated on Drawings. Include opening size(s), handing of doors, frame throat dimensions, details of each frame type, elevations of door design types, details of construction, location and installation requirements of door hardware and reinforcements, hardware group numbers, details of joints and connections, fire label requirements including fire rating time duration, maximum temperature rise requirements, and smoke label requirements.

1. Indicate routing of electrical conduit and dimensions and locations of cutouts in doors and frames to accept electric hardware devices.

C. Construction Samples Submit approximately 18 by 24 inches construction samples, representing the required construction of doors and frames for Project.

1. Doors: Show vertical-edge, top, and bottom construction; insulation; face stiffeners; and hinge and other applied hardware reinforcement. Include louver section and glazing stops if applicable.
2. Welded Frames: Show profile, welded corner joint, welded hinge reinforcement, dust-cover boxes, floor and wall anchors, stops, and silencers. Include panel and louver sections and glazing stops if applicable.

1.3 INFORMATIONAL SUBMITTALS

A. Certificate of Compliance for Fire Rated Doors: Provide copies of Certificate of Compliance for all fire rated door assemblies, all smoke and draft control door assemblies, and all temperature rise rated door assemblies.

B. Oversize Construction Certification: For door assemblies required to be fire rated and exceeding limitations of labeled assemblies, submit certification of a testing agency acceptable to authorities having jurisdiction that each door and frame assembly has been constructed to comply with design, materials, and construction equivalent to requirements for labeled construction.

1.4 QUALITY ASSURANCE

A. Hollow Metal Door and Frame Standard: Comply with the applicable provisions and recommendations of the following publications by Hollow Metal Manufacturers Association (HMMA) Div. of National Association of Architectural Metal Manufacturers (NAAMM), unless more stringent requirements are indicated in the Contract Documents:

1. HMMA "Hollow Metal Manual."
2. HMMA 861 "Guide Specifications for Commercial Hollow Metal Doors and Frames."
3. HMMA 866 "Guide Specifications for Stainless Steel Hollow Metal Doors and Frames."

B. Manufacturer Qualifications: A firm experienced in manufacturing hollow metal doors and frames similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 or UL 10C "Standard for Positive Pressure Fire Tests of Door Assemblies." Fire classification labels at all doors with fire ratings greater than 20 minutes shall indicate the temperature rise developed on the unexposed surface of the door after the first 30 minutes of fire exposure.

1. Provide metal labels permanently fastened on each door which is within the size limitations established by the labeling authority having jurisdiction.
2. Temperature-Rise Rating: Where indicated, provide doors that have a temperature-rise rating of 450 deg F (250 deg C) maximum in 30 minutes of fire exposure.
3. Positive Pressure Rated Door Assemblies: Where indicated provide positive pressure rated fire rated door assemblies. Sizes and configurations as shown on

the Drawings. Installed door assemblies shall be in accordance with door manufacturer's certified assemblies.

a. Test Pressure: Test according to NFPA 252 or UL 10C**.** After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches or less above the sill**.**

4. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

D. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palleted, wrapped, or crated to provide protection during transit and Project site storage.

B. Inspect doors and frames, on delivery, for damage. Tool marks, rust, blemishes, and other damage on exposed surfaces will not be acceptable. Remove and replace damaged items as directed by Architect. Store doors and frames at building site in a dry location, off the ground, and in such a manner as to prevent deterioration.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide doors and frames by one of, but not limited to, the following:

1. Hollow Metal Doors and Frames:

a. Ceco Door Products; an Assa Abloy Group Company.
b. Curries Company; an Assa Abloy Group Company.
c. Steelcraft; an Ingersoll-Rand Company.

2.2 MATERIALS

A. Hot-Rolled Steel Sheets: ASTM A 1008/A 1008M, CS (commercial steel), Type B; free of scale, pitting, or surface defects; pickled and oiled. Not less than 16 gauge, (0.053 inch) thick where frames are indicated to be built into exterior walls, hot dip galvanize after fabrication in compliance with ASTM A153/A153M, Class B.

B. Cold-Rolled Steel Sheets: ASTM A 1011/A 1011M, CS (commercial steel), Type B, free from scale, pitting, coil breaks, surface blemishes, buckles, waves, or other defects, exposed (matte) dull finish, suitable for exposed applications.

C. Metallic-Coated Steel Sheets: ASTM ASTM A 653/A 653M, CS (commercial steel), Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating, mill phosphatized.

D. Inserts, Bolts, and Fasteners: Galvanized or cadmium plated steel.

1. Expansion Bolts and Shields: FS FF-S-325, Group III, Type 1 or 2.
2. Machine Screws: FS FF-S-92, carbon steel, Type III cross recessed, design I or II recess, style 2C flat head.

E. Filler: Sound deadening and heat retarding mineral fiber insulating material.

F.

2.3 DOORS

A. General: Provide flush-design doors, 1-3/4 inches thick, of seamless hollow construction, unless otherwise indicated. Construct doors with sheets joined at their vertical edges by continuous welding the full height of the door, with no visible seams on their faces or vertical edges, and all welds ground and finished flush.

1. Visible joints or seams around glazed or louvered panel inserts are permitted.
2. For single-acting swing doors, bevel both vertical edges 1/8 inch in 2 inches.
3. For double-acting swing doors, round vertical edges with 2-1/8-inch radius.

B. Core Construction: Doors shall be stiffened by continuous vertically formed steel sections which, upon assembly, shall span the full thickness of the interior space between door faces. These stiffeners shall be 0.026-inch minimum thickness, spaced so that the vertical interior webs shall be not more than 6 inches apart and spot welded to face sheets a maximum of 5 inches o.c. Place filler between stiffeners for full height of door.

C. Fire Door Cores: A continuous mineral fiberboard core permanently bonded to the inside face of the outer face sheet unless otherwise required to provide fire-protection and temperature-rise ratings indicated.

D. Astragals: As required by NFPA 80 to provide fire ratings indicated.

E. Top and Bottom Channels: Spot weld metal channel not less than thickness of face sheet to face sheets not more than 6 inches o.c.

1. Reinforce tops and bottoms of doors with inverted horizontal channels of same material as face sheet so flanges of channels are even with bottom and top edges of face sheets.

F. Hardware Reinforcement: Fabricate reinforcing from the same material as door to comply with the following. Offset reinforcement so that faces of mortised hardware items are flush with door surfaces.

1. Hinges and Pivots: 7 gauge (0.167 inch) thick by 1-1/2 inches wide by 9 inches
2. Lock Front, Strike, and Flushbolt Reinforcements: 12 gauge (0.093 inch) thick by size as required by hardware manufacturer.
3. Lock Reinforcement Units: 14 gauge (0.067 inch) thick by size as required by hardware manufacturer.
4. Closer Reinforcements: 12 gauge (0.093 inch) thick one-piece channel by size as required by hardware manufacturer.
5. Other Hardware Reinforcements: As required for adequate strength and anchorage.
6. In lieu of reinforcement specified, hardware manufacturer's recommended reinforcing units may be used.
7. Exit Device Reinforcements: 0.250 inch thick by 10 inches high by 4 inches wide centered on exit device case body, unless otherwise recommended by exit device manufacturer.

G. Interior Hollow Metal Doors:

1. Typical Interior Doors: Flush design with 18 gauge (0.042-inch-) thick cold-rolled stretcher-leveled steel face sheets and other metal components from hot- or cold-rolled steel sheets.
2. Extra Heavy Use Doors: Flush design with 14 gauge (0.067-inch-) thick cold-rolled, stretcher-leveled steel face sheets and other metal components from hot- or cold-rolled steel sheets. Provide only where indicated.
3. Provide metallic-coated stretcher-leveled steel face sheets and other metal components at doors adjacent to corrosives storage areas and wet or high-humidity areas.

2.4 FRAMES

A. Fabricate hollow metal frames, formed to profiles indicated, with full 5/8 inch stops, and of the following minimum thicknesses.

1. For interior use, form frames from cold- rolled steel sheet of the following thicknesses:

a. Openings up to and Including 48 Inches Wide: 16 gauge (0.053 inch)
b. Openings More Than 48 Inches Wide: 14 gauge (0.067 inch)

c. Fabricate frames from metallic-coated steel sheet for openings adjacent to corrosives storage areas and wet or high- humidity areas.

B. Provide frames either saw mitered and full (continuously) profile welded, or machine mitered and full profile welded, on back side at frame corners and stops with edges straight and true. Grind welds smooth and flush on exposed surfaces.

C. Hardware Reinforcement: Fabricate reinforcements from same material as frame to comply with the following. Offset reinforcement so that faces of mortised hardware items are flush with surface of the frame.

1. Hinges and Pivots: 7 gauge (0.167 inch) thick by 1-1/4 inches wide by 10 inches.
2. Strike, Surface Mounted Hold Open Arms, and Flushbolt Reinforcements: 12 gauge (0.093 inch) thick by size as required by hardware manufacturer.
3. Closer Reinforcements: 12 gauge (0.093 inch) thick one piece channel by size as required by hardware manufacturer.
4. Other Hardware Reinforcements: As required for adequate strength and anchorage.

D. Jamb Anchors: Locate jamb anchors above hinges and directly opposite on strike jamb as required to secure frames to adjacent construction. At metal stud partitions locate the additional jamb anchor below the top hinge.

1. Masonry Construction: Adjustable, corrugated or perforated, anchors to suit frame size; formed of same material and gauge thickness as frame; at non-rated frames use friction fit T-shaped anchors, at rated frames use anchors consisting of spot welded strap and adjustable anchor; with leg not less than 2 inches wide by 10 inches long. Furnish at least the number of anchors per jamb according to the following frame heights:

a. Two anchors per jamb up to 60 inches in height.
b. Three anchors per jamb from 60 to 90 inches in height.
c. Four anchors per jamb from 90 to 96 inches in height.
d. One additional anchor per jamb for each 24 inches or fraction thereof more than 96 inches in height.

E. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, formed of same material as frame, 12 gauge (0.093 inch) thick, and punched with two holes to receive two (2) 0.375 inch fasteners. Where floor fill or setting beds occur support frame by adjustable floor anchors bolted to the structural substrate. Terminate bottom of frames at finish floor surface. Weld floor anchors to frames with at least 4 spot welds per anchor.

F. Head Strut Supports: Provide 3/8-by-2-inch vertical steel struts extending from top of frame at each jamb to supporting construction above. Bend top of struts to provide flush contact for securing to supporting construction above by bolting, welding, or other suitable anchorage. Provide adjustable wedged or bolted anchorage to frame

jamb members to permit height adjustment during installation. Adapt jamb anchors at struts to permit adjustment.

G. Head Reinforcement: For frames more than 48 inches wide in masonry wall openings, provide continuous steel channel or angle stiffener, 12 gauge (0.093 inch) thick for full width of opening, welded to back of frame at head. Head reinforcements shall not be used as a lintel or load-bearing member for masonry.

H. Spreader Bars: Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions to serve as bracing during shipment and handling and to hold frames in proper position until anchorage and adjacent construction have been completed.

I. Door Silencer Holes: Drill strike jamb stop to receive three silencers on single door frames and for two silencers on double door frames. Insert plastic plugs in holes to keep holes clear during installation.

J. Plaster Guards and Removable Access Plates: Provide 26 gauge (0.016-inch-) thick plaster guards or dust-cover boxes of same material as frame, welded to frame at back of hardware cutouts to close off interior of openings and prevent mortar or other materials from obstructing hardware operation. Provide removable access plates in the heads of frames to receive overhead concealed door closers.

2.5 STOPS AND MOLDINGS

A. Provide continuous stops and moldings around solid, glazed, and louvered panels where indicated.

B. Form fixed stops and moldings integral with frame, on the exterior (non-secured) side of the frame.

C. Provide removable stops and moldings formed of 20 gauge (0.032-inch-) thick steel sheets matching hollow metal frames. Secure with countersunk oval head machine screws spaced uniformly not more than 12 inches o.c. Form corners with butted or mitered hairline joints.

D. Coordinate rabbet width between fixed and removable stops with type of glass or panel and type of installation indicated.

2.6 FABRICATION

A. Fabricate doors and frames rigid, neat in appearance, and free of defects, warp, wave, and buckle. Accurately form metal to sizes and profiles indicated. Accurately machine, file, and fit exposed connections with hairline joints. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

B. Exposed Fasteners: Provide countersunk flat heads for exposed screws and bolts, unless otherwise indicated.

C. Hardware Preparation: Prepare doors and frames to receive hardware, including cutouts, reinforcement, mortising, drilling, and tapping, according to final hardware schedule and templates provided by hardware supplier. Secure reinforcement by spot welding. Comply with applicable requirements of ANSI/BHMA A156.115 and A156.115W specifications for door and frame preparation for hardware. Factory-reinforce doors and frames to receive surface-applied hardware. Factory drill and tap for surface-applied hardware, except at pushplates and kickplates provide reinforcing only.

1. Locate hardware as indicated on the Drawings or in Section 08 71 00 "Door Hardware" or, if not indicated, according to HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."

2.7 METALLIC-COATED STEEL FINISHES

A. General: Clean, treat and prime surfaces of fabricated steel door and frame work, inside and out, whether exposed or concealed in the construction.

B. Surface Preparation: Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

C. Factory Priming for Field-Painted Finish: Apply shop primer immediately after surface preparation and pretreatment. Apply a sufficient number of coats, baked on, to obtain uniformly smooth exposed surfaces. Touch up surfaces having runs, smears, or bare spots.

1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, primer complying with ANSI A250.10 acceptance criteria; recommended by primer manufacturer for zinc-coated steel; compatible with substrate and field-applied finish paint system indicated.

2.8 STEEL SHEET FINISHES

A. General: Clean, treat and prime surfaces of fabricated steel door and frame work, inside and out, whether exposed or concealed in the construction.

B. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale, shavings, filings, and rust, if present, complying with SSPC-SP 3, "Power Tool Cleaning."

C. Factory Priming for Field-Painted Finish: Apply shop primer immediately after surface preparation and pretreatment. Apply a sufficient number of coats, baked on, to obtain uniformly smooth exposed surfaces. Touch up surfaces having runs, smears, or bare spots.

1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, corrosion-inhibiting, lead- and chromate-free, universal primer complying with ANSI A250.10 acceptance criteria; compatible with substrate and field-applied finish paint system indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install doors and frames according to the referenced standards, the Architect reviewed shop drawings, and manufacturer's written recommendations and installation instructions.

B. Frames: Install frames where indicated. Extend frame anchorages below fills and finishes. Coordinate the installation of built-in anchors for wall and partition construction as required with other work.

1. Welded Frames:

a. Set masonry anchorage devices where required for securing frames to in-place concrete or masonry construction.

1) Set anchorage devices opposite each anchor location as specified and anchorage device manufacturer's written instructions. Leave drilled holes rough, not reamed, and free of dust and debris.

b. Placing Frames: Set frames accurately in position; plumb; align, and brace securely until permanent anchors are set.

1) At concrete or masonry construction, set frames and secure in place with machine screws and masonry anchorage devices. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
2) Anchor bottom of frames to floors through floor anchors with threaded fasteners.

3) Field splice only at approved locations indicated on the shop drawings. Weld, grind, and finish as required to conceal evidence of splicing on exposed faces.
4) Remove spreader bars only after frames are properly set and secured. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

2. At fire-rated openings, install frames according to NFPA 80.

C. Doors:

1. Non-Fire Rated Doors: Fit non-fire-rated doors accurately in their respective frames, with the following clearances:

a. Jambs and Head: 3/32 inch.
b. Meeting Edges, Pairs of Doors: 1/8 inch
c. Bottom: 3/8 inch if no threshold or carpet.
d. Bottom: 1/8 inch, at threshold or carpet.

2. Fire-Rated Doors: Install with clearances as specified in NFPA 80.
3. Smoke Control Doors: Install according to NFPA 105.

D. Apply hardware in accordance with hardware manufacturer's instructions and Section 08 71 00 "Door Hardware." Drill and tap for machine screws as required. Do not use self tapping sheet metal screws. Adjust door installation to provide uniform clearance at head and jambs, and to contact stops uniformly. Adjust hardware items just prior to final inspection. Leave work in complete and proper operating condition.

1. Field cut existing hollow metal doors and frames indicated to receive new hardware. Field cutting shall be executed in a workmanlike manner and shall not void the existing door and frame labeling.

3.2 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items just before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames that are warped, bowed, or otherwise unacceptable.

B. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

1. Finish Painting: Refer to Section 09911 " Painting."

C. Remove and replace defective work, including doors or frames that are warped, bowed, or otherwise defective.

D. Institute protective measures required throughout the remainder of the construction period to ensure that the hollow metal doors and frames will be without damage or deterioration, at time of Substantial Completion.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the lump sum contract price.

END OF SECTION 08110

DIVISION 8 – DOORS AND WINDOWS

SECTION 08305

ACCESS DOORS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes access doors for installation in the following types of construction:

1. Gypsum drywall.
2. Masonry.

B. Provide fire-rated access doors where access door penetrates a fire rated wall. Access door rating to equal wall fire rating.

1.02 RELATED DOCUMENTS

A. Drawings, general and special conditions, general requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 15 and 16 mechanical and electrical sections for equipment requiring access.

B. Building-in of anchors and grouting of frames set in masonry construction is specified in Section 04200, "Unit Masonry".

C. Roof hatches are specified in Section 07700, "Roof Specialties and Accessories".

D. Cylinders for access doors are specified in Section 08710, "Hardware".

E. Chute doors are specified with chute assemblies in Section 14560, "Chutes".

1.04 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data in form of manufacturer's technical data and installation instructions for each type of access door assembly, including setting drawings, templates, instructions, and directions for installation of anchorage, devices.

1. Include complete schedule, including types, general locations, sizes, wall and ceiling construction details, finishes, latching or locking provisions, and other data pertinent to installation.

C. Shop drawings showing fabrication and installation of customized access doors and frames, including details of each frame type, elevations of door design types, anchorage and accessory items.

D. Samples, 3 inches by 5 inches minimum size, of each panel face material showing

factory-finished color and texture.

1.05 QUALITY ASSURANCE

A. Single-Source Responsibility: Obtain access doors for entire project from one source from a single manufacturer.

B. Fire-Resistance Ratings: Wherever a fire-resistance classification is required, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in Underwriters Laboratories, Inc.'s "Building Materials Directory" for rating required.

1. Provide UL label on each fire-rated access door.

C. Size Variations: Obtain Resident Engineer's acceptance of manufacturer's standard size units, which may vary slightly from sizes indicated.

D. Coordination: Furnish inserts and anchoring devices that must be built into other work for installation of access doors. Coordinate delivery with other work to avoid delay.

1.06 PROJECT CONDITIONS

A. Verification: Obtain specific locations and sizes for required access doors from trades requiring access to concealed equipment, and indicate on submittal schedule.

B. Special-Size Access Doors: Use where required or requested; indicate on schedule.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering access doors that may be incorporated in the work include, but are not limited to, the following:

1. Elmdoor, Inc.

2.02 MATERIALS AND FABRICATION

A. General: Furnish each access door assembly manufactured as an integral unit, complete with all parts, and ready for installation.

B. Steel Access Doors and Frames: Fabricate units of continuous welded steel construction unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of support shown.

C. Frames: Fabricate from 16-gage steel.

1. Fabricate frame with exposed flange nominal 1-inch wide around perimeter of frame for units installed in the following construction:
   a. Exposed masonry.
   b. Exposed concrete.
   c. Drywall finish.
   d. Ceramic tile finish.

2. For gypsum drywall or gypsum veneer plaster, furnish perforated frames with drywall bead.

3. For installation in masonry construction, furnish frames with adjustable metal masonry anchors.

D. Flush Panel Doors: Fabricate from not less than 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees. Finish with manufacturer's factory-applied prime paint.

1. For fire-rated units, provide manufacturer's standard insulated flush panel/doors, with continuous piano hinge and self-closing mechanism.

2. For 2'-0" X 2'-0" or larger doors, provide minimum 3 hinges.

E. Locking Devices: Furnish flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with manufacturer's instructions for installation of access doors.

B. Coordinate installation with work of other trades.

C. Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.

D. Provide 2'x 2' access panels at each dynamic signage junction box.

3.02 ADJUST AND CLEAN

A. Adjust hardware and panels after installation for proper operation.

B. Remove and replace panels or frames that are warped, bowed, or otherwise damaged.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the lump sum contract price.

END OF SECTION 08305

SECTION 08710

HARDWARE

PART 1 - GENERAL

1.01 SUMMARY OF WORK

A. This section covers materials and installation of Architectural Hardware and Keying System.

1. Furnish all hardware required by the Contract Drawings and in accordance with these specifications.
   a. The specified hardware shall be purchased by the Contractor from the Hardware Supplier.
   b. The Contractor shall make all necessary arrangements for the purchase of the specified hardware with the Hardware Supplier, including scheduling, purchasing, delivery, training and warranty. The Contractor shall bear all storage, handling, transportation, training, administration and supervisory costs associated with the purchase of the specified hardware.
   c. The Contractor's warranties for the hardware and its installation are contained in Article 16 of the General Conditions. The one year warranty period set forth in General Condition 1601.3 shall be changed to two years.
2. Installation of all hardware shall be by this Contractor. Coordinate with electrical, door, and security system installation.
3. The Contractor shall coordinate the purchase, supply, deliver, scheduling, training, storage, installation and required Submittals of all hardware with the Hardware Supplier. Coordination shall include coordination of approved manufacturer type and model number for each item of hardware. The Contractor shall coordinate with the Hardware Manufacturer as required. The Contractor assumes the risk of nonperformance by the Hardware Supplier or Manufacturer.

1.02 DESIGN REQUIREMENTS

A. The drawings and schedules show the sizes and locations of plates and trim for door protection.

B. Hardware shall comply with requirements of DHI, BHMA, and ANSI standards.

C. Where required for handicap code hardware shall have a shape that is easy to grasp with one hand and does not require high grasping, tight pinching, or twisting of the wrist to operate. Lever type, push type mechanisms and "U" shape handles are acceptable designs.

D. Acceptable lockset manufacturer is Best Access Systems. No Substitutions.

1.03 HARDWARE MINIMUM CRITERIA

A. The following shall establish minimum criteria for architectural hardware and shall be coordinated through the Hardware Supplier:

B. Butts and Hinges:

1. Hinges shall conform to ANSI A156.1. Hinges used on metal doors and frames shall also conform to ANSI A156.7. Hinge size shall conform to the hinge manufacturer's printed recommendations and shall be indicated on the hardware schedule.

2. Hinges for reverse-bevel doors with locks shall have pins non-removable by means such as a set screw in the barrel. Set screw shall be inaccessible when the door is closed.

3. Hinges with anti-friction bearings may be furnished in lieu of ball bearing hinges unless prohibited by building codes.

4. Butt hinges shall conform to the following types unless otherwise specified under hardware sets:

	Wrought Steel		Wrought Brass or Bronze		Stainless Steel	
	Grade	Grade	Grade	Grade	Grade	Grade
CLASSIFICATION	1	2	1	2	1	2
a. Full Mortise	A8111	A8112	A2111	A2112	A5111	A5112
b. Half Mortise	A8211	A8212	A2211	A2212	A5211	A5212
c. Full Surface	A8311	A8312	A2311	A2312	A5311	A5312
d. Half Surface	A8411	A8412	A2411	A2412	A5411	A5412

5. Grade 1 hinges shall be used for doors subject to very high frequency use (more than 60,000 cycles per year), unusually heavy doors including all lead lined doors, doors 42 inches wide or wider, exterior doors equipped with overhead holders, and doors subject to other unusual stress conditions.

6. Grade 2 hinges shall be used for doors subject to high frequency use (10,000 to 60,000 cycles per year), outswinging exterior doors not equipped with overhead holders, and standard weight doors with closers.

7. Number of hinges shall be three hinges for each door leaf up to 5' high, four hinges for doors from 5' to 7'6" in height, and one additional hinge for each additional 30" or fraction thereof in height.

8. Height of hinge shall be 4-1/2” for doors up to and including 36” wide and 5” for doors 36” to 48”.

9. Exterior outswing doors shall be finished with non-ferrous hinges.

10. Refer to hardware schedule for specific requirements.

11. Acceptable hinge manufacturer is Hager. No Substitutions.

C. Pivots:

1. Pivots shall conform to ANSI A156.4. Pivots shall be Grade 1.

D. Continuous Hinges:

1. Continuous Hinges shall conform to ANSI A156.26.

2. Door hanging system is to be Hager ROTON Continuous Hinge manufactured of 6063-T6 anodized aluminum, non-handed and anodized as required by design. Hinges shall be manufactured of three interlocking components, two hinge leaves and one cover channel. The door leaf and jamb leaf shall be geared together for the entire length of the hinge, and joined by a cover channel. The pinless assembly of three interlocking extrusions shall be applied to the full height of the door and frame without mortising. All exposed working metal surfaces shall be coated with a TFE dry

lubricant. Vertical door loads shall be carried on Lubriloy™ RL bearings through a full 180º opening; no other substitute material will be accepted. Standard Duty Continuous Geared Hinges, up to 83", shall have 16 each bearings; Heavy Duty Hinges, up to 83" shall have 32 each bearings. Hinges of greater length will have proportionately greater number of bearings. Bearings are to be completely concealed in the cover channel. Hinge cover channel is to be monolithic in appearance and withstand 7000 foot pounds of pull apart pressure. Hinges with visible knuckle separations are not acceptable. Self-Drilling (Teks Point), hardened and plated steel fasteners 12-24 x 11/16", flat head undercut. Phillips head screws are to be furnished. All aluminum components are to be anodized in accordance with 202-R1 (AA-M12C22A21) Clear, as required by design. All fire rated hinges shall carry Underwriters Laboratory Inc. Certification, up to and including all 90-minute applications for wood doors, as well as 3-hour applications for all fire rated metal doors.

3. Acceptable continuous hinge manufacturer is Hager. No Substitutions.

E. Sliding and Folding Door Hardware:

1. Sliding and Folding Door Hardware shall conform to ANSI A156.14. Sliding and Folding Hardware shall be specified with the appropriate Grade for the test door weights listed in ANSI A156.14.

F. Locks and Latches:

1. Locks and Latches shall conform to ANSI A156.13. Locks, latches, and deadlocks shall be the products of a single manufacturer. Installed locksets shall provide the required degree of resistance to unauthorized entry. Type and Function shall be as specified under hardware sets. Series 1000, Grade 1 lever handles shall be either forged or solid cast and conform to ANSI A117. Series 1000 lock and latches shall have a latch with a minimum of 3/4 inches throw, and a deadbolt with a minimum of 1 inch throw.

2. Acceptable lock and latch manufacturer is Best Access Systems. No Substitutions.

G. Keypad Locksets:

1. Keypad locksets shall conform to ANSI A156.13. Locks shall have 12 position keypad design with audible and visual feedback. Locks shall include optional extended battery pack. Maximum of 50 users. All programming occurs through keypad.

2. Acceptable keypad lock manufacturer is Best Access Systems "EZ" Series. No Substitutions.

H. Exit Devices:

1. Exit devices shall conform to ANSI A156.3. Finish shall match that specified for lock trim. Exit devices shall be Grade 1. Type and Function shall be as specified under hardware sets. Exit devices to be Modern style, with touch pad in lieu of cross bar with lever arms, as called out in ANSI A156.3. Exit devices shall have a hydraulic sound damper to reduce noise of the operation of the device. All working parts must be made of stamped steel zincdichromate parts. No diecast, plastic, or cast brass parts shall be used. Only compression springs are acceptable in device mechanism. All surface strikes shall be roller type and come complete with a plate underneath to prevent movement. The latchbolt shall have a self-lubricating coating to reduce friction and wear. Plated latch bolts are unacceptable. Wherever possible all exit devices shall have deadlocking feature. If electric operation is required for use with security system, all rim, vertical rod, and mortise lock devices shall have the capability of electric latch retraction. Manufacturer shall have accessory products available

including power supplies, monitoring switches, and controls to complete the system. All components shall be UL listed. Manufacturer shall have a minimum of two years experience with electrified products installed in similar facilities. Exit Devices shall have manufacturers standard warranty for a minimum of three (3) years. The use of vertical rod devices is discouraged.

2. Acceptable lockset manufacturer is Von Duprin. No Substitutions.

I. Closers:

1. Closers shall conform to ANSI A156.4. Closers shall be Grade 1. Type and closer options to be selected for appropriate applications as recommended by closer manufacturer. Overhead closers shall have manufacturers standard warranty for a minimum of ten (10) years. Floor closers shall have a warranty for a minimum of ten (10) years. All closers to be specified with hydraulic backcheck. Separate adjusting valves shall be provided for closing speed, latching speed, and backcheck. Closers shall have multi-size spring power adjustment to permit setting of spring from (BF) 1 through 4 or 2 through 6 with additional spring power available. Closer may be deleted off HARDWARE SETS when not appropriate or required by code. All closers shall be furnished with sex nuts and bolts. Place closers inside building, stairs and rooms. Provide plates, brackets and special templating when needed for interface with particular header, door and wall conditions and neighboring hardware.

2. Acceptable closer manufacturer is Norton. No Substitutions. Use Norton 7500 at exterior doors and 7500BF at interior doors.

J. Low-Energy Power Operators:

1. Low-Energy power operators shall conform to ANSI A156.19. Furnish all labor, materials, equipment and services necessary for the proper installation of Low-Energy power operator handicap door system. Low-Energy power operators shall be completely electromechanical with microprocessor control, requiring no microswitches on the operator. The electrical contractor shall provide 115V., 60Hz., one-phase 15-amp supply to the door header. Also conduit and electrical boxes, if switches are remote. Doors shall be equipped with decal(s) visible from either side, instructing the user to the operation and function of the door. In the handicap mode, one of the activating switches on either side of the door is actuated and the door opens slowly-to backcheck (80º) in 3 to 6 seconds and to fully open position in 4 to 7 seconds. The door will remain open for a period of 5 seconds (the minimum

2. allowed by the ANSI standard) to 30 seconds as determined by the setting entered into the variable time delay on the control box. After the time delay, the door closes by the spring in the door operator from 90º to 10º in 3 to 6 seconds, and from 10º to fully closed in 1-1/2 to 2 seconds. The operator shall function as a manual door closer when not activated by activating switches.

3. Acceptable Low-energy power operator manufacturer is Dor-O-Matic Senior Swing. No Substitutions.

K. Door Trim:

1. Door trim shall conform to ANSI A156.6. Flat metal trim shall be a minimum of 0.050 inches (1.27mm) thick. Size and type Kick, Mop, and Armor plates are specified or shown on the drawings.

L. Weatherstrip and Thresholds:

1. Weatherstrip and Thresholds shall conform to ANSI A156.21 and ANSI A156.22. Type as scheduled.

2. Furnish surface mount fire rated door sweeps at openings where undercut of door exceeds requirements as listed in NFPA 80, Table 1-11.4 Clearances Under the Bottoms of Doors.

M. Auxiliary Hardware:

1. Auxiliary hardware shall conform to ANSI A156.16. Type as scheduled.

N. Wall and Floor Stops:

1. Wall shall conform to ANSI A156.16. Type as scheduled.
2. At openings where wall stops are inappropriate a “stop arm closer” at outswing doors or an overhead stop at inswing doors shall be used.

O. Electro-Magnetic Door Holders:

1. Electro-Magnetic door holders shall conform to ANSI A156.15.
2. Provide wall mounted Electro-Magnetic door holders having a holding power of 25-40 pounds.
3. All electrical wiring shall be concealed. Provide units with the required clearance needed for trim projection.
4. Provide units with triple voltage coils, 12VDC, 24VAC/DC, and 120VAC.
5. Anchor the electromagnet firmly since the wall portion will function as a door stop. Locate magnet approximately 6 inches in from lock edge of door. Wall magnets should be mounted approximately 2 to 4 feet above the floor for optimum performance.
6. All armatures shall have quick release button to aid in eliminating residual magnetism.
7. Acceptable Electro-Magnetic door holder manufacturer is Rixson. No Substitutions.

P. Overhead Stops and Holders:

1. Overhead stops and holders shall conform to ANSI A156.8.

Q. Electro-Mechanical and Security Hardware:

1. Due to the high level of security required by the F.A.A. for international airports, selective hardware will be required to be electrically actuated, controlled, and/or monitored as required by the security consultants. Coordinate equipment and related devices associated with security system with all trades affected, refer to Section 16722, "Computerized Card Access System." The Contractor shall install and test low voltage wiring between the electric hinge and the lockset. The Contractor shall assure that the templates provided by the Hardware supplier provides oversized openings in the hollow-metal jamb for wiring entrance of the electric hinge harness. The Contractor shall provide a plastic grommet in the wiring opening of the hollow-metal frame and door.
2. Intellikey Access Control: Where indicated in schedule this contractor shall furnish Intellikey Access Control consisting of ACS4000 Intelligent Lock Controller which consists of a circuit board with a microprocessor and associated circuitry. The miniature computer reads access information from an Intelligent Key, compares this information with the information programmed into the controller's memory, and determines if the key should be granted access. Each controller can operate as an independent, stand-alone unit. The controller right at the point of access makes all access control decisions. The controller's memory shall retain programming and audit trail information, even without batteries, for up to 100 years. The electronic controller

is designed to work with any Intellikey electronic cylinder. A typical installation consists of mounting the INTELLIKEY controller using an External slimline housing. The Intelligent Key carries the access control and personal identity data of the assigned keyholder. The Intelligent Key cannot be read or duplicated except by authorized personnel equipped with site-specific INTELLIKEY equipment. The Electronic Cylinder provides the link between the INTELLIKEY controller and key. INTELLIKEY controllers and keys communicate through an invisible, encrypted infrared link provided by the cylinder. INTELLIKEY cylinders are available as replacements for the standard cylinder types, including mortise and rim. The electronic cylinder may be configured for rotating operation. The Rotating Cylinder is used in conjunction with new or existing mechanical locking devices where rotation of the cylinder retracts or throws a latch bolt.

3. Photoelectric Sensor: Where indicated on Security System drawings this contractor shall furnish 18mm threaded barrel photoelectric sensor. Acceptable photoelectric sensor manufacturer Banner S18SN6L. No Substitutions.

4. Door Position Switch: Where indicated on Security System drawings this contractor shall furnish surface mount door position switch with 3' of stainless steel armored cable. Acceptable door position switch manufacturer Sentrol 2507A or Sentrol 2207A. No Substitutions.

R. Key Systems:

1. Locks: 3 keys for each lock

2. All keys to be nickel silver.

3. Cylinders shall be 7-pin interchangeable core. Facility locksmith shall determine keyway of cylinders.

4. Construction cores shall be supplied for construction phase keying. Contractor shall provide one new core for each lock to the Owner 60 calendar days prior to scheduled initial punchlist date. Permanent master keyed cores are to be installed by the Owner to replace construction cores. The construction core shall be returned to the supplier.

5. Acceptable key system manufacturer is Best Access Systems. No Substitutions.

1.04 QUALITY CONTROL

A. Manufacturer shall submit a certificate evidencing not less than five years' experience in the manufacturing and supplying of the types of products to that specified.

B. Hardware supplier: direct factory contract supplier who employs a certified architectural hardware consultant (AHC), available at reasonable times during course Work for project hardware consultation to Owner, Architect and Contractor and is responsible for detailing, scheduling and ordering of finish hardware.

C. Hardware for fire rated openings to comply with NFPA Standards 80 and 101.

D. Each type of hardware to be obtained from a single manufacturer.

E. Reference standards as applicable: DBC BHMA UL ANSI NFPA DHI

F. A warranty shall be required for a period of two years, by the Installer/Contractor.

G. Pre-Installation Conference: Prior to installation of hardware, this Contractor Installer to meet at the project site or other mutually agreed location with installers of related work,

General Contractor, Hardware Supplier, Security System Installer, and Project Manager. Record discussion and provide copy to each participant.

H. Coordinate power supply requirements for each electrically operated hardware device with Electrical/Security Contractor.

I. Security door equipment installation requirements: Prior to the installation of the Electronic Security Equipment, the Installer of the door and door hardware shall confirm in writing the following: 1) the door has been adjusted, 2) the door has been properly aligned on all sides, 3) the latch is working properly, 4) the closer is working properly. Submit copy to Project Manager.

J. The Electronic Equipment Installer shall inspect the door and door hardware installation and confirm in writing the door and hardware installation is acceptable for proper installation of the electronic equipment. 30 Days prior to installation, the Electronic Equipment supplier shall submit a current 'Access Control System' permit issued by the City and County of Denver Building Inspection Division.

K. Should any adjustment be required for the approval of the Security door system, the modifications and or adjustments must be made concurrently by the Electronic Equipment Installer and the Door Hardware Installer.

L. Coordinate all work with work of other trades.

1.05 SUBMITTALS

A. Manufacturer's technical data for each product specified.

B. The Hardware Supplier shall be required by the Contractor to submit templates with the Hardware Submittal.

1. Type, fastener, finish, style, function, size, quantity required, location, door and frame size, each hardware item.

2. Name of manufacturer of each item.

C. Operation and maintenance data.

D. Certification that materials are per contract requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Finishes for hardware shall be as follows with listed ANSI A156.18 designations.

1. Interior hinges - 652, Exterior hinges - 626 or 630, Locks and latchsets - 630, Exit devices – US32D, Door trim - 630, Closers - 689, Thresholds and weather-strip - manufacturers standard clear aluminum finish.

2. Use of other finishes shall not be accepted.

B. Templates: Furnish hardware templates to each fabricator of doors, frames and other work to be factory-prepared for the installation of hardware The Contractor shall check shop drawings of such other work, to confirm that adequate provisions are made for proper location and installation of hardware.

C. Refer to Hardware Schedule at the end of this Section.

2.02 PRODUCT HANDLING

A. The Hardware Supplier shall tag each item or package of items with identification related to final hardware schedule, and include basic installation instructions with each item or package.

B. Packaging of hardware, is responsibility of supplier. As material is received by Hardware Supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in same container.

C. Inventory hardware jointly with representatives of Hardware Supplier and Hardware Installer until each is satisfied that count is correct.

D. Deliver individually packaged hardware items at the proper times to the proper locations (shop or project site) for installation.

E. This contractor to securely lock-up hardware delivered to the project, but not yet installed. Control handling and installation of hardware items which are not immediately replaceable, so that completion of the work will not be delayed by hardware losses, both before and after installation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. This Hardware Contractor to examine and approve in writing the substrate and conditions under which work is to be preformed.

B. Hardware Contractor shall have a representative of the hardware manufacturer check all hardware for adjustment and installation prior to the Contractor’s request for final acceptance and notify in writing the Project Manager for contractor correction.

C. Mount hardware units at heights indicated in "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute, except as specifically indicated or required to comply with governing regulations, and except as may be otherwise directed by Project Manager.

D. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, coordinate removal, storage and reinstallation or application of surface protections with finishing work specified in the Division-9 sections. Do not install surface-mounted items until finishes have been completed on the substrate. NOTE: NO POWER DRIVEN TOOLS SHALL BE USED FOR INSTALLATION OF LOCKSETS AND HARDWARE ON DOORS. ALL HOLES SHALL BE PRE-DRILLED THE APPROPRIATE SIZE FOR THE FASTENERS.

E. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

F. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

G. Set thresholds for exterior doors in full bed of grout. Seal with butyl-rubber or polyisobutylene mastic sealant.

3.02 ADJUST AND CLEAN

A. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly as intended for the application made.

B. Clean adjacent surfaces soiled by hardware installation.

C. Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

D. Instruct Owner's personnel in proper adjustment and maintenance of and hardware finishes, during the final adjustment of hardware.

E. Continued Maintenance Service: Approximately six months after the acceptance of hardware in each area, the Installer, accompanied by the representative of the latch and lock manufacturer, shall return to the project and re-adjust every item of hardware to restore proper function of doors and hardware. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures. Replace hardware items that have deteriorated or failed due to faulty design, materials or installation of hardware units. Prepare a written report of current and predictable problems in the performance of the hardware.

3.03 HARDWARE SCHEDULE

A. Hardware Schedule Legend:

	ITEM	**MANUFACTURER**	**APPROVED SUBSTITUTES**
1.	Hinges Electric Hinges	(HA)Hager Hinge (HA)Hager Hinge	No Substitution No Substitution
2.	Locksets	(BE)Best Access Systems	No Substitution
3.	Cylinders	(BE)Best Access Systems	No Substitution
4.	Exit Devices	(VD)Von Duprin	No Substitution
5.	Closers	(NO)Norton	No substitution
6.	Trim	(TR)Trimco	Ives, Hager
7.	Magnetic Locks	(LO)Locknetics	No Substitution
8.	Threshold, Weatherstrip	(PE)Pemko	Reese, National Guard, Hager
9.	Auto Flush Bolt	(DC)Door Controls	Trimco, Ives
10.	Photoelectric Sensor	(BA)Banner	No Substitute
11.	Door Position Switch	(SE)Sentrol	No Substitute

12.	Intellikey Access Control	(IL)Intellikey	No Substitute

B. Hardware Schedule Notes:

1. Hardware specified is for typical doors. Doors that do not meet the criteria contained within the schedule contact DIA PERSONNEL for additional hardware requirements.
2. Delayed Egress Doors to be supplied as follows:
   a. All Hardware adjustments on the delayed egress doors are to be made by the Contractor, through a qualified technician. The final electrical connection to panic, magnetic lock, electric hinge, power supply/controller, reset switch, and horn will be by the Contractor in the presence of DIA PERSONNEL. Coordinate with the electrical, security, and fire alarm REPRESENTATIVES OF DIA. Contractor to install all approved electrical wires, power supplies, low voltage wiring, conduit, and devices.
   b. System must be U. L. listed and be approved by Denver Code Department, specifically for this project.
   c. Power supply for system shall be U. L. approved as a power supply.
   d. System, will not have manual reset at door. Reset is at Central Security.
   e. System shall conform to current building code section "Special Egress-Control Devices."
   f. Door frames shall be constructed to accept any special construction of the electric hinges, and electric eye recessed in the frame and magnetic holding device where applicable. Electric boxes or raceways need to be provided on or in the frame to accommodate these devices.

C. Schedule of Hardware: Each door shall have the hardware and trim as noted below

HW-8.6		
Door: Interior Mechanical and Electrical Pair with Storeroom Lock, Labeled. Occupied.		
4 pr.	BUTTS	(HA) BB1168 4.5 X 4.5
1 ea.	STOREROOM LOCKSET	(BE) 35H 7EW 14H
1 ea.	INTELLIKEY ACCESS CONTROL	(IL) 00004 (INCLUDES CONTROLLER AND CYLINDER)
1 set	AUTO FLUSH BOLTS	(DC) 842 OR 942
1 ea.	DUSTPROOF STRIKE	(DC) 80
1 ea.	CO-ORDINATOR	(DC) 600 SERIES WITH FILLER BAR
2 ea.	CLOSER	(NO) 7500BF
2 ea.	KICKPLATES	(TR) 12" X 2" L.D.W. X .050"
2 ea.	WALL STOPS	(TR) 1270WXCP
1 ea.	ASTRAGAL	(PE) 355AS
1 set	SMOKE SEAL	(PE) S88D HEAD AND JAMBS
	Electrical rooms where equipment is rated 1200 amperes or more and over 1.8 m (6 ft) wide that contains overcurrent devices, switching devices, or control devices and where the entrance has a personal door(s), the door(s) shall open in the direction of egress and be equipped with panic bars. Coordinate with Electrical Engineer.	

HW-9.4

Door: Interior Door to Mechanical and Electrical Areas, Labeled.		
2 pr.	BUTTS	(HA) BB1279 4.5 X 4.5
1 ea.	STOREROOM LOCKSET	(BE) 35H 7EW 14H
1 ea.	INTELLIKEY ACCESS CONTROL	(IL) 00004 (INCLUDES CONTROLLER AND CYLINDER)
1 ea.	CLOSER	(NO) 7500BF
1 ea.	KICKPLATE	(TR) 12" X 2" L.D.W. X .050"
1 ea.	WALL STOP	(TR) 1270WXCP
1 set	SMOKE SEAL	(PE) S88D HEAD AND JAMBS
	Electrical rooms where equipment is rated 1200 amperes or more and over 1.8 m (6 ft) wide that contains overcurrent devices, switching devices, or control devices and where the entrance has a personal door(s), the door(s) shall open in the direction of egress and be equipped with panic bars. Coordinate with Electrical Engineer.	

CYLINDERS TO BE PROVIDED FOR WORK OF OTHER TRADES.

HW-06400	Best 5L Series Cylinder for Cabinets.
HW-8305	Best 1E or 5E Series Cylinder for Access Doors.
HW-8311	Best 1E74 Series for Aluminum Sliding Glass Doors.
HW-8330	Best 1E74 or 1E72 Series for Overhead Coiling Doors.
HW-8900	Best 1E74 Series for Doors in Curtainwall.
HW-14240	Best 1E74 Cylinder for Hydraulic Elevators.
HW-14310	Best 1E74 Cylinder for Escalators.

D. For other Sections requiring cylinders supplied by this Section, provide cylinder recommended by the Manufacturer.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 08710

DIVISION 09 – FINISHES

SECTION 09255

GYPSUM BOARD FINISHES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Nonload-bearing steel framing members for gypsum board assemblies.
2. Gypsum board assemblies attached to steel framing.

B. Related Work Specified Elsewhere:

1. For load-bearing steel framing: SECTION 05400.
2. For fireproofing structural steel members concealed behind gypsum board assemblies: SECTION 07811.
3. For joint sealers: SECTION 07900

1.02 REFERENCES

A. American National Standards Institute (ANSI):

1. A108.11 - Interior Installation of Cementitious Backer Units.
2. A118.9 - Cementitious Backer Units.

B. American Society for Testing and Materials (ASTM):

1. A568/A568MN - Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements.
2. A641/A641M - Zinc-Coated (Galvanized) Carbon Steel Wire.
3. A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. B221 - Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
5. B221M - Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
6. C11 - Terminology Relating to Gypsum and Related Building Materials and Systems.
7. C36/C36M - Gypsum Wallboard.
8. C423 - Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
9. C475 - Joint Compound and Joint Tape for Finishing Gypsum Board.
10. C514 - Nails for the Application of Gypsum Wallboard.
11. C557 - Adhesives for Fastening Gypsum Wallboard to Wood Framing.
12. C578 - Rigid, Cellular Polystyrene Thermal Insulation.
13. C630/C630M - Water-Resistant Gypsum Backing Board.

14. C645 - Nonload (Axial) Bearing Steel Studs, Runners (Track) and Rigid Furring Channels for Screw Application of Gypsum Board.
15. C665 - Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
16. C754 - Installation of Steel Framing Members to Receive Screw-Attached Gypsum Board.
17. C834 - Latex Sealants..
18. C840 - Application and Finishing of Gypsum Board.
19. C919 - Practices for Use of Sealants in Acoustical Applications.
20. C931/C931M - Exterior Gypsum Soffit Board.
21. C954 - Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
22. C1002 - Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
23. C1047 - Accessories for Gypsum Wallboard and Gypsum Veneer Base.
24. C1178/C1178M - Glass Mat Water-Resistant Gypsum Backing Board.
25. D226 - Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
26. D4397 - Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
27. E84 - Test Method for Surface Burning Characteristics of Building Materials.
28. E90 - Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
29. E119 - Method for Fire Tests of Building Construction and Materials.
30. E413 - Classification for Rating Sound Insulation.
31. E488 - Test Method for Strength of Anchors in Concrete and Masonry Elements.
32. E1190 - Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members.

C. Gypsum Association (GA):

1. 214 - Recommended Specification: Levels of Gypsum Board Finish.
2. 216 - Application and Finishing of Gypsum Board.
3. 600 - Fire Resistance Design Manual.

D. Underwriters Laboratories (UL):

1. Fire Resistance Directory.

E. United States Gypsum Co.

1. Gypsum Construction Handbook.

1.03 DEFINITIONS

A. Gypsum Board Construction Terminology: Refer to ASTM C11 for definitions of terms for

gypsum board assemblies not defined in this Section or in other referenced standards.

1.04 ASSEMBLY PERFORMANCE REQUIREMENTS

A. .

B. Fire Resistance: Provide gypsum board assemblies with fire-resistance ratings indicated.

1.05 SUBMITTALS

A. General: Submit in accordance with DIVISION 1.

B. Product Data for each type of product specified.

C. Shop Drawings showing locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.

1.06 QUALITY ASSURANCE

A. Single-Source Responsibility for Steel Framing: Obtain steel framing members for gypsum board assemblies from a single manufacturer, unless otherwise indicated.

B. Single-Source Responsibility for Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.

C. Single-Source Responsibility for Finishing Materials: Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to gypsum board manufacturer.

D. Fire-Test-Response Characteristics: Where fire-resistance-rated gypsum board assemblies are indicated, provide gypsum board assemblies that comply with the following requirements:

1. Fire-Resistance Ratings: As indicated by GA File Numbers in GA-600 "Fire Resistance Design Manual" or design designations in UL "Fire Resistance Directory" or in the listing of another testing and inspecting agency acceptable to authorities having jurisdiction.

2. Gypsum board assemblies indicated are identical to assemblies tested for fire resistance according to ASTM E119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack gypsum panels flat to prevent sagging.

1.08 PROJECT CONDITIONS

A. Environmental Conditions, General: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C840 requirements or gypsum

board manufacturer's recommendations, whichever are more stringent.

B. Room Temperatures: For nonadhesive attachment of gypsum board to framing, maintain not less than 40°F (4°C). For adhesive attachment and finishing of gypsum board, maintain not less than 50ºF (10°C) for 48 hours before application and continuously after until dry. Do not exceed 95° (35°C) when using temporary heat sources.

C. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Steel Framing and Furring:
   a. Clark Steel Framing, Inc.
   b. Consolidated Systems, Inc.
   c. Dale Industries, Inc.
   d. Dietrich Industries, Inc.
   e. National Gypsum Co.; Gold Bond Building Products Division.
   f. Unimast, Inc.
   g. Substitutions per Division 1
2. Grid Suspension Assemblies:
   a. Armstrong World Industries, Inc.
   b. Chicago Metallic Corp.
   c. USG Interiors, Inc.
   d. Worthington Steel Company (formerly National Rolling Mills).
   e. Substitutions per Division 1
3. Gypsum Board and Related Products:
   a. American Gypsum Co.
   b. Georgia-Pacific Corp.
   c. National Gypsum Co.; Gold Bond Building Products Division.
   d. United States Gypsum Co.
   e. Substitutions per Division 1

2.02 STEEL FRAMING FOR WALLS AND PARTITIONS

A. General: Provide steel framing members complying with the following requirements:

1. Protective Coating:
   a. ASTM A653, G40 (ASTM A653M, Z90) hot-dip galvanized coating.

B. Steel Studs and Runners: ASTM C645, with flange edges of studs bent back 90° and doubled over to form 3/16-inch- (5-mm-) wide minimum lip (return), and complying with the following requirements for minimum thickness of base (uncoated) metal and for depth:

1. Thickness:
   a. 0.0179-inch (0.45 mm), unless otherwise indicated.

1) For head runner, sill runner, jamb, and cripple studs at door and other openings.

2. Depth:
   a. 3-5/8 inches (92.1 mm), unless otherwise indicated.

C. Deflection Track: Manufacturer's top runner complying with the requirements of ASTM C645 and with 2-inch- (50.8-mm-) deep flanges.

D. Steel Rigid Furring Channels: ASTM C645, hat shaped, depth and minimum thickness of base (uncoated) metal as follows:

1. Thickness:
   a. 0.0179-inch (0.45 mm), unless otherwise indicated.
2. Depth:
   a. 7/8 inch (22.2 mm).

E. Furring Brackets: Serrated-arm type, adjustable, fabricated from corrosion-resistant steel sheet complying with ASTM C645, minimum thickness of base (uncoated) metal of 0.0329 inch (0.84 mm), designed for screw attachment to steel studs and steel rigid furring channels used for furring.

F. Steel Flat Strap and Backing Plate: Steel sheet for blocking and bracing complying with ASTM A653 (ASTM A653M) or ASTM A568 (ASTM A568M), length and width as indicated, and with a minimum base metal (uncoated) thickness as follows:

1. Thickness:
   a. 0.0179-inch (0.45 mm), unless otherwise indicated.

G. Fasteners for Metal Framing: Provide fasteners of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel framing and furring members securely to substrates involved; complying with the recommendations of gypsum board manufacturers for applications indicated.

2.03 GYPSUM BOARD PRODUCTS

A. General: Provide gypsum board of types indicated in maximum lengths available that will minimize end-to-end butt joints in each area indicated to receive gypsum board application.

1. Width:
   a. Provide gypsum board in widths of 48 inches (1219 mm).

B. Gypsum Wallboard: ASTM C36 and as follows:

1. Type:
   a. Type X where required for fire-resistance-rated assemblies.
2. Edges:
   a. Tapered.
3. Thickness:
   a. 5/8-inch (15.9 mm) where indicated.

C. Gypsum Board Base Layer(s) for Multilayer Applications: Gypsum wallboard, ASTM C36, and as follows:

1. Type:
    a. Type X where indicated or required for fire-resistance-rated assemblies.
2. Edges:
    a. Manufacturer's standard.
3. Thickness:
    a. 5/8 inch (15.9 mm) where indicated.

2.04 TRIM ACCESSORIES

A. Accessories for Interior Installation: Cornerbead, edge trim, and control joints complying with ASTM C1047 and requirements indicated below:

1. Material: Formed metal or plastic, with metal complying with the following requirement:
    a. Steel sheet zinc coated by hot-dip process or rolled zinc.
2. Shapes indicated below by reference to Fig. 1 designations in ASTM C1047:
    a. Cornerbead on outside corners, unless otherwise indicated.
    b. L-bead with face flange only; face flange formed to receive joint compound. Use L-bead where indicated.

2.05 JOINT TREATMENT MATERIALS

A. General: Provide joint treatment materials complying with ASTM C475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.

B. Joint Tape for Gypsum Board: Paper reinforcing tape, unless otherwise indicated.

C. Setting-Type Joint Compounds for Gypsum Board: Factory-packaged, job-mixed, chemical-hardening powder products formulated for uses indicated.

1. Where setting-type joint compounds are indicated as a taping compound only or for taping and filling only, use formulation that is compatible with other joint compounds applied over it.
2. Ready-Mixed Formulation: Factory-mixed product.
    a. Taping compound formulated for embedding tape and for first coat over fasteners and face flanges of trim accessories.
    b. Topping compound formulated for fill (second) and finish (third) coats.
    c. All-purpose compound formulated for both taping and topping compounds.

2.06 ACOUSTICAL SEALANT

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C834 and the following requirements:

1. Product is effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.

B. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing

interior concealed joints to reduce transmission of airborne sound.

C. Products: Subject to compliance with requirements, provide one of the following:

1. Acoustical Sealant for Exposed and Concealed Joints:
   a. PL Acoustical Sealant; ChemRex, Inc.; Contech Brands.
   b. AC-20 FTR Acoustical and Insulation Sealant; Pecora Corp.
   c. SHEETROCK Acoustical Sealant; United States Gypsum Co.

2.07 MISCELLANEOUS MATERIALS

A. General: Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.

B. Steel drill screws complying with ASTM C1002 for the following applications:

1. Fastening gypsum board to steel members less than 0.033 inch (0.84 mm) thick.
2. Fastening gypsum board to gypsum board.

C. Sound-Attenuation Blankets: Unfaced mineral-fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C665 for Type I (blankets without membrane facing).

1. Mineral-Fiber Type:
   a. Fibers manufactured from glass, slag wool, or rock wool.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Before sprayed-on fireproofing is applied, attach offset anchor plates or ceiling runners

3.03 INSTALLING STEEL FRAMING, GENERAL

A. Steel Framing Installation Standard: Install steel framing to comply with ASTM C754 and with ASTM C840 requirements that apply to framing installation.

B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with recommendations of gypsum board manufacturer or, if none available, with United States Gypsum Co. "Gypsum Construction Handbook."

C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement. Comply with details shown on Drawings.

1. Where partition framing and wall furring abut structure, except at floor.

a. Provide slip- or cushioned-type joints as detailed to attain lateral support and avoid axial loading.

b.

D. Do not bridge building control and expansion joints with steel framing or furring members. Independently frame both sides of joints with framing or furring members as indicated.

3.04 INSTALLING STEEL FRAMING FOR WALLS AND PARTITIONS

A. Install runners (tracks) at floors, ceilings, and structural walls and columns where gypsum board stud assemblies abut other construction.

B. Installation Tolerances: Install each steel framing and furring member so that fastening surfaces do not vary more than 1/8-inch (3 mm) from the plane formed by the faces of adjacent framing.

C. Install steel studs and furring in sizes and at spacings indicated.

1. Multilayer Construction: Space studs 24 inches (610 mm) o.c., unless otherwise indicated.

2.

D. Install steel studs so flanges point in the same direction and leading edge or end of each gypsum board panel can be attached to open (unsupported) edges of stud flanges first.

1. Attach runners to structural elements at floor and ceiling with fasteners located 50 mm from ends and spaced 600 mm o.c.

2. Position studs vertically with open sides facing in same direction and engaging floor and ceiling runners. Begin and end each arc with a stud and space intermediate studs equally along arcs at stud spacing recommended by gypsum board manufacturer for radii indicated. Attach studs to runners with 3/8-inch- (9.5-mm-) long pan head framing screws. On straight lengths at ends of arcs, place studs 6 inches (150 mm) o.c. with last stud left free standing.

3.05 APPLYING AND FINISHING GYPSUM BOARD, GENERAL

A. Gypsum Board Application and Finishing Standards: Install and finish gypsum panels to comply with ASTM C840 and GA-216.

B. Install sound-attenuation blankets, where indicated, prior to installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

C. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

D. Locate both edge or end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Avoid joints other than control joints at corners of framed openings where possible.

E. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

F. Attach gypsum panels to framing provided at openings and cutouts.

3.06 GYPSUM BOARD APPLICATION METHODS

A. Multilayer Application on Partitions/Walls: Apply gypsum board indicated for base layers and gypsum wallboard face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints. Stagger joints on opposite sides of partitions.

B. Multilayer Fastening Methods: Apply base layers of gypsum panels and face layer to base layers as follows:

1. Fasten both base layers and face layers separately to supports with screws.

3.07 INSTALLING TRIM ACCESSORIES

A. General: For trim accessories with back flanges, fasten to framing with the same fasteners used to fasten gypsum board. Otherwise, fasten trim accessories according to accessory manufacturer's directions for type, length, and spacing of fasteners.

B. Install cornerbead at external corners.

C. Install edge trim where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound, except where other types are indicated.

1. Install LC-bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.

2. Install L-bead where edge trim can only be installed after gypsum panels are installed.

3.08 FINISHING GYPSUM BOARD ASSEMBLIES

A. General: Treat gypsum board joints, interior angles, flanges of cornerbead, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.

B. Prefill open joints, rounded or beveled edges, and damaged areas using setting-type joint compound.

C. Apply joint tape over gypsum board joints, except those with trim accessories having flanges not requiring tape.

D. Levels of Gypsum Board Finish: Provide the following levels of gypsum board finish per GA-214.

1. Level 4 for gypsum board surfaces, unless otherwise indicated.

E. Use one of the following joint compound combinations as applicable to the finish levels specified:

1. Embedding and First Coat: Setting-type joint compound. Fill (Second) Coat: Setting-type joint compound. Finish (Third) Coat: Ready-mixed, drying-type, all-purpose or topping compound.

2. Embedding and First Coat: Ready-mixed, drying-type, all-purpose or taping compound. Fill (Second) Coat: Ready-mixed, drying-type, all-purpose or topping compound. Finish (Third) Coat: Ready-mixed, drying-type, all-purpose or topping

compound.

F. For Level 4 gypsum board finish, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects and ready for decoration.

3.09 CLEANING AND PROTECTION

A. Promptly remove any residual joint compound from adjacent surfaces.

B. Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure gypsum board assemblies are without damage or deterioration at the time of Substantial Completion.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 09255

DIVISION 9 - FINISHES

SECTION 09911

PAINTING (CONSUMER LINE PRODUCTS)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes surface preparation and field painting of exposed interior items and surfaces.

1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

B. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.

1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1. Prefinished items include the following factory-finished components:
   a. Finished mechanical and electrical equipment.
   b. Light fixtures.
2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
   a. Foundation spaces.
   b. Furred areas.
   c. Ceiling plenums.
   d. Utility tunnels.
   e. Pipe spaces.
   f. Duct shafts.
3. Finished metal surfaces include the following:
   a. Stainless steel.
   b. Copper and copper alloys.
   c. Bronze and brass.
4. Operating parts include moving parts of operating equipment and the following:
   a. Valve and damper operators.

b. Linkages.
c. Sensing devices.
d. Motor and fan shafts.

5. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Related Sections include the following:

1. Division 5 Section "Structural Steel" for shop priming structural steel.
2. Division 5 Section "Metal Fabrications" for shop priming ferrous metal.
3. Division 8 Section "Steel Doors and Frames" for factory priming steel doors and frames.
4. Division 9 Section "Gypsum Board Assemblies" for surface preparation of gypsum board.
5. Division 9 Section "High-Performance Coatings" for industrial paints and maintenance and for special coatings.

1.03 DEFINITIONS

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.

1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
2. Eggshell refers to los-sheen finish with a floss range between 20-35 when measured at a 60-degree meter.Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.

1.04 SUBMITTALS

A. Product Data: For each paint system indicated. Include block fillers and primers.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

B. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.

1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
   a. Concrete6-by-10 inch Samples for each color and finish.
   b. Concrete Unit Masonry: 6-by-10-inchSamples of masonry, with mortar joint in the center, for each finish and color.
   c. Ferrous Metal: 4-inchsquare Samples of flat metal and 8-inchlong Samples of solid metal for each color and finish.

C. Qualification Data: For Applicator.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Source Limitations: Obtain [block fillers] [and] [primers] for each coating system from the same manufacturer as the finish coats.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain storage containers in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily.

1.07 PROJECT CONDITIONS

A. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 deg F.

B. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.08 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.

1. Quantity: Furnish Owner with 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

C. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Benjamin Moore & Co. (Benjamin Moore).
2. Coronado Paint Company (Coronado).
3. ICI Dulux Paint Centers (ICI Dulux Paints).
4. Kelly-Moore Paint Co. (Kelly-Moore).
5. M. A. Bruder & Sons, Inc. (M. A. B. Paint).
6. PPG Industries, Inc. (Pittsburgh Paints).
7. Sherwin-Williams Co. (Sherwin-Williams).

2.02 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. Colors: As indicated by manufacturer's designations.

2.03 CONCRETE UNIT MASONRY BLOCK FILLERS

A. Concrete Unit Masonry Block Filler: Factory-formulated high-performance latex block fillers.

1. Benjamin Moore; Moorcraft Super Craft Latex Block Filler No. 285: Applied at a dry film thickness of not less than 8.1 mils.
2. Coronado; 946-11 Super Kote 5000 Commercial Latex Block Filler: Applied at a dry film thickness of not less than 8.4 mils.
3. ICI Dulux Paints; Bloxfil 4000-1000 Interior/Exterior Heavy Duty Acrylic Block Filler: Applied at a dry film thickness of not less than 7.0 to 14.5 mils.
4. Kelly-Moore; 521 Fill and Prime Acrylic Block Filler: Applied at a dry film thickness of not less than 10.0 mils.
5. M. A. B. Paint; Block Kote No. 1000 Acrylic Latex Block Filler 064-145: Applied at a dry film thickness of not less than 12.0 mils.
6. Pittsburgh Paints; 6-7 SpeedHide Interior/Exterior Masonry Latex Block Filler: Applied at a dry film thickness of not less than 6.0 to 12.5 mils.

7. Sherwin-Williams; PrepRite Interior/Exterior Block Filler B25W25: Applied at a dry film thickness of not less than 8.0 mils.

2.04 INTERIOR PRIMERS

A. Interior Concrete and Masonry Primer: Factory-formulated alkali-resistant acrylic-latex interior primer for interior application.

1. Benjamin Moore; Regal FirstCoat Interior Latex Primer & Underbody No. 216: Applied at a dry film thickness of not less than 1.0 mil.
2. Coronado; 78-11 Super Kote 5000 Acrylic Enamel Undercoat: Applied at a dry film thickness of not less than 1.6 mils.
3. ICI Dulux Paints; 1000-1200 Dulux Ultra Basecoat Interior Latex Wall Primer: Applied at a dry film thickness of not less than 1.2 mils.
4. Kelly-Moore; 971 Acry-Prime Interior Latex Primer/Sealer: Applied at a dry film thickness of not less than 1.6 mils.
5. M. A. B. Paint; Rich Lux Prime Fast 037-138: Applied at a dry film thickness of not less than 1.5 mils.
6. Pittsburgh Paints; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil.
7. Sherwin-Williams; PrepRite Masonry Primer B28W300: Applied at a dry film thickness of not less than 3.0 mils.

B. Interior Gypsum Board Primer: Factory-formulated latex-based primer for interior application.

1. Benjamin Moore; Regal FirstCoat Interior Latex Primer & Underbody No. 216: Applied at a dry film thickness of not less than 1.0 mil.
2. Coronado; 40-11 Super Kote 5000 Latex Primer-Sealer: Applied at a dry film thickness of not less than 1.1 mils.
3. ICI Dulux Paints; 1000-1200 Dulux Ultra Basecoat Interior Latex Wall Primer: Applied at a dry film thickness of not less than 1.2 mils.
4. Kelly-Moore; 971 Acry-Prime Interior Latex Primer/Sealer: Applied at a dry film thickness of not less than 1.6 mils.
5. M. A. B. Paint; Rich Lux Prime Fast 037-138: Applied at a dry film thickness of not less than 1.5 mils.
6. Pittsburgh Paints; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil.
7. Sherwin-Williams; PrepRite 200 Latex Wall Primer B28W200 Series: Applied at a dry film thickness of not less than 1.6 mils.
8. Sherwin-Williams; PrepRite Masonry Primer B28W300 Series: Applied at a dry film thickness of not less than 3.0 mils.

C. Interior Ferrous-Metal Primer: Factory-formulated quick-drying rust-inhibitive alkyd-based metal primer.

1. Benjamin Moore; IronClad Alkyd Low Lustre Medal and Wood Enamel No. 163: Applied at a dry film thickness of not less than 1.3 mils.
2. Coronado; 35-147 Rust Scat Alkyd Metal Primer: Applied at a dry film thickness of

not less than 1.8 mils.

3. ICI Dulux Paints; 4130-6130 Devshield Rust Penetrating Metal Primer: Applied at a dry film thickness of not less than 2.2 mils.
4. ICI Dulux Paints; 4160-6130 Devguard Multi-Purpose Tank & Structural Primer: Applied at a dry film thickness of not less than 2.0 mils.
5. Kelly-Moore; 1711 Kel-Guard Alkyd White Rust Inhibitive Primer: Applied at a dry film thickness of not less than 2.0 mils.
6. M. A. B. Paint; Rust-O-Lastic Anti-Corrosive Primer 073-132: Applied at a dry film thickness of not less than 2.0 mils.
7. Pittsburgh Paints; 7-858 Pittsburgh Paints Industrial Rust Inhibitive Steel Primer: Applied at a dry film thickness of not less than 1.5 mils.
8. Sherwin-Williams; Kem Kromik Universal Metal Primer B50NZ6/B50WZ1: Applied at a dry film thickness of not less than 3.0 mils.

D. Interior Zinc-Coated Metal Primer: Factory-formulated galvanized metal primer.

1. Benjamin Moore; IronClad Latex Low Lustre Metal and Wood Enamel No. 363: Applied at a dry film thickness of not less than 1.6 mils.
2. Coronado; 36-11 Rust Scat Latex Metal Primer: Applied at a dry film thickness of not less than 1.3 mils.
3. ICI Dulux Paints; 4160-6130 Devguard Multi-Purpose Tank & Structural Primer: Applied at a dry film thickness of not less than 2.0 mils.
4. Kelly-Moore; 1722 Kel-Guard Acrylic Galvanized Iron Primer: Applied at a dry film thickness of not less than 1.8 mils.
5. M. A. B. Paint; Rust-O-Lastic Hydro-Prime II Acrylic (DTM) Maintenance Primer 073-189: Applied at a dry film thickness of not less than 2.0 mils.
6. Pittsburgh Paints; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils.
7. Sherwin-Williams; primer not required over this substrate.
8. Sherwin-Williams; Galvite Paint B50W3: Applied at a dry film thickness of not less than 2.0 mils.

2.05 INTERIOR FINISH COATS

A. Interior Flat Acrylic Paint: Factory-formulated flat acrylic-emulsion latex paint for interior application.

1. Benjamin Moore; Regal Wall Satin No. 215 Premium Interior Finishes Flat Finish: Applied at a dry film thickness of not less than 1.3 mils.
2. Coronado; 26 Line Gold Acrylic Latex Flat Wall Paint: Applied at a dry film thickness of not less than 1.1 mils.
3. ICI Dulux Paints; 1201-XXXX Dulux Ultra Velvet Sheen Interior Flat Latex Wall & Trim Finish: Applied at a dry film thickness of not less than 1.7 mils.
4. Kelly-Moore; 550 Super Latex Interior Flat Wall Paint: Applied at a dry film thickness of not less than 1.9 mils.
5. M. A. B. Paint; Rich Lux Wal-Shield Latex Flat 041 Line: Applied at a dry film thickness of not less than 1.5 mils.

6. Pittsburgh Paints; 80-Line Wallhide Interior Wall Flat Latex Paint: Applied at a dry film thickness of not less than 1.2 mils.

7. Sherwin-Williams; SuperPaint Interior Latex Flat Wall Paint, A86 Series: Applied at a dry film thickness of not less than 1.5 mils.

B. Interior Flat Latex-Emulsion Size: Factory-formulated flat latex-based interior paint.

1. Benjamin Moore; Colorscapes Interior Latex Flat No. 515: Applied at a dry film thickness of not less than 1.4 mils.

2. Coronado; 28 Line Super Kote 5000 Vinyl Latex Flat Wall: Applied at a dry film thickness of not less than 1.0 mil.

3. ICI Dulux Paints; 1201-XXXX Dulux Ultra Velvet Sheen Interior Flat Latex Wall & Trim Finish: Applied at a dry film thickness of not less than 1.7 mils.

4. Kelly-Moore; 550 Super Latex Interior Flat Wall Paint: Applied at a dry film thickness of not less than 1.9 mils.

5. M. A. B. Paint; Rich Lux Wal-Shield Latex Flat 041 Line: Applied at a dry film thickness of not less than 1.5 mils.

6. Pittsburgh Paints; 6-700 Series SpeedHide Ultra Interior Wall Flat Latex 100 Percent Acrylic: Applied at a dry film thickness of not less than 1.0 mil.

7. Sherwin-Williams; SuperPaint Flat Wall Paint A86 Series: Applied at a dry film thickness of not less than 1.5 mils.

C. Interior Low-Luster Acrylic Enamel: Factory-formulated eggshell acrylic-latex interior enamel.

1. Benjamin Moore; Moore's Regal AquaVelvet No. 319: Applied at a dry film thickness of not less than 1.4 mils.

2. Coronado; 34 Line Tough Walls Acrylic Eggshell Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.2 mils.

3. ICI Dulux Paints; 1403-XXXX Dulux Ultra Eggshell Interior Latex Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.6 mils.

4. Kelly-Moore; 1610 Sat-N-Sheen Interior Latex Low Sheen Wall and Trim Finish: Applied at a dry film thickness of not less than 1.7 mils.

5. Kelly-Moore; 1686 Dura-Poxy Eggshell Acrylic Enamel: Applied at a dry film thickness of not less than 1.6 mils.

6. M. A. B. Paint; Rich Lux Low Lustre Latex Enamel 028 Line: Applied at a dry film thickness of not less than 1.5 mils.

7. Pittsburgh Paints; 89-Line Manor Hall Interior Eggshell Wall and Trim: Applied at a dry film thickness of not less than 1.4 mils.

8. Sherwin-Williams; SuperPaint Interior Latex Satin Wall Paint A87 Series: Applied at a dry film thickness of not less than 1.6 mils.

D. Interior Semigloss Acrylic Enamel: Factory-formulated semigloss acrylic-latex enamel for interior application.

1. Benjamin Moore; Regal AquaGlo No. 333 Premium Interior Finishes Latex Semi-Gloss: Applied at a dry film thickness of not less than 1.3 mils.

2. Coronado; 22 Line Tough Walls Acrylic Semi-Gloss Enamel: Applied at a dry film thickness of not less than 1.1 mils.

3. ICI Dulux Paints; 1407-XXXX Dulux Ultra Semi-Gloss Interior Acrylic Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.6 mils.
4. Kelly-Moore; 1650 Acry-Plex Latex Interior Latex Semi-Gloss Enamel: Applied at a dry film thickness of not less than 1.5 mils.
5. Kelly-Moore; 1685 Dura-Poxy Semi-Gloss Acrylic Enamel: Applied at a dry film thickness of not less than 1.5 mils.
6. M. A. B. Paint; Rich Lux Semi-Gloss Latex Enamel 023 Line: Applied at a dry film thickness of not less than 1.5 mils.
7. Pittsburgh Paints; 88-110 Satinhide Interior Enamel Wall & Trim Lo-Lustre Semi-Gloss Latex: Applied at a dry film thickness of not less than 1.1 mils.
8. Sherwin-Williams; SuperPaint Interior Latex Semi-Gloss Enamel A88 Series: Applied at a dry film thickness of not less than 1.6 mils.
9. <Insert manufacturer's comparable interior finish-coat material.>

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application. Comply with procedures specified in PDCA P4.
   1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
   2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
   1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

3.02 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.
   1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
   1. Provide barrier coats over incompatible primers or remove and reprime.

2. Cementitious Materials: Prepare concrete, concrete unit masonry, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
   a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
   b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.
   c. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.
3. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.
   a. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
   b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.
4. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.03 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently

fixed equipment or furniture with prime coat only.

6. Sand lightly between each succeeding enamel or varnish coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.

2. Omit primer over metal surfaces that have been shop primed and touchup painted.

3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.

2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.

3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and occupied spaces.

F. Mechanical items to be painted include, but are not limited to, the following:

1. Uninsulated metal piping.

2. Uninsulated plastic piping.

3. Pipe hangers and supports.

4. Tanks that do not have factory-applied final finishes.

5. Duct, equipment, and pipe insulation having "all-service jacket" or other paintable jacket material.

6. Mechanical equipment that is indicated to have a factory-primed finish for field painting.

G. Electrical items to be painted include, but are not limited to, the following:

1. Switchgear.
2. Panelboards.
3. Electrical equipment that is indicated to have a factory-primed finish for field painting.

H. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

I. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

J. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

K. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.

L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.04 FIELD QUALITY CONTROL

A. Owner reserves the right to invoke the following test procedure at any time and as often as Owner deems necessary during the period when paint is being applied:

1. Owner will engage a qualified independent testing agency to sample paint material being used. Samples of material delivered to Project will be taken, identified, sealed, and certified in the presence of Contractor.
2. Owner may direct Contractor to stop painting if test results show material being used does not comply with specified requirements. Contractor shall remove noncomplying paint from Project site, pay for testing, and repaint surfaces previously coated with the noncomplying paint. If necessary, Contractor may be required to remove noncomplying paint from previously painted surfaces if, on repainting with specified paint, the two coatings are incompatible.

3.05 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

3.06 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.

1. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.07 INTERIOR PAINT SCHEDULE

A. Concrete and Masonry (Other Than Concrete Unit Masonry): Provide the following paint systems over interior concrete and brick masonry substrates:

1. Flat Acrylic Finish: Two finish coatsover a primer.
   a. Primer: Interior concrete and masonry primer.
   b. Finish Coats: Interior flat acrylic paint.
2. Low-Luster Acrylic-Enamel Finish: Two finish coatsover a primer.
   a. Primer: Interior concrete and masonry primer.
   b. Finish Coats: Interior low-luster acrylic enamel.

B. Concrete Unit Masonry: Provide the following finish systems over interior concrete masonry:

1. Flat Acrylic Finish: Two finish coatsover a block filler.
   a. Block Filler: Concrete unit masonry block filler.
   b. Finish Coats: Interior flat acrylic paint.
2. Low-Luster Acrylic-Enamel Finish: Two finish coatsover a block filler.
   a. Block Filler: Concrete unit masonry block filler.
   b. Finish Coats: Interior low-luster acrylic enamel.

C. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces:

1. Flat Acrylic Finish: Two finish coatsover a primer.
   a. Primer: Interior gypsum board primer.
   b. Finish Coats: Interior flat acrylic paint.
2. Low-Luster Acrylic-Enamel Finish: [One finish coat] [Two finish coats] [<Insert number> finish coats] over a primer.
   a. Primer: Interior gypsum board primer.
   b. Finish Coats: Interior low-luster acrylic enamel.

D. Ferrous Metal: Provide the following finish systems over ferrous metal:

1. Flat Acrylic Finish: Two finish coatsover a primer.
   a. Primer: Interior ferrous-metal primer.
   b. Finish Coats: Interior flat acrylic paint.
2. Low-Luster Acrylic-Enamel Finish: Two finish coats over a primer.
   a. Primer: Interior ferrous-metal primer.
   b. Finish Coats: Interior low-luster acrylic enamel.
3. Semigloss Acrylic-Enamel Finish: Two finish coatsover a primer.
   a. Primer: Interior ferrous-metal primer.
   b. Finish Coats: Interior semigloss acrylic enamel.

E. Zinc-Coated Metal: Provide the following finish systems over interior zinc-coated metal sur-

faces:

1. Flat Acrylic Finish: Two finish coatsover a primer.
   a. Primer: Interior zinc-coated metal primer.
   b. Finish Coats: Interior flat acrylic paint.
2. Low-Luster Acrylic-Enamel Finish: [One finish coat] [Two finish coats] [<Insert number> finish coats] over a primer.
   a. Primer: Interior zinc-coated metal primer.
   b. Finish Coats: Interior low-luster acrylic enamel.

F. All-Service Jacket over Insulation: Provide the following finish system on cotton or canvas insulation covering:

1. Flat Acrylic Finish: [Two] finish coats. Add fungicidal agent to render fabric mildew proof.
   a. Finish Coats: Interior flat latex-emulsion size.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the lump sum contract price.

END OF SECTION 09911

SECTION 09960

HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes surface preparation and field application of high-performance coating systems to items and surfaces scheduled.

B. Related Sections include the following:

1. Division 5 Section "Structural Steel" for shop priming structural steel.
2. Division 5 Section "Formed-Metal Fabrications" for shop-primed ferrous metal.
3. Division 9 Section "Painting" for general field painting.

C. Alternates: Refer to Division 1 Section "Alternates" for description of Work in this Section affected by alternates.

1.03 DEFINITIONS

A. Standard coating terms defined in ASTM D 16 apply to this Section.

B. Gloss ranges used in this Section include the following:

1. Semigloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
2. High gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

C. Environments: The following terms are used in Part 2 of this Section to distinguish between different corrosive exposures:

1. "Severe environments" are highly corrosive industrial atmospheres with sustained exposure to high humidity and condensation and with frequent cleaning using strong chemicals. Environments with heavy concentrations of strong chemical fumes and frequent splashing and spilling of harsh chemical products are severe environments.
2. "Moderate environments" are corrosive industrial atmospheres with intermittent exposure to high humidity and condensation, occasional mold and mildew development, and regular cleaning with strong chemicals. Environments with exposure to heavy concentrations of chemical fumes and occasional splashing and spilling of chemical products are moderate environments.
3. "Mild environments" are industrial atmospheres with normal exposure to moderate humidity and condensation, occasional mold and mildew development, and infrequent cleaning with strong chemicals. Environments with low levels of mild chemical fumes and occasional splashing and spilling of chemical products are mild environments.

Normal outdoor weathering is also considered a mild environment.

1.04 SUBMITTALS

A. Product Data: For each coating system indicated. Include block fillers and primers.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference the specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.

2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each material specified.

B. Certification by manufacturer that products supplied comply with requirements indicated that limit the amount of VOCs in coating products.

C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.

1. After color selection, Architect will furnish color chips for surfaces to be coated.

D. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.

1. Provide stepped Samples defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.

2. List of material and application for each coat of each sample. Label each sample for location and application.

3. Submit samples on the following substrates for Architect's review of color and texture:
   a. Concrete: Provide two 4-inch- square samples for each color and finish.
   b. Concrete Masonry: Provide two 8-inch- square samples of masonry, with mortar joint in the center, for each finish and color.
   c. Wood: Provide two 12-inch- square samples of each color and material on hardboard.
   d. Ferrous and Nonferrous Metal: Provide two 4-inch- square samples of flat metal and two 8-inch- long samples of solid metal for each color and finish.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed high-performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.

B. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

C. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample of each type of coating and substrate required. Comply with procedures specified in PDCA P5. Duplicate finish of approved sample Submittals.

1. Architect will select one room, area, or surface to represent surfaces and conditions for application of each type of coating and substrate.
   a. Wall Surfaces: Provide samples on at least 100 sq. ft. of wall surface.
   b. Small Areas and Items: Architect will designate items or areas required.
2. After permanent lighting and other environmental services have been activated, apply coatings in this room or to each surface as specified. Provide the required sheen, color, and texture of each surface.
   a. After finishes are accepted, Architect will use the room or surface to evaluate coating systems of a similar nature.
3. Final approval of colors will be from benchmark samples.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:
   1. Name or title of material.
   2. Product description (generic classification or binder type).
   3. Manufacturer's stock number and date of manufacture.
   4. Contents by volume, for pigment and vehicle constituents.
   5. Thinning instructions.
   6. Application instructions.
   7. Color name and number.
   8. Handling instructions and precautions.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.
   1. Protect materials from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and applying coatings.

1.07 PROJECT CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 45 and 95 deg F.

B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
   1. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.
   2. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods.

1.08 EXTRA MATERIALS

A. Furnish extra high-performance coating materials from the same production run as materi-

als applied and in quantities described below. Package coating materials in unopened, factory-sealed containers for storage and identify with labels describing contents.

1. Quantity: Furnish extra coating materials in quantities indicated below:
   a. High-Gloss, Aliphatic Polyurethane Enamel: One case of each color applied.
   b. Semigloss, Aliphatic Polyurethane Enamel: 2 gal. of each color applied.
   c. High-Gloss, Waterborne, Acrylic Enamel: One case of each color applied.
   d. Semigloss, Waterborne, Acrylic Enamel: 1 gal. of each color applied.
   e. High-Gloss, Polyamide Epoxy Coatings: One case of each color applied.
   f. Semigloss, Polyamide Epoxy Coatings: One case of each color applied.
2. Quantity: Furnish an additional 5 percent, but not less than 1 gal. or 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products indicated in the coating system descriptions.

B. Products: Subject to compliance with requirements, provide one of the products indicated in the coating system descriptions.

C. Manufacturers' Names: The following manufacturers are referred to in the coating system descriptions by shortened versions of their names shown in parenthesis:

1. Carboline Company (Carboline).
2. DuPont Company, High Performance Coatings (DuPont).
3. ICI Dulux Paints; Devoe Coatings (ICI).
4. International Protective Coatings; Courtaulds Coatings (International).
5. Moore: Benjamin Moore & Co. (Moore).
6. Pittsburgh Paint; PPG Industries, Inc. (PPG).
7. Rust-Oleum Corporation (R-O).
8. Sherwin Williams; Industrial and Marine Coatings (S-W).
9. Tnemec Company, Inc. (Tnemec).
10. <Insert manufacturer.>

2.02 COATINGS MATERIALS, GENERAL

A. Material Compatibility: Provide primers, undercoats, and finish-coat materials that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's highest grade of the various high-performance coatings specified. Materials not displaying manufacturer's product identification are not acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be

used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. VOC Classification: Provide high-performance coating materials, including primers, undercoats, and finish-coat materials, that have a VOC classification of 450 g/L or less.

2.03 COLORS

A. Colors: As indicated by manufacturer's designations.

B. Colors: Match Architect's samples.

C. Colors: As selected by Architect from manufacturer's full range.

2.04 EXTERIOR HIGH-PERFORMANCE COATING SYSTEMS

A. Concrete and Masonry (Other Than Concrete Masonry Units): Provide the following finish systems over exterior concrete and brick masonry surfaces:

1. Severe and Moderate Environments (High-Gloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Pre-Prime 167 100% Solids Epoxy Penetrating Sealer.
      4) International: Intergard 345 DTM Semi-Gloss Epoxy.
      5) Moore: M36-00/M37 Polyamide Epoxy Clear Sealer/Finish.
      6) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
      7) R-O: 9100 System High Performance Epoxy.
      8) S-W: Heavy Duty Epoxy B67W300 Series.
      9) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.
   b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 8.0 mils.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devran 224HS High Build Epoxy.
      4) S-W: Heavy Duty Epoxy B67W300 Series.
      5) Tnemec: Series 84 H. S. Epoxy.
   c. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) International: Interthane 990 Low VOC Thin Film Polyurethane.
      2) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
      3) PPG: 97-8XXX Series Pitthane Acrylic-Aliphatic Urethane.
      4) R-O: 9700 System High Solids Polyurethane Coating.
   d. Topcoat: High-gloss, aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) Carboline: 134-HS 2-Component Acrylic-Aliphatic Urethane.
      2) DuPont: Imron 333 High Gloss Polyurethane Enamel.
      3) ICI: Devthane 369 Aliphatic Urethane Gloss Enamel.
      4) International: Interthane 990 Low VOC Thin Film Polyurethane.
      5) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
      6) PPG: Pitthane Acrylic-Aliphatic Urethane 97-8XXX Series.
      7) R-O: 9700 System High Solids Polyurethane Coatings.
      8) S-W: Corothane II Gloss B65W400 Series.
      9) Tnemec: Series 74 Endurashield Aliphatic Acrylic Polyurethane.

2. Severe and Moderate Environments (Semigloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Epoxy primer/sealer applied at spreading rate recommended by manufacturer.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Pre-Prime 167 100% Solids Epoxy Penetrating Sealer.
      4) Moore: M36-00/M37 Polyamide Epoxy Clear Sealer/Finish.
      5) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
      6) S-W: Heavy Duty Epoxy B67W300 Series.
      7) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.
   b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 8.0 mils.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devran 224HS High Build Epoxy.
      4) S-W: Heavy Duty Epoxy B67W300 Series.
      5) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.
   c. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 4.0 mils.
      1) Moore: M73/M75 Aliphatic Acrylic Urethane Semi-Gloss.
      2) PPG: 97-8XXX Series Pitthane High Build Acrylic-Aliphatic Urethane.
   d. Topcoat: Semigloss, aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 4.0 mils.
      1) Carboline: 133-HB 2-Component Aliphatic Polyurethane.
      2) DuPont: Imron 326 (13P) Semi-Gloss Polyurethane Enamel.
      3) ICI: Devthane 378 Aliphatic Urethane Semi-Gloss Enamel.
      4) Moore: M73/M75 Aliphatic Acrylic Urethane Semi-Gloss.
      5) PPG: 97-8XXX Series Pitthane High Build Acrylic-Aliphatic Urethane.
      6) S-W: Corothane II Low VOC Satin Finish B65W200 Series.
      7) Tnemec: Series 75 Endurashield Aliphatic Acrylic Polyurethane.

3. Mild Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Acrylic primer applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 3.0 mils.
      1) DuPont: 310 Acrylic Emulsion.
      2) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
      3) International: Interlock 6015 Waterborne Acrylic Sealer.
      4) Moore: M04 Acrylic Primer.
      5) PPG: 6-603 Speedhide Interior/Exterior Acrylic Latex Alkali Resistant Primer.
      6) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
      7) S-W: Loxon Exterior Masonry Acrylic Primer A24W300.
      8) Tnemec: Series 18 Enviroprime.
   b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
      2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
      3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
      4) Moore: M28 Acrylic Gloss Enamel.
      5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
      6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic

Gloss Finish.
7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

c. Topcoat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
4) Moore: M28 Acrylic Gloss Enamel.
5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Gloss Finish.
7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

4. Mild Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Acrylic primer applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 3.5 mils.
1) Carboline: Multi-Bond 120 Waterborne Acrylic Primer.
2) DuPont: 310 Acrylic Emulsion.
3) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
4) International: Interlock 6015 Waterborne Acrylic Sealer.
5) Moore: M04 Acrylic Primer.
6) PPG: 6-603 Speedhide Interior/Exterior Acrylic Latex Alkali Resistant Primer.
7) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
8) S-W: Loxon Exterior Masonry Acrylic Primer A24W300.
9) Tnemec: Series 18 Enviroprime.

b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 3359 Waterborne Acrylic.
2) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semi-Gloss Enamel.
4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
5) Moore: M29 D.T.M. Acrylic Semi-Gloss.
6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Semigloss Finish.
8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
9) Tnemec: Series 29 Tufcryl Acrylic Emulsion.

c. Topcoat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 3359 Waterborne Acrylic.
2) DuPont: Corlar 76P 2-Component Waterborne Acrylic Epoxy Enamel.
3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semi-Gloss Enamel.
4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
5) Moore: M29 D.T.M. Acrylic Semi-Gloss.
6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Semigloss Finish.

8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
9) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

B. Concrete Masonry Units: Provide the following finish systems over exterior concrete masonry block:

1. Severe and Moderate Environments (High-Gloss Finish): One finish coat over an intermediate coat and a block filler.

a. Block Filler: Acrylic or epoxy block filler applied at spreading rate recommended by manufacturer as sufficient to fill pores.
1) Carboline: Flexide Masonry Block Filler.
2) DuPont: 300P Latex Block Filler.
3) ICI: Devran 224HS High Build Epoxy.
4) International: Interlac 895 Epoxy Ester Block Filler.
5) Moore: M31/M32 Waterborne Epoxy Block Filler.
6) PPG: 97-68X Series Aquapon Polyamide-Epoxy Block Filler.
7) R-O: 5199 Block Filler Surfa-Sele.
8) S-W: Epoxy Ester Masonry Filler/Sealer B61W2.
9) Tnemec: Series 130 Envirofill Waterborne Cementitious Acrylic.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 8.0 mils.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 224HS High Build Epoxy.
4) R-O: 9100 System High Performance Epoxy.
5) S-W: Heavy Duty Epoxy B67W300 Series.
6) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

c. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) International: Interthane 990 Low VOC Thin Film Polyurethane.
2) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
3) PPG: 97-8XXX Series Pitthane Acrylic-Aliphatic Urethane Enamel.

d. Topcoat: High-gloss, aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 134-HS 2-Component Acrylic-Aliphatic Urethane.
2) DuPont: Imron 333 High Gloss Polyurethane Enamel.
3) ICI: Devthane 369 Aliphatic Urethane Gloss Enamel.
4) International: Interthane 990 Low VOC Thin Film Polyurethane.
5) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
6) PPG: 97-8XXX Series Pitthane Acrylic-Aliphatic Urethane Enamel.
7) R-O: 9700 System High Solids Polyurethane Coating.
8) S-W: Corothane II Gloss B65W400 Series.
9) Tnemec: Series 74 Endura-Shield Gloss Aliphatic Acrylic Polyurethane.

2. Severe and Moderate Environments (Semigloss Finish): One finish coat over an intermediate coat and a block filler.

a. Block Filler: Acrylic or epoxy block filler applied at spreading rate recommended by manufacturer as sufficient to fill pores.
1) Carboline: Flexide Masonry Block Filler.
2) DuPont: 300P Latex Block Filler.
3) ICI: Devran 224HS High Build Epoxy.
4) Moore: M31/M32 Waterborne Epoxy Block Filler.
5) PPG: 97-68X Series Aquapon Polyamide-Epoxy Block Filler.
6) S-W: Epoxy Ester Masonry Filler/Sealer B61W2.
7) Tnemec: Series 130 Envirofill Waterborne Cementitious Acrylic.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 8.0 mils.
   1) Carboline: 890 2-Component Epoxy.
   2) DuPont: 25P High Solids Epoxy Mastic.
   3) ICI: Devran 224HS High Build Epoxy.
   4) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

c. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
   1) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
   2) PPG: 97-84XX Series Pitthane High Build Acrylic-Aliphatic Urethane Enamel.
   3) S-W: Corothane II Gloss B65W400 Series.

d. Topcoat: Semigloss, aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
   1) Carboline: 133-HB 2-Component Aliphatic Polyurethane.
   2) DuPont: Imron 326 (13P) Semi-Gloss Polyurethane Enamel.
   3) ICI: Devthane 378 Aliphatic Urethane Semi-Gloss Enamel.
   4) Moore: M73/M75 Aliphatic Acrylic Urethane Semi-Gloss.
   5) PPG: 97-84XX Series Pitthane High Build Acrylic-Aliphatic Urethane Enamel.
   6) S-W: Corothane II Low VOC Satin Finish B65W200 Series.
   7) Tnemec: Series 75 Endura-Shield Semi-Gloss Aliphatic Acrylic Polyurethane.

3. Mild Environment (High-Gloss Finish): One finish coat over an intermediate coat and a block filler.

a. Block Filler: Acrylic or epoxy block filler applied at spreading rate recommended by manufacturer as sufficient to fill pores.
   1) DuPont: 300P Latex Block Filler.
   2) ICI: Bloxfil 4000 Interior/Exterior Heavy Duty Acrylic Block Filler.
   3) International: Acri-Fil 896 Acrylic Block Filler.
   4) Moore: M88-01 Acrylic Latex Block Filler.
   5) PPG: 16-90 Pitt-Glaze High Performance Acrylic Latex Block Filler.
   6) R-O: 5199 Block Filler Surfa-Sele.
   7) S-W: Heavy Duty Block Filler B42W46.
   8) Tnemec: Latex Masonry Block Filler.

b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
   1) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
   2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
   3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
   4) Moore: M28 Acrylic Gloss Enamel.
   5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamels.
   6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Gloss Finish.
   7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
   8) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

c. Topcoat: High-gloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
   1) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
   2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
   3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
   4) Moore: M28 Acrylic Gloss Enamel.
   5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance

Waterborne High Gloss DTM Industrial Enamels.
6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Gloss Finish.
7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

4. Mild Environment (Semigloss Finish): One finish coat over an intermediate coat and a block filler.
   a. Block Filler: Acrylic or epoxy block filler applied at spreading rate recommended by manufacturer as sufficient to fill pores.
      1) Carboline: Flexide Masonry Block Filler.
      2) DuPont: 300P Latex Block Filler.
      3) ICI: Bloxfil 4000 Interior/Exterior Heavy Duty Acrylic Block Filler.
      4) International: Acri-Fil 896 Acrylic Block Filler.
      5) Moore: M31/M32 Waterborne Epoxy Block Filler.
      6) PPG: 16-90 Pitt-Glaze High Performance Acrylic Latex Block Filler.
      7) R-O: 5199 Block Filler Surfa-Sele.
      8) S-W: Heavy Duty Block Filler B42W46.
      9) Tnemec: Latex Masonry Block Filler.
   b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) Carboline: 3350 Acrylic Latex.
      2) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
      3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semi-Gloss Enamel.
      4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
      5) Moore: M29 D.T.M. Acrylic Semi-Gloss.
      6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
      7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Semigloss Finish.
      8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
      9) Tnemec: Series 29 Tufcryl Acrylic Emulsion.
   c. Topcoat: Semigloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) Carboline: 3350 Acrylic Latex.
      2) DuPont: Corlar 76P 2-Component Waterborne Acrylic Epoxy Enamel.
      3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semi-Gloss Enamel.
      4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
      5) Moore: M29 D.T.M. Acrylic Semi-Gloss.
      6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
      7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Semigloss Finish.
      8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
      9) Tnemec: Series 29 Tufcryl Acrylic Emulsion.

C. Wood: Provide the following finish systems over exterior wood surfaces:

1. Mild Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Acrylic or alkyd primer applied at spreading rate recommended by manufacturer.
      1) DuPont: 310 Acrylic Emulsion.
      2) ICI: Ultra-Hide 3210 Aquacrylic Gripper Stain Killer Primer-Sealer.
      3) International: 515 Acrylic Bonding Primer.
      4) Moore: M04 Acrylic Primer.

5) PPG: 17-21 Seal Grip Interior/Exterior Acrylic Latex Stain Blocking Primer.
6) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
7) S-W: A-100 Alkyd Exterior Wood Primer Y24W20.
8) Tnemec: Series 51-792 PVA Sealer.

b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
4) Moore: M28 Acrylic Gloss Enamel.
5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Gloss DTM Industrial Enamel.
6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Gloss Finish.
7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

c. Topcoat: High-gloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
4) Moore: M28 Acrylic Gloss Enamel.
5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Gloss DTM Industrial Enamel.
6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Gloss Finish.
7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

2. Mild Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Acrylic emulsion or alkyd primer applied at spreading rate recommended by manufacturer.
1) Carboline: Multi-Bond 120.
2) DuPont: 310 Acrylic Emulsion.
3) ICI: Ultra-Hide 3210 Aquacrylic Gripper Stain Killer Primer-Sealer.
4) International: 515 Acrylic Bonding Primer.
5) Moore: M04 Acrylic Primer.
6) PPG: 17-21 Seal Grip Interior/Exterior Acrylic Latex Stain Blocking Primer.
7) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
8) S-W: A-100 Alkyd Exterior Wood Primer Y24W20.
9) Tnemec: Series 51-792 PVA Sealer.

b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 3350 Acrylic Latex.
2) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semi-Gloss Enamel.
4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
5) Moore: M29 D.T.M. Acrylic Semi-Gloss.
6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Semigloss Finish.

8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
9) Tnemec: Series 29 Tufcryl Acrylic Emulsion.

c. Topcoat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 3350 Acrylic Latex.
2) DuPont: Corlar 76P 2-Component Waterborne Acrylic Epoxy Enamel.
3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semi-Gloss Enamel.
4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
5) Moore: M29 D.T.M. Acrylic Semi-Gloss.
6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Semigloss Finish.
8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
9) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

D. Ferrous Metal: Provide the following finish systems over exterior ferrous-metal surfaces:

1. Severe Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
1) Carboline: 893 2-Component Cross-Linked Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 224HS High Build Epoxy.
4) International: Intergard 251 Thin Film Polyamide Epoxy Rust Inhibitive Primer.
5) Moore: M36-00/M37 Polyamide Epoxy Clear Sealer/Finish.
6) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
7) R-O: 9100 System High Performance Epoxy.
8) S-W: Recoatable Epoxy Primer B67 Series/B67V5.
9) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 8.0 mils.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) International: Intergard 345 DTM Semi-Gloss Epoxy.
4) S-W: Heavy Duty Epoxy B67W300 Series.
5) Tnemec: Series 66 Hi-Build Epoxoline II Polyamide Epoxy.

c. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) ICI: Devthane 369 Aliphatic Urethane Gloss Enamel.
2) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
3) PPG: 97-8XXX Series Pitthane Acrylic-Aliphatic Urethane Enamel.
4) R-O: 9700 System High Solids Polyurethane Coating.

d. Topcoat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 134-HS 2-Component Acrylic-Aliphatic Urethane.
2) DuPont: Imron 333 High Gloss Polyurethane Enamel.
3) ICI: Devthane 369 Aliphatic Urethane Gloss Enamel.
4) International: Interthane 990 Low VOC Thin Film Polyurethane.
5) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
6) PPG: 97-8XXX Series Pitthane Acrylic-Aliphatic Urethane Enamel.
7) R-O: 9700 System High Solids Polyurethane Coating.
8) S-W: Corothane II Gloss B65W400 Series.
9) Tnemec: Series 74 Endura-Shield.

2. Severe Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
      1) Carboline: 893 2-Component Cross-Linked Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devran 224HS High Build Epoxy.
      4) Moore: M36-00/M37 Polyamide Epoxy Clear Sealer/Finish.
      5) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
      6) S-W: Recoatable Epoxy Primer B67 Series/B67V5.
      7) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.
   b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 5.0 mils.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) S-W: Heavy Duty Epoxy B67W300 Series.
      4) Tnemec: Series 66 Hi-Build Epoxoline.
   c. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) ICI: Devthane 378 Aliphatic Urethane Semi-Gloss Enamel.
      2) Moore: M73/M75 Aliphatic Acrylic Urethane Semi-Gloss.
      3) PPG: 97-84XX Series Pitthane High Build Acrylic-Aliphatic Urethane Enamel.
   d. Topcoat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) Carboline: 133-HB 2-Component Aliphatic Polyurethane.
      2) DuPont: Imron 326 (13P) Semi-Gloss Polyurethane Enamel.
      3) ICI: Devthane 378 Aliphatic Urethane Semi-Gloss Enamel.
      4) Moore: M73/M75 Aliphatic Acrylic Urethane Semi-Gloss.
      5) PPG: 97-84XX Series Pitthane High Build Acrylic-Aliphatic Urethane Enamel.
      6) S-W: Corothane II Satin B65W400 Series.
      7) Tnemec: Series 75 Endura-Shield.

3. Moderate Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
      1) Carboline: 893 2-Component Cross-Linked Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devran 224HS High Build Epoxy Coating.
      4) International: Intergard 251 Thin Film Polyamide Epoxy Rust Inhibitive Primer.
      5) Moore: M36-00/M37 Polyamide Epoxy Clear Sealer/Finish.
      6) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
      7) R-O: 9100 System High Performance Epoxy.
      8) S-W: Recoatable Epoxy Primer B67 Series/B67V5.
      9) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.
   b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 5.0 mils.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) S-W: Heavy Duty Epoxy B67W300 Series.
      4) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.
   c. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.

1) ICI: Devthane 369 Aliphatic Urethane Gloss Enamel.
2) International: Interthane 990 Low VOC Thin Film Polyurethane.
3) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
4) PPG: 97-8XXX Series Pitthane Acrylic-Aliphatic Urethane Enamel.
5) R-O: 9700 System High Solids Aliphatic Polyurethane Enamel.
6) Tnemec: Series 74 Endura-Shield.

d. Topcoat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 134-HS 2-Component Acrylic-Aliphatic Urethane.
2) DuPont: Imron 333 High Gloss Polyurethane Enamel.
3) ICI: Devthane 369 Aliphatic Urethane Gloss Enamel.
4) International: Interthane 990 Low VOC Thin Film Polyurethane.
5) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
6) PPG: 97-8XXX Series Pitthane Acrylic-Aliphatic Urethane Enamel.
7) R-O: 9700 System High Solids Aliphatic Polyurethane Enamel.
8) S-W: Corothane II Gloss B65W400 Series.
9) Tnemec: Series 74 Endura-Shield.

4. Moderate Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.
a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
1) Carboline: 893 2-Component Cross-Linked Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 224HS High Build Epoxy.
4) Moore: M36-00/M37 Polyamide Epoxy Clear Sealer/Finish.
5) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
6) S-W: Recoatable Epoxy Primer B67 Series/B67V5.
7) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 8.0 mils.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) S-W: Heavy Duty Epoxy B67W300 Series.
4) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

c. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) ICI: Devthane 378 Aliphatic Urethane Semi-Gloss Enamel.
2) Moore: M73/M75 Aliphatic Acrylic Urethane Semi-Gloss.
3) PPG: 97-84XX Series Pitthane High Build Acrylic-Aliphatic Urethane Enamel.

d. Topcoat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: Carboline 133 HB Aliphatic Polyurethane.
2) DuPont: Imron 326 (13P) Semi-Gloss Polyurethane Enamel.
3) ICI: Devthane 378 Aliphatic Urethane Semi-Gloss Enamel.
4) Moore: M73/M75 Aliphatic Acrylic Urethane Semi-Gloss.
5) PPG: 97-84XX Series Pitthane High Build Acrylic-Aliphatic Urethane Enamel.
6) S-W: Corothane II Satin B65W400 Series.
7) Tnemec: Series 75 Endura-Shield.

5. Mild Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.
a. Primer: Acrylic primer applied at spreading rate recommended by manufacturer.
1) DuPont: Tufcote 72P Waterborne Acrylic Enamel.

2) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
3) International: Intercryl 520 WB Waterborne Acrylic Primer or Finish.
4) Moore: M04 Acrylic Primer.
5) PPG: 90-7XX Series Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel.
6) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
7) S-W: Kem Kromik Universal Metal Primer B50Z Series.
8) Tnemec: Series 18 Enviroprime.

b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
4) Moore: M28 Acrylic Gloss Enamel.
5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamels.
6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Semi-Gloss Finishes.
7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

c. Topcoat: High-gloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
4) Moore: M28 Acrylic Gloss Enamel.
5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamels.
6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Semi-Gloss Finishes.
7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

6. Mild Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Acrylic primer applied at spreading rate recommended by manufacturer.
1) Carboline: Multi-Bond 120.
2) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
3) ICI: Devflex 4020 DTM Flat Waterborne Primer and Finish.
4) International: Intercryl 520 WB Waterborne Acrylic Primer or Finish.
5) Moore: M04 Acrylic Primer.
6) PPG: 90-7XX Series Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel.
7) R-O: 5281 Industrial Enamel High Performance Acrylic Primers.
8) S-W: Kem Kromik Universal Metal Primer B50Z Series.
9) Tnemec: Series 18 Enviroprime.

b. Intermediate Coat: Semigloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 3359 Waterborne Acrylic.
2) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semi-Gloss Enamel.
4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
5) Moore: M29 D.T.M. Acrylic Semi-Gloss.
6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance

Waterborne Satin DTM Industrial Enamels.
7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
9) Tnemec: Series 29 Tufcryl Acrylic Emulsion.

c. Topcoat: Semigloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 3359 Waterborne Acrylic.
2) DuPont: Corlar 76P 2-Component Waterborne Acrylic Epoxy Enamel.
3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semi-Gloss Enamel.
4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
5) Moore: M29 D.T.M. Acrylic Semi-Gloss.
6) PPG: Pitt-Tech One Pack Interior/Exterior 90-4XX Series High Performance Waterborne Satin DTM Industrial Enamels.
7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
9) Tnemec: Series 29 Tufcryl Acrylic Emulsion.

E. Nonferrous Metal: Provide the following finish systems over exterior nonferrous-metal surfaces:

1. Severe Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
1) Carboline: Rustbond Penetrating Sealer SG.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 4170 Corrosion Resistant Epoxy Primer.
4) International: Intergard 251 Thin Film Polyamide Epoxy Rust Inhibitive Primer.
5) Moore: M36-00/M37 Polyamide Epoxy Clear Sealer/Finish.
6) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
7) R-O: 9100 System High Performance Epoxy.
8) S-W: DTM Wash Primer B71Y1.
9) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 8.0 mils.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
4) S-W: Heavy Duty Epoxy B67W300 Series.
5) Tnemec: Intermediate coat not required.

c. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) ICI: Devthane 369 Aliphatic Urethane Gloss Enamel.
2) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
3) PPG: 97-8XXX Series Pitthane Acrylic-Aliphatic Urethane Enamel.
4) R-O: 9800 System Urethane High Build Mastic Coatings.
5) Tnemec: Intermediate coat not required.

d. Topcoat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 134-HS 2-Component Acrylic-Aliphatic Urethane.
2) DuPont: Imron 333 High Gloss Polyurethane Enamel.
3) ICI: Devthane 369 Aliphatic Urethane Gloss Enamel.

4) International: Interthane 990 Low VOC Thin Film Polyurethane.
5) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
6) PPG: 97-8XXX Series Pitthane Acrylic-Aliphatic Urethane Enamel.
7) R-O: 9800 System Urethane High Build Mastic Coatings.
8) S-W: Corothane II Gloss B65W400 Series.
9) Tnemec: Series 74 Endura-Shield.

2. Severe Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
      1) Carboline: Rustbond Penetrating Sealer SG.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devran 4170 Corrosion Resistant Epoxy Primer.
      4) Moore: M36-00/M37 Polyamide Epoxy Clear Sealer/Finish.
      5) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
      6) S-W: DTM Wash Primer, B71Y1.
      7) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.
   b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 8.0 mils.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) S-W: Heavy Duty Epoxy B67W300 Series.
      4) Tnemec: Intermediate coat not required.
   c. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) ICI: Devthane 378 Aliphatic Urethane Semi-Gloss Enamel.
      2) Moore: M73/M75 Aliphatic Acrylic Urethane Semi-Gloss.
      3) PPG: 97-84XX Series Pitthane High Build Acrylic-Aliphatic Urethane Enamel.
      4) Tnemec: Intermediate coat not required.
   d. Topcoat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) Carboline: Carboline 133 HB Aliphatic Polyurethane.
      2) DuPont: Imron 326 (13P) Imron Semi-Gloss Polyurethane Enamel.
      3) ICI: Devthane 378 Aliphatic Urethane Semi-Gloss Enamel.
      4) Moore: M73/M75 Aliphatic Acrylic Urethane Semi-Gloss.
      5) PPG: 97-84XX Series Pitthane High Build Acrylic-Aliphatic Urethane Enamel.
      6) S-W: Corothane II Satin B65W200 Series.
      7) Tnemec: Series 75 Endura-Shield.

3. Moderate Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
      1) Carboline: Rustbond Penetrating Sealer SG.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devran 4170 Corrosion Resistant Epoxy Primer.
      4) International: Intergard 251 Thin Film Polyamide Epoxy Rust Inhibitive Primer.
      5) Moore: M36-00/M37 Polyamide Epoxy Clear Sealer/Finish.
      6) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
      7) R-O: System 5369/5381 Water-Based Epoxy Primer.
      8) S-W: DTM Wash Primer B71Y1.
      9) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.
   b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufac-

turer to achieve a dry film thickness of 3.0 to 5.0 mils.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
4) Tnemec: Intermediate coat not required.

c. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) ICI: Devthane 369 Aliphatic Urethane Gloss Enamel.
2) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
3) PPG: 97-8XXX Series Pitthane Acrylic-Aliphatic Urethane Enamel.
4) R-O: 9800 System Urethane High Build Mastic Coatings.
5) S-W: Corothane II Gloss B65W400 Series.
6) Tnemec: Intermediate coat not required.

d. Topcoat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 134 HS 2-Component Acrylic-Aliphatic Urethane.
2) DuPont: Imron 333 High Gloss Polyurethane Enamel.
3) ICI: Devthane 369 Aliphatic Urethane Gloss Enamel.
4) International: Interthane 990 Low VOC Thin Film Polyurethane.
5) Moore: M74/M75 Aliphatic Acrylic Urethane Gloss.
6) PPG: 97-8XXX Series Pitthane Acrylic-Aliphatic Urethane Enamel.
7) R-O: 9800 System Urethane High Build Mastic Coatings.
8) S-W: Corothane II Gloss B65W400 Series.
9) Tnemec: Series 74 Endura-Shield.

4. Moderate Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
1) Carboline: Rustbond Penetrating Sealer SG.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 4170 Corrosion Resistant Epoxy Primer.
4) Moore: M36-00/M37 Polyamide Epoxy Clear Sealer/Finish.
5) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
6) S-W: DTM Wash Primer B71Y1.
7) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 5.0 mils.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) Tnemec: Intermediate coat not required.

c. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) ICI: Devthane 378 Aliphatic Urethane Semi-Gloss Enamel.
2) Moore: M73/M75 Aliphatic Acrylic Urethane Semi-Gloss.
3) PPG: 97-84XX Series Pitthane High Build Acrylic-Aliphatic Urethane Enamel.
4) S-W: Corothane II Satin B65W200 Series.
5) Tnemec: Intermediate coat not required.

d. Topcoat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 133 HB Aliphatic Polyurethane.
2) DuPont: Imron 326 (13P) Semi-Gloss Polyurethane Enamel.
3) ICI: Devthane 378 Aliphatic Urethane Semi-Gloss Enamel.
4) Moore: M73/M75 Aliphatic Acrylic Urethane Semi-Gloss.

5) PPG: 97-84XX Series Pitthane High Build Acrylic-Aliphatic Urethane Enamel.
6) S-W: Corothane II Satin B65W200 Series.
7) Tnemec: Series 75 Endura-Shield.

5. Mild Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Acrylic primer applied at spreading rate recommended by manufacturer.
      1) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
      2) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
      3) International: Intercryl 520 WB Waterborne Acrylic Primer or Finish.
      4) Moore: M04 Acrylic Primer.
      5) PPG: 90-7XX Series Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel.
      6) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
      7) S-W: DTM Wash Primer B71Y1.
      8) Tnemec: Series 18 Enviroprime.
   b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) DuPont: Intermediate coat not required.
      2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
      3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
      4) Moore: M28 Acrylic Gloss Enamel.
      5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamels.
      6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
      7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
      8) Tnemec: Intermediate coat not required.
   c. Topcoat: High-gloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
      2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
      3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
      4) Moore: M28 Acrylic Gloss Enamel.
      5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamels.
      6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
      7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
      8) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

6. Mild Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Acrylic primer applied at spreading rate recommended by manufacturer.
      1) Carboline: Multi-Bond 120 Waterborne Acrylic Primer.
      2) DuPont: Tufcote 72P Waterborne Acrylic Enamel.
      3) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
      4) International: Intercryl 520 WB Waterborne Acrylic Primer or Finish.
      5) Moore: M04 Acrylic Primer.
      6) PPG: 90-7XX Series Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel.
      7) R-O: 5269/5281 Industrial Enamel High Performance Acrylic Primers.
      8) S-W: DTM Wash Primer B71Y1.
      9) Tnemec: Series 18 Enviroprime.

b. Intermediate Coat: Unless otherwise indicated, acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
   1) Carboline: 3350 Acrylic Latex.
   2) DuPont: Intermediate coat not required.
   3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semi-Gloss Enamel.
   4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
   5) Moore: M29 D.T.M. Acrylic Semi-Gloss.
   6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamels.
   7) R-O: 5200 System Labor Saver Industrial Enamel Semi-Gloss High Performance Acrylic Finishes.
   8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
   9) Tnemec: Intermediate coat not required.

c. Topcoat: Semigloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
   1) Carboline: 3350 Acrylic Latex.
   2) DuPont: Corlar 76P 2-Component Waterborne Acrylic Epoxy Enamel.
   3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semi-Gloss Enamel.
   4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
   5) Moore: M29 D.T.M. Acrylic Semi-Gloss.
   6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamels.
   7) R-O: 5200 System Labor Saver Industrial Enamel Semi-Gloss High Performance Acrylic Finishes.
   8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
   9) Tnemec: Series 29 Tufcryl Acrylic Emulsion.

2.05 INTERIOR HIGH-PERFORMANCE COATING SYSTEMS

A. Concrete and Masonry (Other Than Concrete Masonry Units): Provide the following finish systems over interior concrete and brick masonry surfaces:

1. Severe Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.

   a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Pre-Prime 167 100% Solids Epoxy Penetrating Sealer.
      4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
      5) Moore: M36-00/M37 Polyamide Epoxy Clear Sealer/Finish.
      6) PPG: 97-14XX Series Pitt-Guard DTR Epoxy.
      7) R-O: 9100 System Labor Saver High Performance Epoxy.
      8) S-W: Heavy Duty Epoxy B67W300 Series/B60V3.
      9) Tnemec: Series 84 H. S. Epoxy.

   b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: Corlar 26P HB DTM High Build Epoxy Enamel.
      3) ICI: Devran 224HS High Build Epoxy.
      4) International: Intermediate coat not required.
      5) Moore: M36/M37 Polyamide Epoxy Gloss Coating.
      6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
      7) R-O: Intermediate coat not required.

8) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
9) Tnemec: Intermediate coat not required.

c. Topcoat: High-gloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: Corlar 26P HB DTM High Build Epoxy Enamel.
3) ICI: Devthane 250 Direct-to Metal (DTM) Gloss Epoxy.
4) International: Intergard 607 HS High Build Gloss Polyamine Epoxy Finish at 8.0-mil dry film thickness.
5) Moore: M36/M37 Polyamide Epoxy Gloss Coating.
6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
7) R-O: 9100 System Labor Saver High Performance Polyamine Epoxy at 5.0- to 8.0-mil dry film thickness.
8) S-W: Tile Clad II High Solids B62WZ Series B60VZ70.
9) Tnemec: Series 84 H. S. Epoxy.

2. Severe Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
1) Carboline: 888 2-Component Polyamide Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Pre-Prime 167 100% Solids Epoxy Penetrating Sealer.
4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
5) Moore: M36-00/M37 Polyamide Epoxy Clear Sealer/Finish.
6) PPG: 97-14XX Series Pitt-Guard DTR Epoxy.
7) R-O: 9500 System High Build Polyamide Epoxy.
8) S-W: Primer not required.
9) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
1) Carboline: 888 2-Component Polyamide Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 224HS High Build Epoxy.
4) International: Intergard 345 DTM Semi-Gloss Epoxy.
5) Moore: M36/M38 Polyamide Epoxy Semi-Gloss Coating.
6) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
7) R-O: Intermediate coat not required.
8) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
9) Tnemec: Intermediate coat not required.

c. Topcoat: Semigloss polyamide epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
1) Carboline: 888 2-Component Polyamide Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 224HS High Build Epoxy.
4) International: Intergard 345 DTM Semi-Gloss Epoxy.
5) Moore: M36/M38 Polyamide Epoxy Semi-Gloss Coating.
6) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
7) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.
8) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
9) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

3. Moderate Environment (High-Gloss Finish): One finish coat over an intermediate coat

and a primer.

a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
   1) Carboline: 890 2-Component Epoxy.
   2) DuPont: 25P High Solids Epoxy Mastic.
   3) ICI: Tru-Glaze-WB 4408 Waterborne Epoxy Gloss Coating.
   4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
   5) Moore: M43-00/M44-84 Acrylic Epoxy Clear Gloss Coating.
   6) PPG: 97-14XX Series Pitt-Guard DTR Epoxy.
   7) R-O: 9100 System Labor Saver High Performance Epoxy.
   8) S-W: Heavy Duty Epoxy B67W300 Series/B60V3.
   9) Tnemec: Series 84 H. S. Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
   1) Carboline: 890 2-Component Epoxy.
   2) DuPont: Corlar 26P High Solids Epoxy Enamel.
   3) ICI: Tru-Glaze-WB 4408 Waterborne Epoxy Gloss Coating.
   4) International: Intergard 740 Thin Film Gloss Polyamide Epoxy.
   5) Moore: M43/M44 Acrylic Epoxy Gloss Coating.
   6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
   7) R-O: Intermediate coat not required.
   8) S-W: Tile Clad II High Solids B62WZ Series B60VZ70.
   9) Tnemec: Intermediate coat not required.

c. Topcoat: High-gloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
   1) Carboline: 890 2-Component Epoxy.
   2) DuPont: Corlar 26P High Solids Epoxy Enamel.
   3) ICI: Tru-Glaze-WB 4408 Waterborne Epoxy Gloss Coating.
   4) International: Intergard 740 Thin Film Gloss Polyamide Epoxy.
   5) Moore: M43/M44 Acrylic Epoxy Gloss Coating.
   6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
   7) R-O: 9100 System Labor Saver High Performance Polyamine Epoxy at 5.0- to 8.0-mil dry film thickness.
   8) S-W: Tile Clad II High Solids B62WZ Series B60VZ70.
   9) Tnemec: Series 84 H. S. Epoxy.

4. Moderate Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.

   a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
      1) Carboline: 888 2-Component Polyamide Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Tru-Glaze-WB 4406 Waterborne Epoxy Semigloss Coating.
      4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
      5) PPG: 97-14XX Series Pitt-Guard DTR Epoxy.
      6) R-O: 9500 System High Build Polyamide Epoxy.
      7) S-W: Primer not required.
      8) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

   b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
      1) Carboline: 888 2-Component Polyamide Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Tru-Glaze-WB 4406 Waterborne Epoxy Semigloss Coating.
      4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.

5) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
6) R-O: Intermediate coat not required.
7) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
8) Tnemec: Intermediate coat not required.

c. Topcoat: Semigloss polyamide epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils, unless otherwise indicated.
1) Carboline: 888 2-Component Polyamide Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Tru-Glaze-WB 4406 Waterborne Epoxy Semigloss Coating.
4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
5) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
6) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.
7) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
8) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

5. Mild Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Acrylic or epoxy primer, as recommended by manufacturer for this substrate, applied at spreading rate recommended by manufacturer.
1) DuPont: 25P High Solids Epoxy Mastic.
2) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
3) International: Intercryl 520 WB Waterborne Acrylic Primer or Finish.
4) Moore: M04 Acrylic Metal Primer.
5) PPG: 6-603 Speedhide Interior/Exterior Acrylic Latex Alkali Resistant Primer.
6) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
7) S-W: PrepRite Masonry Primer B28W300 Series.
8) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.
1) DuPont: Corlar 76P 2-Component Waterborne Acrylic Epoxy Enamel.
2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
4) Moore: M28 Acrylic Gloss Enamel.
5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Intermediate coat not required.

c. Topcoat: High-gloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.
1) DuPont: Corlar 76P 2-Component Waterborne Acrylic Epoxy Enamel.
2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
4) Moore: M28 Acrylic Gloss Enamel.
5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic

Finishes.

7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Series 28 Tufcryl Acrylic Emulsion.

6. Mild Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Acrylic primer applied at spreading rate recommended by manufacturer.
      1) Carboline: Multi-Bond 120 Waterborne Acrylic Primer.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
      4) International: Intercryl 520 WB Waterborne Acrylic Primer or Finish.
      5) Moore: M04 Acrylic Metal Primer.
      6) PPG: 6-603 Speedhide Interior/Exterior Acrylic Latex Alkali Resistant Primer.
      7) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primer.
      8) S-W: PrepRite Masonry Primer B28W300 Series.
      9) Tnemec: Series 29 Tufcryl Acrylic Emulsion.
   b. Intermediate Coat: Waterborne acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) Carboline: 3359 Water-Borne Acrylic.
      2) DuPont: Intermediate coat not required.
      3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semigloss Enamel.
      4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
      5) Moore: M29 D.T.M. Acrylic Semi-Gloss Finish.
      6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
      7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Semi-Gloss Acrylic Finishes.
      8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
      9) Tnemec: Intermediate coat not required.
   c. Topcoat: Semigloss acrylic emulsion applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) Carboline: 3359 Water-Borne Acrylic.
      2) DuPont: Tufcote 72P Waterborne DTM Acrylic Enamel.
      3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semigloss Enamel.
      4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
      5) Moore: M29 D.T.M. Acrylic Semi-Gloss Finish.
      6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
      7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Semi-Gloss Acrylic Finishes.
      8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
      9) Tnemec: Series 29 Tufcryl Acrylic Emulsion.

B. Concrete Masonry Units: Provide the following finish systems over interior concrete masonry block:

1. Severe Environment (High-Gloss Finish): One finish coat over an intermediate coat and a block filler.
   a. Block Filler: Acrylic or epoxy block filler applied at spreading rate recommended by manufacturer as sufficient to fill pores.
      1) Carboline: Flexide Masonry Block Filler.
      2) DuPont: 300P Acrylic Emulsion Block Filler.
      3) ICI: Tru-Glaze 4010 Waterproofing Base Coat and Filler.
      4) International: Interlac 895 Epoxy Ester Block Filler.

5) Moore: M31/M32 Waterborne Epoxy Block Filler.
6) PPG: 97-68X Series Aquapon Polyamide-Epoxy Block Filler.
7) R-O: 5199 Block Filler Surfa-Sele.
8) S-W: Epoxy Ester Masonry Filler Sealer B61W2 Series.
9) Tnemec: Series 130 Envirofill Waterborne Cementitious Acrylic.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils, unless otherwise indicated.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: Corlar 26P HB DTM High Build Epoxy Enamel.
3) ICI: Devran 224HS High Build Epoxy.
4) International: Intermediate coat not required.
5) Moore: M36/M37 Polyamide Epoxy Gloss Coating.
6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
7) R-O: 9100 System Labor Saver High Performance Polyamine Epoxy at 5.0- to 8.0-mil dry film thickness.
8) S-W: Tile Clad II High Solids B62WX Series B60V3.
9) Tnemec: Series 84 H. S. Epoxy.

c. Topcoat: High-gloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils, unless otherwise indicated.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: Corlar 26P HB DTM High Build Epoxy Enamel.
3) ICI: Devran 250 Direct to Metal Gloss Enamel.
4) International: Intergard 607 HS High Build Gloss Polyamine Epoxy Finish at 8.0-mil dry film thickness.
5) Moore: M36/M37 Polyamide Epoxy Gloss Coating.
6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
7) R-O: 9100 System Labor Saver High Performance Polyamine Epoxy at 5.0- to 8.0-mil dry film thickness.
8) S-W: Tile Clad II High Solids B62WX Series B60V3.
9) Tnemec: Series 84 H. S. Epoxy.

2. Severe Environment (Semigloss Finish): One finish coat over an intermediate coat and a block filler.

a. Block Filler: Acrylic or epoxy block filler applied at spreading rate recommended by manufacturer as sufficient to fill pores.
1) Carboline: Flexide Masonry Block Filler.
2) DuPont: 300P Acrylic Emulsion Block Filler.
3) ICI: Tru-Glaze 4010 Waterproofing Base Coat and Filler.
4) International: Interlac 895 Epoxy Ester Block Filler.
5) Moore: M31/M32 Waterborne Epoxy Block Filler.
6) PPG: 97-68X Series Aquapon Polyamide-Epoxy Block Filler.
7) R-O: 5199 Block Filler Surfa-Sele.
8) S-W: Epoxy Ester Masonry Filler Sealer B61W2 Series.
9) Tnemec: Series 130 Envirofill Waterborne Cementitious Acrylic.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils, unless otherwise indicated.
1) Carboline: 888 2-Component Polyamide Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 224HS High Build Epoxy.
4) International: Intergard 345 DTM Semi-Gloss Epoxy.
5) Moore: M36/M38 Polyamide Epoxy Semi-Gloss Coating.
6) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
7) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.

8) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
9) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

c. Topcoat: Semigloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils, unless otherwise indicated.
1) Carboline: 2-Component Polyamide Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 224HS High Build Epoxy.
4) International: Intergard 345 DTM Semi-Gloss Epoxy.
5) Moore: M36/M38 Polyamide Epoxy Semi-Gloss Coating.
6) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
7) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.
8) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
9) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

3. Moderate Environment (High-Gloss Finish): One finish coat over an intermediate coat and a block filler.

a. Block Filler: Acrylic or epoxy block filler applied at spreading rate recommended by manufacturer as sufficient to fill pores.
1) Carboline: Flexide Masonry Block Filler.
2) DuPont: 300P Acrylic Emulsion Block Filler.
3) ICI: Bloxfil 4000 Interior/Exterior Heavy Duty Acrylic Block Filler.
4) International: Interlac 895 Epoxy Ester Block Filler.
5) Moore: M31/M32 Waterborne Epoxy Block Filler.
6) PPG: 97-68X Series Aquapon Polyamide-Epoxy Block Filler.
7) R-O: 5199 Block Filler Surfa-Sele.
8) S-W: Epoxy Ester Masonry Filler Sealer B61W2 Series.
9) Tnemec: Series 130 Envirofill Waterborne Cementitious Acrylic.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 6.0 mils, unless otherwise indicated.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: Corlar 26P HB DTM High Build Epoxy Enamel.
3) ICI: Devran 224 HS High Build Epoxy Enamel.
4) International: Intergard 740 Thin Film Gloss Polyamide Epoxy.
5) Moore: M36/M37 Polyamide Epoxy Gloss Coating.
6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coatings.
7) R-O: 9100 System Labor Saver High Performance Epoxy at 5.0- to 8.0-mil dry film thickness.
8) S-W: Tile Clad II High Solids B62WZ Series B60VZ70.
9) Tnemec: Series 84 H. S. Epoxy.

c. Topcoat: High-gloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 6.0 mils, unless otherwise indicated.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: Corlar 26P HB DTM High Build Epoxy Enamel.
3) ICI: Devran 250 Direct to Metal Gloss Epoxy.
4) International: Intergard 740 Thin Film Gloss Polyamide Epoxy.
5) Moore: M36/M37 Polyamide Epoxy Gloss Coating.
6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
7) R-O: 9100 System Labor Saver High Performance Polyamine Epoxy at 5.0- to 8.0-mil dry film thickness.
8) S-W: Tile Clad II High Solids B62WZ Series B60VZ70.
9) Tnemec: Series 84 H. S. Epoxy.

4. Moderate Environment (Semigloss Finish): One finish coat over an intermediate coat and a block filler.

a. Block Filler: Acrylic or epoxy block filler applied at spreading rate recommended by manufacturer as sufficient to fill pores.
   1) Carboline: Flexide Masonry Block Filler.
   2) DuPont: 300P Acrylic Emulsion Block Filler.
   3) ICI: Bloxfil 4000 Interior/Exterior Heavy Duty Acrylic Block Filler.
   4) International: Interlac 895 Epoxy Ester Block Filler.
   5) PPG: 97-68X Series Aquapon Polyamide-Epoxy Block Filler.
   6) R-O: 5199 Block Filler Surfa-Sele.
   7) S-W: Epoxy Ester Masonry Filler Sealer B61W2 Series.
   8) Tnemec: Series 130 Envirofill Waterborne Cementitious Acrylic.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils, unless otherwise indicated.
   1) Carboline: Sanitile 250 WB Finish Waterborne Epoxy-Acrylic.
   2) DuPont: 25P High Solids Epoxy Mastic.
   3) ICI: Devran 224 HS High Build Epoxy Enamel.
   4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
   5) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
   6) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.
   7) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
   8) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

c. Topcoat: Semigloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils, unless otherwise indicated.
   1) Carboline: Sanitile 250 WB Finish Waterborne Epoxy-Acrylic.
   2) DuPont: 25P High Solids Epoxy Mastic.
   3) ICI: Devran 224 HS High Build Epoxy Enamel.
   4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
   5) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
   6) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.
   7) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
   8) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

5. Mild Environment (High-Gloss Finish): One finish coat over an intermediate coat and a block filler.

   a. Block Filler: Acrylic or epoxy block filler applied at spreading rate recommended by manufacturer as sufficient to fill pores.
      1) DuPont: 300P Acrylic Emulsion Block Filler.
      2) ICI: Bloxfil 4000 Interior/Exterior Heavy Duty Acrylic Block Filler.
      3) International: Porter Acri-Fil 896 Acrylic Block Filler.
      4) Moore: M88 Latex Block Filler.
      5) PPG: 16-90 Pitt-Glaze High Performance Acrylic Latex Block Filler.
      6) R-O: 5199 Block Filler Surfa-Sele.
      7) S-W: Heavy Duty Block Filler B42W46.
      8) Tnemec: Latex Masonry Block Filler.

   b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.
      1) DuPont: Corlar 76P 2-Component Waterborne Acrylic Epoxy Enamel.
      2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
      3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
      4) Moore: M28 Acrylic Gloss Enamel.

5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Series 28 Tuf-Cryl Water Based Acrylic Emulsion.

c. Topcoat: High-gloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.
1) DuPont: Corlar 76P 2-Component Waterborne Acrylic Epoxy Enamel.
2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
4) Moore: M28 Acrylic Gloss Enamel.
5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Series 28 Tuf-Cryl Water Based Acrylic Emulsion.

6. Mild Environment (Semigloss Finish): One finish coat over an intermediate coat and a block filler.

a. Block Filler: Acrylic or epoxy block filler applied at spreading rate recommended by manufacturer as sufficient to fill pores.
1) Carboline: Flexide Masonry Block Filler.
2) DuPont: 300P Acrylic Emulsion Block Filler.
3) ICI: Bloxfil 4000 Interior/Exterior Heavy Duty Acrylic Block Filler.
4) International: Porter Acri-Fil 896 Acrylic Block Filler.
5) Moore: M88 Latex Block Filler.
6) PPG: 16-90 Pitt-Glaze High Performance Acrylic Latex Block Filler.
7) R-O: 5199 Block Filler Surfa-Sele.
8) S-W: Heavy Duty Block Filler B42W46.
9) Tnemec: Latex Masonry Block Filler.

b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 3359 Water-Borne Acrylic.
2) DuPont: Intermediate coat not required.
3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semigloss Enamel.
4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
5) Moore: M29 D.T.M. Acrylic Semi-Gloss Finish.
6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Semi-Gloss Acrylic Finishes.
8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
9) Tnemec: Series 29 Tuf-Cryl Water Based Acrylic Emulsion.

c. Topcoat: Semigloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) Carboline: 3359 Water-Borne Acrylic.
2) DuPont: Tufcote 72P Waterborne DTM Acrylic Enamel.
3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semigloss Enamel.
4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
5) Moore: M29 D.T.M. Acrylic Semi-Gloss Finish.
6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Semi-

Gloss Acrylic Finishes.
8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
9) Tnemec: Series 28 Tuf-Cryl Water Based Acrylic Emulsion.

C. Wood: Provide the following finish systems over interior wood surfaces:

1. Severe Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devran 224HS High Build Epoxy.
      4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish thinned 15 percent.
      5) Moore: M08/M09 Waterborne Epoxy Primer.
      6) S-W: Heavy Duty Epoxy B67W300 Series/B60V3.
      7) Tnemec: Series 151 Elasto-Grip Waterborne Polyamide Epoxy.
   b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: Corlar 26P High Solids Epoxy Enamel.
      3) ICI: Devran 224 HS High Build Epoxy Enamel.
      4) International: Intermediate coat not required.
      5) Moore: M36/M37 Polyamide Epoxy Gloss Coating.
      6) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
      7) Tnemec: Series 84 H. S. Epoxy.
   c. Topcoat: High-gloss polyamide epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 8.0 mils.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: Corlar 26P High Solids Epoxy Enamel.
      3) ICI: Devran 250 Direct to Metal Gloss Epoxy.
      4) International: Intergard 607 HS High Build Gloss Polyamine Epoxy Finish at 8.0-mil dry film thickness.
      5) Moore: M36/M37 Polyamide Epoxy Gloss Coating.
      6) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
      7) Tnemec: Series 84 H. S. Epoxy.
2. Severe Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
      1) Carboline: 888 2-Component Polyamide Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devran 224HS High Build Epoxy.
      4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish thinned 15 percent.
      5) Moore: M08/M09 Waterborne Epoxy Primer.
      6) S-W: Heavy Duty Epoxy B67W300 Series/B60V3.
      7) Tnemec: Series 151 Elasto-Grip Waterborne Polyamide Epoxy.
   b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
      1) Carboline: 888 2-Component Polyamide Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devran 224HS High Build Epoxy.
      4) International: Intergard 345 DTM Semi-Gloss Epoxy.
      5) Moore: M36/M38 Polyamide Epoxy Semi-Gloss Coating.

6) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
7) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

c. Topcoat: Semigloss polyamide epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
1) Carboline: 888 2-Component Polyamide Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 224HS High Build Epoxy Enamel.
4) International: Intergard 345 DTM Semi-Gloss Epoxy.
5) Moore: M36/M38 Polyamide Epoxy Semi-Gloss Coating.
6) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
7) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

3. Moderate Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Tru-Glaze-WB 4408 Waterborne Epoxy Gloss Coating.
4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish thinned 15 percent.
5) Moore: M08/M09 Waterborne Epoxy Primer.
6) R-O: 9100 System Labor Saver High Performance Epoxy.
7) S-W: Heavy Duty Epoxy B67W300 Series/B60V3.
8) Tnemec: Series 151 Elasto-Grip Waterborne Polyamide Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: Corlar 26P High Solids Epoxy Enamel.
3) ICI: Tru-Glaze-WB 4408 Waterborne Epoxy Gloss Coating (129XX).
4) International: Intergard 740 Thin Film Gloss Polyamide Epoxy.
5) Moore: M43/M44 Acrylic Epoxy Gloss Coating.
6) R-O: Intermediate coat not required.
7) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
8) Tnemec: Series 28 Tuf-Cryl Water Based Acrylic Emulsion.

c. Topcoat: High-gloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils, unless otherwise indicated.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: Corlar 26P High Solids Epoxy Enamel.
3) ICI: Tru-Glaze-WB 4408 Waterborne Epoxy Gloss Coating (129XX).
4) International: Intergard 740 Thin Film Gloss Polyamide Epoxy.
5) Moore: M43/M44 Acrylic Epoxy Gloss Coating.
6) R-O: 9100 System Labor Saver High Performance Epoxy at 5.0- to 8.0-mil dry film thickness.
7) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
8) Tnemec: Series 28 Tuf-Cryl Water Based Acrylic Emulsion.

4. Moderate Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Acrylic or epoxy primer, as recommended by manufacturer for this substrate, applied at spreading rate recommended by manufacturer.
1) Carboline: Multi-Bond 120 Waterborne Acrylic Primer.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Tru-Glaze-WB 4406 Waterborne Epoxy Semigloss Coating (128XX).
4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish thinned 15 percent.

5) R-O: 9500 System High Build Polyamide Epoxy.
6) S-W: Heavy Duty Epoxy B67W300 Series/B60V3.
7) Tnemec: Series 151 Elasto-Grip Waterborne Polyamide Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 6.0 mils.
1) Carboline: Sanitile 250 WB Finish Waterborne Epoxy-Acrylic.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Tru-Glaze-WB 4406 Waterborne Epoxy Semigloss Coating (128XX).
4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
5) R-O: Intermediate coat not required.
6) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
7) Tnemec: Series 29 Tuf-Cryl Water Based Acrylic Emulsion.

c. Topcoat: Semigloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 6.0 mils, unless otherwise indicated.
1) Carboline: Sanitile 250 WB Finish Waterborne Epoxy-Acrylic.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Tru-Glaze-WB 4406 Waterborne Epoxy Semigloss Coating (128XX).
4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
5) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.
6) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
7) Tnemec: Series 29 Tuf-Cryl Water Based Acrylic Emulsion.

5. Mild Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Acrylic or alkyd primer, as recommended by manufacturer for this substrate, applied at spreading rate recommended by manufacturer.
1) DuPont: 310 Exterior Flat Industrial Acrylic Emulsion.
2) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
3) International: Porter 515 Acrylic Bonding Primer.
4) Moore: Super-Hide Latex Primer-Undercoater 284.
5) PPG: 6-855 Speedhide Interior Latex Enamel Undercoater.
6) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
7) S-W: ProMar 200 Alkyd Enamel Undercoater B49W200.
8) Tnemec: Series 51-792 PVA Sealer.

b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
1) DuPont: Intermediate coat not required.
2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
4) Moore: M28 Acrylic Gloss Enamel.
5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Series 28 Tuf-Cryl Water Based Acrylic Emulsion.

c. Topcoat: High-gloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.
1) DuPont: Corlar 76P Waterborne Acrylic Epoxy Enamel.
2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.

3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
4) Moore: M28 Acrylic Gloss Enamel.
5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/ Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
8) Tnemec: Series 28 Tuf-Cryl Water Based Acrylic Emulsion.

6. Mild Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Acrylic or alkyd primer, as recommended by manufacturer for this substrate, applied at spreading rate recommended by manufacturer.
      1) Carboline: Multi-Bond 120 Waterborne Acrylic Primer.
      2) DuPont: 310 Exterior Flat Industrial Acrylic Emulsion.
      3) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
      4) International: Porter 515 Acrylic Bonding Primer.
      5) Moore: Super-Hide Latex Primer-Undercoater 284.
      6) PPG: 6-855 Speedhide Interior Latex Enamel Undercoater.
      7) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
      8) S-W: ProMar 200 Alkyd Enamel Undercoater B49W200.
      9) Tnemec: Series 51-792 PVA Sealer.
   b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) Carboline: 3359 Water-Borne Acrylic.
      2) DuPont: Intermediate coat not required.
      3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semigloss Enamel.
      4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
      5) Moore: M29 D.T.M. Acrylic Semi-Gloss Finish.
      6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
      7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Semi-Gloss Acrylic Finishes.
      8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
      9) Tnemec: Series 29 Tuf-Cryl Water Based Acrylic Emulsion.
   c. Topcoat: Semigloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) Carboline: 3359 Water-Borne Acrylic.
      2) DuPont: Tufcote 72P DTM Waterborne Acrylic Enamel.
      3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semigloss Enamel.
      4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
      5) Moore: M29 D.T.M. Acrylic Semi-Gloss Finish.
      6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
      7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Semi-Gloss Acrylic Finishes.
      8) S-W: DTM Acrylic Semi-Gloss Coating B66W2100 Series.
      9) Tnemec: Series 29 Tuf-Cryl Water Based Acrylic Emulsion.

D. Ferrous Metal: Provide the following finish systems over interior ferrous-metal surfaces:

1. Severe Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
      1) Carboline: 893 2-Component, High Build Epoxy Primer.

2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 224HS High Build Epoxy.
4) International: Intergard 251 Thin Film Polyamide Epoxy Rust Inhibitive Primer.
5) Moore: M33/M34 Polyamide Epoxy Metal Primer.
6) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
7) R-O: 9100 System Labor Saver High Performance Epoxy.
8) S-W: Recoatable Epoxy Primer B67 Series/B67V5.
9) Tnemec: 27 F. C. Typoxy Polyamide Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: Corlar 26P HB DTM High Build Epoxy Enamel.
3) ICI: Devran 224HS High Build Epoxy.
4) International: Intermediate coat not required.
5) Moore: M36/M38 Polyamide Epoxy Semi-Gloss Coating.
6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
7) R-O: Intermediate coat not required.
8) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
9) Tnemec: Series 84 H. S. Epoxy.

c. Topcoat: High-gloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils, unless otherwise indicated.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: Corlar 26P HB DTM High Build Epoxy Enamel.
3) ICI: Devthane 250 Direct-to Metal (DTM) Gloss Epoxy.
4) International: Intergard 607 HS High Build Gloss Polyamine Epoxy Finish at 8.0-mil dry film thickness.
5) Moore: M36/M37 Polyamide Epoxy Gloss Coating.
6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
7) R-O: 9100 System Labor Saver High Performance Epoxy at 5.0- to 8.0-mil dry film thickness.
8) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
9) Tnemec: Series 84 H. S. Epoxy.

2. Severe Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
1) Carboline: 888 2-Component Polyamide Epoxy at 2.0 to 4 mils.
2) DuPont: 25P High Solids Epoxy Mastic at 4.0-mil dry film thickness.
3) ICI: Devran 224HS High Build Epoxy at 4.0-mil dry film thickness.
4) International: Intergard 251 Thin Film Polyamide Epoxy Rust Inhibitive Primer at 2.0-mil dry film thickness.
5) Moore: M33/M34 Polyamide Epoxy Metal Primer at 2.0-mil dry film thickness.
6) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating at 6.0-mil dry film thickness.
7) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.
8) S-W: Recoatable Epoxy Primer B67 Series/B67V5 at 4.0- to 6.0-mil dry film thickness.
9) Tnemec: 27 F. C. Typoxy Polyamide Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 4.0 mils.
1) Carboline: 888 2-Component Polyamide Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.

3) ICI: Devran 224HS High Build Epoxy.
4) International: Intergard 345 DTM Semi-Gloss Epoxy.
5) Moore: M36/M38 Polyamide Epoxy Semi-Gloss Coating.
6) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
7) R-O: Intermediate coat not required.
8) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
9) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

c. Topcoat: Semigloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
1) Carboline: 888 2-Component Polyamide Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 224HS High Build Epoxy.
4) International: Intergard 345 DTM Semi-Gloss Epoxy.
5) Moore: M36/M38 Polyamide Epoxy Semi-Gloss Coating.
6) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
7) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.
8) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
9) Tnemec: Series 66 Hi-Build Epoxoline Polamidoamine Epoxy.

3. Moderate Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
1) Carboline: 888 2-Component Polyamide Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Tru-Glaze-WB 4030 Waterborne Epoxy Primer.
4) International: Intergard 251 Thin Film Polyamide Epoxy Rust Inhibitive Primer.
5) Moore: M08/M09 Waterborne Epoxy Primer.
6) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
7) R-O: 9100 System Labor Saver High Performance Epoxy.
8) S-W: Recoatable Epoxy Primer B67 Series/B67V5.
9) Tnemec: 27 F. C. Typoxy Polyamide Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: Corlar 26P High Solids Epoxy Enamel.
3) ICI: Tru-Glaze-WB 4408 Waterborne Epoxy Gloss Coating (129XX).
4) International: Intergard 740 Thin Film Gloss Polyamide Epoxy.
5) Moore: M43/M44 Acrylic Epoxy Gloss Coating.
6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
7) R-O: Intermediate coat not required.
8) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
9) Tnemec: Series 84 H. S. Epoxy.

c. Topcoat: High-gloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils, unless otherwise indicated.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: Corlar 26P High Solids Epoxy Enamel.
3) ICI: Tru-Glaze-WB 4408 Waterborne Epoxy Gloss Coating (129XX).
4) International: Intergard 740 Thin Film Gloss Polyamide Epoxy.
5) Moore: M43/M44 Acrylic Epoxy Gloss Coating.
6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
7) R-O: 9100 System Labor Saver High Performance Epoxy at 5.0- to 8.0-mil

dry film thickness.
8) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
9) Tnemec: Series 84 H. S. Epoxy.

4. Moderate Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.
      1) Carboline: 888 2-Component Polyamide Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Tru-Glaze-WB 4030 Waterborne Epoxy Primer.
      4) International: Intergard 251 Thin Film Polyamide Epoxy Rust Inhibitive Primer.
      5) PPG: 97-14XX Series Pitt-Guard DTR Polyamide Epoxy Coating.
      6) R-O: 9500 System High Build Polyamide Epoxy.
      7) S-W: Recoatable Epoxy Primer B67 Series/B67V5.
      8) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.
   b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
      1) Carboline: Sanitile 250 WB Finish Waterborne Epoxy-Acrylic.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Tru-Glaze-WB 4406 Waterborne Epoxy Semigloss Coating (128XX).
      4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
      5) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
      6) R-O: Intermediate coat not required.
      7) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
      8) Tnemec: Series 66 Hi-Build Epoxoline.
   c. Topcoat: Semigloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils, unless otherwise indicated.
      1) Carboline: Sanitile 250 WB Finish Waterborne Epoxy-Acrylic.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Tru-Glaze-WB 4406 Waterborne Epoxy Semigloss Coating (128XX).
      4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
      5) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
      6) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.
      7) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
      8) Tnemec: Series 66 Hi-Build Epoxoline.

5. Mild Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Acrylic, alkyd, or epoxy primer, as recommended by manufacturer for this substrate, applied at spreading rate recommended by manufacturer.
      1) DuPont: 25P High Solids Epoxy Mastic.
      2) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
      3) International: Intercryl 520 WB Waterborne Acrylic Primer or Finish.
      4) Moore: M04 Acrylic Metal Primer.
      5) PPG: 90-7XX Series Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel.
      6) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
      7) S-W: Kem Kromik Universal Metal Primer B50Z Series.
      8) Tnemec: Series 18 Enviroprime.

b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.
   1) DuPont: Intermediate coat not required.
   2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
   3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
   4) Moore: M28 Acrylic Gloss Enamel.
   5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
   6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
   7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
   8) Tnemec: Series 28 Tuf-Cryl Water Based Acrylic Emulsion.

c. Topcoat: High-gloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
   1) DuPont: Corlar 76P Waterborne Acrylic Epoxy Enamel.
   2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
   3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
   4) Moore: M28 Acrylic Gloss Enamel.
   5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
   6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
   7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
   8) Tnemec: Series 28 Tuf-Cryl Water Based Acrylic Emulsion.

6. Mild Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.

   a. Primer: Acrylic or epoxy primer, as recommended by manufacturer for this substrate, applied at spreading rate recommended by manufacturer.
      1) Carboline: 888 2-Component Polyamide Epoxy.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
      4) International: Intercryl 520 WB Waterborne Acrylic Primer or Finish.
      5) Moore: M04 Acrylic Metal Primer.
      6) PPG: 90-7XX Series Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel.
      7) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
      8) S-W: Kem Kromik Universal Metal Primer B50Z Series.
      9) Tnemec: Series 18 Enviroprime.

   b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.
      1) Carboline: 3359 Water-Borne Acrylic.
      2) DuPont: Intermediate coat not required.
      3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semigloss Enamel.
      4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
      5) Moore: M29 D.T.M. Acrylic Semi-Gloss Finish.
      6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
      7) R-O: 5200 System Labor Saver Industrial Enamel Semi-Gloss High Performance Acrylic Finishes.
      8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
      9) Tnemec: Series 29 Tuf-Cryl Water Based Acrylic Emulsion.

   c. Topcoat: Semigloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.

1) Carboline: 3359 Water-Borne Acrylic.
2) DuPont: Tufcote 72P DTM Waterborne Acrylic Enamel.
3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semigloss Enamel.
4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
5) Moore: M29 D.T.M. Acrylic Semi-Gloss Finish.
6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
7) R-O: 5200 System Labor Saver Industrial Enamel Semi-Gloss High Performance Acrylic Finishes.
8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
9) Tnemec: Series 29 Tuf-Cryl Water Based Acrylic Emulsion.

E. Nonferrous Metal: Provide the following finish systems over interior nonferrous-metal surfaces:

1. Severe Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Acrylic or epoxy primer, as recommended by manufacturer for this substrate, applied at spreading rate recommended by manufacturer.
      1) Carboline: Rustbond Penetrating Sealer SG.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devran 4170 Corrosion Resistant Epoxy Primer.
      4) International: Intergard 251 Thin Film Polyamide Epoxy Rust Inhibitive Primer.
      5) Moore: M33/M34 Polyamide Epoxy Metal Primer.
      6) PPG: 97-14XX Series Pitt-Guard DTR Epoxy.
      7) R-O: 9100 System Labor Saver High Performance Epoxy.
      8) S-W: DTM Wash Primer B71Y1.
      9) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.
   b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 5.0 mils.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: Corlar 26P High Solids Epoxy Enamel.
      3) ICI: Devran 224HS High Build Epoxy.
      4) International: Intermediate coat not required.
      5) Moore: M36/M38 Polyamide Epoxy Semi-Gloss Coating.
      6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
      7) R-O: Intermediate coat not required.
      8) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
      9) Tnemec: Intermediate coat not required.
   c. Topcoat: High-gloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 5.0 mils, unless otherwise indicated.
      1) Carboline: 890 2-Component Epoxy.
      2) DuPont: Corlar 26P High Solids Epoxy Enamel.
      3) ICI: Devran 250 Direct-to Metal (DTM) Gloss Epoxy.
      4) International: Intergard 607 HS High Build Gloss Polyamine Epoxy Finish at 8.0-mil dry film thickness.
      5) Moore: M36/M37 Polyamide Epoxy Gloss Coating.
      6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
      7) R-O: 9100 System Labor Saver High Performance Epoxy at 5.0- to 8.0-mil dry film thickness.
      8) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
      9) Tnemec: Series 84 H. S. Epoxy.
2. Severe Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Acrylic or epoxy primer, as recommended by manufacturer for this substrate, applied at spreading rate recommended by manufacturer.
   1) Carboline: 888 2-Component Polyamide Epoxy.
   2) DuPont: 25P High Solids Epoxy Mastic.
   3) ICI: Devran 4170 Corrosion Resistant Epoxy Primer.
   4) International: Intergard 251 Thin Film Polyamide Epoxy Rust Inhibitive Primer.
   5) PPG: 97-14XX Series Pitt-Guard DTR Epoxy.
   6) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.
   7) S-W: DTM Wash Primer B71Y1.
   8) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
   1) Carboline: 888 2-Component Polyamide Epoxy.
   2) DuPont: 25P High Solids Epoxy Mastic.
   3) ICI: Devran 224HS High Build Epoxy.
   4) International: Intergard 345 DTM Semi-Gloss Epoxy.
   5) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
   6) R-O: Intermediate coat not required.
   7) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
   8) Tnemec: Intermediate coat not required.

c. Topcoat: Semigloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils, unless otherwise indicated.
   1) Carboline: 888 2-Component Polyamide Epoxy.
   2) DuPont: 25P High Solids Epoxy Mastic.
   3) ICI: Devran 224HS High Build Epoxy.
   4) International: Intergard 345 DTM Semi-Gloss Epoxy.
   5) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
   6) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.
   7) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
   8) Tnemec: Series 66 Hi-Build Epoxoline.

3. Moderate Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Acrylic or epoxy primer, as recommended by manufacturer for this substrate, applied at spreading rate recommended by manufacturer.
   1) Carboline: Multi-Bond 120 Waterborne Acrylic Primer.
   2) DuPont: 25P High Solids Epoxy Mastic.
   3) ICI: Devran 4170 Corrosion Resistant Epoxy Primer.
   4) International: Intergard 251 Thin Film Polyamide Epoxy Rust Inhibitive Primer.
   5) Moore: M15 Bonding Primer.
   6) PPG: 97-14XX Series Pitt-Guard DTR Epoxy.
   7) R-O: 9391 Heavy-Duty Polyamide Epoxy White Primer.
   8) S-W: DTM Wash Primer B71Y1.
   9) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.
   1) Carboline: 890 2-Component Epoxy.
   2) DuPont: Corlar 26P High Solids Epoxy Enamel.
   3) ICI: Tru-Glaze-WB 4408 Waterborne Epoxy Gloss Coating (129XX).

4) International: Intergard 740 Thin Film Gloss Polyamide Epoxy.
5) Moore: M43/M44 Acrylic Epoxy Gloss Coating.
6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
7) R-O: 9300 System Heavy Duty Epoxy Finish.
8) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
9) Tnemec: Intermediate coat not required.

c. Topcoat: High-gloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.
1) Carboline: 890 2-Component Epoxy.
2) DuPont: Corlar 26P High Solids Epoxy Enamel.
3) ICI: Tru-Glaze-WB 4408 Waterborne Epoxy Gloss Coating (129XX).
4) International: Intergard 740 Thin Film Gloss Polyamide Epoxy.
5) Moore: M43/M44 Acrylic Epoxy Gloss Coating.
6) PPG: 97-1XXX Series Aquapon Polyamide-Epoxy Coating.
7) R-O: 9300 System Heavy Duty Epoxy Finish.
8) S-W: Tile Clad II High Solids B62WZ Series/B60VZ70.
9) Tnemec: Series 84 H. S. Epoxy.

4. Moderate Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.

a. Primer: Acrylic or epoxy primer, as recommended by manufacturer for this substrate, applied at spreading rate recommended by manufacturer.
1) Carboline: Multi-Bond 120 Waterborne Acrylic Primer.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Devran 4170 Corrosion Resistant Epoxy Primer.
4) International: Intergard 251 Thin Film Polyamide Epoxy Rust Inhibitive Primer.
5) PPG: 97-14XX Series Pitt-Guard DTR Epoxy.
6) R-O: 9500 System High Build Polyamide Epoxy.
7) S-W: DTM Wash Primer B71Y1.
8) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.

b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
1) Carboline: Sanitile 250 WB Finish Waterborne Epoxy-Acrylic.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Tru-Glaze-WB 4406 Waterborne Epoxy Semigloss Coating (128XX).
4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
5) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
6) R-O: Intermediate coat not required.
7) S-W: Epolon II Multi-Mil Epoxy Series B62V800.
8) Tnemec: Intermediate coat not required.

c. Topcoat: Semigloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils, unless otherwise indicated.
1) Carboline: Sanitile 250 WB Finish Waterborne Epoxy-Acrylic.
2) DuPont: 25P High Solids Epoxy Mastic.
3) ICI: Tru-Glaze-WB 4406 Waterborne Epoxy Semigloss Coating (128XX).
4) International: Intergard 475 Semi-Gloss Polyamide Epoxy Intermediate/Finish.
5) PPG: 97-1XXX Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
6) R-O: 9500 System High Build Polyamide Epoxy at 5.0- to 8.0-mil dry film thickness.
7) S-W: Epolon II Multi-Mil Epoxy Series B62V800.

8) Tnemec: Series 66 Hi-Build Epoxoline.

5. Mild Environment (High-Gloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Acrylic or epoxy primer, as recommended by manufacturer for this substrate, applied at spreading rate recommended by manufacturer.
      1) DuPont: 25P High Solids Epoxy Mastic.
      2) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
      3) International: Intercryl 520 WB Waterborne Acrylic Primer or Finish.
      4) Moore: M15 Bonding Primer.
      5) PPG: 90-7XX Series Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel.
      6) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
      7) S-W: DTM Wash Primer B71Y1.
      8) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.
   b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) DuPont: Intermediate coat not required.
      2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
      3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
      4) Moore: M28 Acrylic Gloss Enamel.
      5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
      6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
      7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
      8) Tnemec: Intermediate coat not required.
   c. Topcoat: High-gloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
      1) DuPont: Corlar 76P 2-Component Waterborne Acrylic Epoxy Enamel.
      2) ICI: Devflex 4208 Interior/Exterior Waterborne Acrylic Gloss Enamel.
      3) International: Intercryl 530 WB Waterborne Acrylic Gloss Finish.
      4) Moore: M28 Acrylic Gloss Enamel.
      5) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
      6) R-O: 5200 System Labor Saver Industrial Enamel High Performance Acrylic Finishes.
      7) S-W: DTM Acrylic Gloss Coating B66W100 Series.
      8) Tnemec: Series 28 Tuf-Cryl Water Based Acrylic Emulsion.

6. Mild Environment (Semigloss Finish): One finish coat over an intermediate coat and a primer.
   a. Primer: Acrylic or epoxy primer, as recommended by manufacturer for this substrate, applied at spreading rate recommended by manufacturer.
      1) Carboline: Multi-Bond 120 Waterborne Acrylic Primer.
      2) DuPont: 25P High Solids Epoxy Mastic.
      3) ICI: Devflex 4020 DTM Flat Interior/Exterior Waterborne Primer and Finish.
      4) International: Intercryl 520 WB Waterborne Acrylic Primer or Finish.
      5) Moore: M15 Bonding Primer.
      6) PPG: 90-7XX Series Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel.
      7) R-O: 5269/5281 System Labor Saver Industrial Enamel High Performance Acrylic Primers.
      8) S-W: DTM Wash Primer B71Y1.
      9) Tnemec: Series 27 F. C. Typoxy Polyamide Epoxy.

b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
   1) Carboline: 3359 Water-Borne Acrylic.
   2) DuPont: Intermediate coat not required.
   3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semigloss Enamel.
   4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
   5) Moore: M29 D.T.M. Acrylic Semi-Gloss Finish.
   6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
   7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Semi-Gloss Acrylic Finishes.
   8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
   9) Tnemec: Intermediate coat not required.

c. Topcoat: Semigloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.
   1) Carboline: 3359 Water-Borne Acrylic.
   2) DuPont: Corlar 76P 2-Component Waterborne Acrylic Epoxy Enamel.
   3) ICI: Devflex 4206 Interior/Exterior Waterborne Acrylic Semigloss Enamel.
   4) International: Intercryl 520 WB Waterborne Acrylic Semi-Gloss Finish.
   5) Moore: M29 D.T.M. Acrylic Semi-Gloss Finish.
   6) PPG: 90-4XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne Satin DTM Industrial Enamel.
   7) R-O: 5200 System Labor Saver Industrial Enamel High Performance Semi-Gloss Acrylic Finishes.
   8) S-W: DTM Acrylic Semi-Gloss Coating B66W200 Series.
   9) Tnemec: Series 29 Tuf-Cryl Water Based Acrylic Emulsion.

PART 3 - EXECUTION

3.01 EXAMINATION

A. With Applicator present, examine substrates and conditions under which high-performance coatings will be applied, for compliance with coating application requirements.

1. Apply coatings only after unsatisfactory conditions have been corrected and surfaces to receive coatings are thoroughly dry.

2. Start of application is construed as Applicator's acceptance of surfaces within that particular area.

B. Coordination of Work: Review other Sections in which primers or other coatings are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of specified finish materials to ensure compatible primers.

1. If a potential incompatibility of primers applied by others exists, obtain the following from the primer Applicator before proceeding:
   a. Confirmation of primer's suitability for expected service conditions.
   b. Confirmation of primer's ability to be top coated with materials specified.

2. Notify Architect about anticipated problems before using the coatings specified over substrates primed by others.

3.02 PREPARATION

A. General: Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item,

provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.

B. Cleaning: Before applying high-performance coatings, clean substrates of substances that could impair bond of coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and coating application so dust and other contaminates from cleaning process will not fall on wet, newly coated surfaces.

C. Surface Preparation: Clean and prepare surfaces to be coated according to manufacturer's written instructions for each substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove primers and reprime substrate.

2. Cementitious Substrates: Prepare concrete, brick, concrete masonry block, and cement plaster surfaces to be coated. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods to prepare surfaces.
   a. Use abrasive blast-cleaning methods if recommended by coating manufacturer.
   b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not coat surfaces if moisture content exceeds that permitted in manufacturer's written instructions.

3. Wood Substrates: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Smoothly sand surfaces exposed to view and dust off.
   a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer, before applying primer.
   b. Immediately on delivery, prime edges, ends, faces, undersides, and backsides of wood to be coated.
   c. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

4. Ferrous-Metal Substrates: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC recommendations.
   a. Blast-clean steel surfaces as recommended by coating manufacturer and according to SSPC-SP 10/NACE No. 2.
   b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
   c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire brush, solvent clean, and touch up with same primer as the shop coat.

5. Nonferrous-Metal Substrates: Clean nonferrous and galvanized surfaces according to manufacturer's written instructions for the type of service, metal substrate, and application required.
   a. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Material Preparation: Carefully mix and prepare coating materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
2. Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.
3. Use only the type of thinners approved by manufacturer and only within recommended limits.

E. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

3.03 APPLICATION

A. General: Apply high-performance coatings according to manufacturer's written instructions.

1. Use applicators and techniques best suited for the material being applied.
2. Do not apply high-performance coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.
3. Coating colors, surface treatments, and finishes are indicated in the coating system descriptions.
4. Provide finish coats compatible with primers used.
5. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, grilles, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
    a. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
    b. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

B. Scheduling Coating: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required is the same regardless of application method.
    a. Omit primer on metal surfaces that have been shop primed and touchup painted.
    b. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer.
    c. Where manufacturer's written instructions require sanding, sand between applications to produce a smooth, even surface.
    d. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until coating has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat does not cause undercoat to lift or lose adhesion.
2. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance. Give special attention to edges, corners, crevices, welds, exposed fasteners, and similar surfaces to ensure that they receive a dry film thickness equivalent to that of flat surfaces.

C. Application Procedures: Apply coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brush Application: Use brushes best suited for material applied and of appropriate size for the surface or item being coated.
   a. Apply primers and first coats by brush unless manufacturer's written instructions permit using roller or mechanical applicators.
   b. Brush out and work brush coats into surfaces in an even film.
   c. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.
2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for the material and texture required.
3. Spray Equipment: Use mechanical methods to apply coating if permitted by manufacturer's written instructions and governing regulations.
   a. Use spray equipment with orifice size recommended by manufacturer for material and texture required.
   b. Apply each coat to provide the equivalent hiding of brush-applied coats.
   c. Do not double back with spray equipment building-up film thickness of two coats in one pass, unless recommended by manufacturer.

D. Minimum Coating Thickness: Apply each material no thinner than manufacturer's recommended spreading rate. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

F. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by manufacturer, to material required to be coated or finished that has not been prime coated by others.

1. Recoat primed and sealed substrates if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn-through or other defects caused by insufficient sealing.

G. Completed Work: Match approved Samples for color, texture, and coverage. Remove, refinish, or recoat work that does not comply with specified requirements.

3.04 FIELD QUALITY CONTROL

A. Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coatings are being applied:

1. Owner will engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform appropriate tests for the following characteristics as required by Owner:
   a. Quantitative materials analysis.
   b. Absorption.
   c. Accelerated weathering.
   d. Accelerated yellowness.
   e. Color retention.

f. Alkali and mildew resistance.
g. Abrasion resistance.
h. Apparent reflectivity.
i. Washability.
j. Dry opacity.
k. Recoating.
l. Skinning.

3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove non-complying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. If necessary, Contractor may be required to remove rejected materials from previously coated surfaces if, on recoating with specified materials, the two coatings are not compatible.

3.05 CLEANING

A. Cleanup: At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3.06 PROTECTION

A. Protect work of other trades, whether being coated or not, against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

1. Provide "Wet Paint" signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.

2. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces. Comply with procedures specified in PDCA P1.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the lump sum contract price.

END OF SECTION 09960

DIVISION 15 – MECHANICAL

SECTION 15010

BASIC MECHANICAL REQUIREMENTS

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, Section 15050 - Basic Mechanical Materials and Methods and Contractor shall review and adhere to all requirements of these Documents.

1.02 WORK INCLUDED

A. Basic requirements common to the work in general of Division 15 and other Divisions and Sections of the Specification where referenced.

B. Provide, unless specified otherwise, all labor, materials and equipment necessary for completely finished and operational mechanical systems described and specified under other Sections of this Division 15.

C. Provide all minor incidental items such as offsets, fittings, and accessories required as part of the work even though not specified or indicated.

D. Inspection: Inspect work preceding or interfacing with work of Division 15 and report any known or observed defects that affect the Work to the General Contractor. Do not proceed with the work until defects are corrected.

1.03 REFERENCES

A. General.

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable Codes.

2. The date of the standard is that in effect as the date of the Contract Documents, except when a specific date is specified.

3. When required by individual Specifications Section by means of reference for cleaning or installation requirements, etc.; obtain a copy of the standard. Maintain the copy at job site during work until substantial completion. Copy may be in electronic format.

4. Schedule of Referenced Organizations: The following is a list of the acronyms of organizations referenced in these Specifications:

Acronym	Organization
AABC	Associated Air Balance Council
ABMA	American Bearing Manufacturers Association
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
ASA	American National Standards on Acoustics and Vibrations

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing of Materials
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ARI	American Refrigerants Institute
ATA	Air Transport Association of America
AWS	American Welding Society
AWWA	American Water Works Association
EPA	Environmental Protective Agency
ETL	Electrical Testing Laboratories
CISPI	Cast Iron Soil Pipe Institute
CTI	Cooling Tower Institute
FM	Factory Mutual Insurance Association
HI	Hydronics Institute
IBC	International Building Code
IFC	International Fire Code
ISA	Instrument Society of America
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NACE	National Association of Corrosion Engineers
NAPCA	National Association of Pipe Coating Applicators
NEMA	National Electrical Manufacturers Association
NEBB	National Environmental Balancing Bureau
NFPA	National Fire Protection Association
NIST	National Institute of Science and Technology
NSF	National Sanitation Foundation.
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
SSPC	The Society for Protective Coatings
STI	Steel Tank Institute
UL	Underwriters' Laboratories
WH	Warnock Hersey

1.04 DEFINITIONS

A. Conform to Division 1: These Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of the Contract Documents so indicates.

B. The following words are re-defined and/or elaborated on for the context of Division 15 work:

1. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.

2. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at Project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

3. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

4. General Contractor: The term "General Contractor" used in Division 15 and elsewhere in the Contract Documents means the party with whom the Owner has executed the Owner-Contractor Agreement.

1.05 QUALITY CONTROL

A. Conform to Division 1. Materials and apparatus required for the work to be new and of first-class quality; to be furnished, delivered, erected, connected and finished in every detail; and to be so selected and arranged so as to fit properly into the building spaces and also provide the manufacturer's recommended maintenance clearance. Where no specific kind or quality of material is given, a first-class standard article shall be furnished.

B. Unless otherwise specifically indicated, equipment and materials to be installed in accordance with the recommendations of the Manufacturer. This includes the performance of tests as recommended by the Manufacturer.

1.06 REGULATORY REQUIREMENTS

A. Comply with latest editions of all applicable Codes, Standards, Ordinances and Regulations in effect as of the date of the Contract Documents adopted by the City and County of Denver (CCD), Building Department (BD), and Fire Department (FD), including but not necessarily limited to the following:

1. National Electrical Code NFPA-70.
2. NFPA.
3. ASHRAE.
4. SMACNA.
5. Underwriters Laboratories.

B. If discrepancies occur between the Contract Documents and any applicable Codes, Guidelines, Ordinances, Acts, or Standards, the most stringent requirements shall apply.

C. Where hourly fire ratings are indicated or required, provide components and assemblies meeting requirements of the American Insurance Association, Factory Mutual Insurance Association and listed by Underwriters Laboratories, Inc.

1.07 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Substitutions: Refer to Division 1, General Requirements.

B. Some materials and equipment are specified by Manufacturer and catalog numbers. The Manufacturer and catalog numbers are used to establish a degree of quality and style for such equipment and material.

C. When alternate or substitute materials and equipment are used, Contractor shall be responsible for space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use.

D. When providing a product and/or service under the qualification of "acceptable equal," Contractor shall be entirely responsible for additional costs incurred due to modifications to

the civil, Architectural, structural, mechanical, and electrical design that may be required to accommodate the "acceptable equal."

E. Substitute materials and equipment are only allowed to be provided from the Manufacturers listed as approved.

1.08 SHOP DRAWINGS AND PRODUCT DATA

A. General: Comply with the General Conditions of the Contract and with Division 1 - General Requirements.

1. All documents shall be submitted in electronic format. Each submittal shall be in a single security free PDF document. PDF documents shall be compatible with Adobe Acrobat 8.0 or newer. All as-built documents shall be submitted in AutoCAD 2007 or newer format and PDF plot files of the project.

1.09 CONTRACT RECORD DOCUMENTS

A. General: Comply with the General Conditions of the Contract and with Division 1 - General Requirements,

1.10 OPERATING AND MAINTENANCE DATA

A. Division 15 Contractor shall submit one (1) CD-ROM containing a single searchable PDF file of the entire maintenance manual to the DIA Project Manager, General Contractor for their approval.

B. The manual shall have:

1. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.
2. Operating instructions for complete system, including emergency procedures for fire or failure of major equipment and procedures for normal starting/operating/shutdown and long-term shutdown.
3. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.
4. Manufacturer's data on each piece of equipment, including:
   a. Installation instructions.
   b. Drawings and specifications (approved shop drawings).
   c. Parts lists.
   d. Complete wiring and temperature control diagrams (approved shop drawings).
5. Each piece identified on any schedule shall be bookmarked in the electronic file by its scheduled tag ID (IE: AHU-1)

C. In addition to the maintenance manual, and keyed to it, the equipment shall be identified and tagged as specified elsewhere. Insert a copy.

1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches with permanently applied, legible markers corresponding to operating instructions in the "Maintenance Manual".

2. Tag all manual operating valves with 1-1/2" diameter brass tags attached with chains. Tags are to be sequence numbered with legible metal stamps.

3. Provide a typed tag list or schedule mounted under glass in the room designated by DIA Project Manager stating number, location, and function of each tagged item. Insert a copy of tag list in each "Maintenance Manual".

D. Division 15 Contractor shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the maintenance manual as a guide. These meetings must be scheduled through the Project Manager, and General Contractor far enough in advance so that all personnel can be notified.

E. Division 15 Contractor shall provide proof of performance certification of all Mechanical Equipment and Systems to demonstrate that all Mechanical Equipment and Systems are operating to the intent of the design.

1.11 FINAL OBSERVATION

A. Comply with the requirements of Division 1 and the following.

B. Prior to the request for final observation, all Work under the contract shall be completed, all systems shall be in proper working order and placed in operation (System Startup of 48 hours).

C. All HVAC systems shall be properly balanced with quantities shown on the Drawings, and all water circuits shall be adjusted to provide the proper flows.

D. All equipment shall be cleaned, including but not limited to, plumbing fixtures. All debris and construction materials shall be removed from the DIA property to a suitable landfill off-airport.

E. Pumps shall be tested in accordance with Sections 15990, 15995 and 15996 and shall be in proper working order and placed in operation.

F. The temperature control system shall be complete and in proper working order. All instruments shall be properly and accurately field calibrated.

G. At the request of the Project Manager, a representative of the Contractor who is thoroughly familiar with the Project and operation of the various systems shall be present during the final observation to demonstrate proper operation of the equipment and controls. If requested by the Project Manager, the Contractor shall have representatives from his subcontractors present to assist during final observation.

1.12 PROJECT CONDITIONS

A. Accessibility.

1. Division 15 Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of his work. He shall cooperate with Contractors of other Divisions of the Work whose work is in the same space and shall advise the General Contractor of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.

2. Division 15 Contractor shall locate all equipment, which must be serviced, operated, or maintained in fully accessible positions. Such equipment shall include (but not be limited to) valves, shock absorbers, traps, cleanouts, motors, controllers, switchgear, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the Project Manager prior to making the change.

3. Division 15 Contractor shall provide the General Contractor with the exact locations of access doors for each concealed valve, shock absorber control, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work. All access doors shall be coordinated with architectural finishes and surfaces. Where walls and/or ceilings are fire rated, Contractor shall provide rated access doors equal to the rating of the wall and/or ceiling.

4. Provide carpentry, masonry, concrete and metal work required for work of this Division where not specifically called for under other Sections.

B. Fabrication.

1. Before any ductwork is fabricated and before running and/or fabricating any lines of piping or ductwork, the Contractor shall assure himself that they can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of existing conditions and new Structural and Architectural Work.

C. Freeze Protection.

1. Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

D. Scaffolding, Rigging and Hoisting.

1. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required. Conform to OSHA requirements and standards.

1.13 COORDINATION

A. General: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

B. Coordination with Electrical Work: Comply with Division 16..

C. Existing System Interruptions: Comply with Division 1.

D. Cutting and Patching: Section 15050 and Division 1.

E. Drawings and Specifications: The Mechanical Drawings indicate the general design and arrangement of lines, equipment, systems, etc. Information shown is diagrammatic in character and does not necessarily indicate every required offset, fitting, etc. Do not scale the Drawings for dimensions. Take dimensions, measurements, locations, levels, etc., from the Architectural Drawings and equipment to be furnished.

F. Discrepancies: Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the Project Manager and obtain written instructions for any changes necessary.

G. Order of Precedence: The precedence of mechanical construction documents are as Specified in Article 4 of the General Conditions.

1.14 START-UP PROCEDURES

A. Before start-up, manufacturer's shipping blocks and other similar materials shall be removed, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, belt tension, proper control sequence, and any other condition, which may cause damage to equipment or endanger personnel.

B. Ensure that all control systems are fully operational in automatic mode.

C. If systems are not to continue in use following the start-up procedures, steps should be taken to ensure against accidental operation or operation by unauthorized personnel. Contractor shall follow OSHA Standards for lockout/tag out procedures to secure equipment not yet placed in operation.

D. Factory personnel shall be notified as appropriate to start systems requiring their services.

E. Notify the DIA Project Manager in writing a minimum of 48 hours prior to start-up of all major mechanical equipment and systems.

F. Should there be any equipment found which had not been properly started up, it will be the responsibility of the Contractor to arrange for the appropriate personnel to start up the equipment at his expense and at a time as scheduled by the DIA Project Manager.

1.15 SCHEDULE OF TESTING

A. Provide testing in accordance with the General Conditions of the Contract.

B. A schedule of testing shall be drawn up by the Division 15 Contractor in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel.

C. Notify the DIA Project Manager, DIA Mechanical Inspector and DIA Mechanical Engineer in writing a minimum of 72 hours prior to testing of any mechanical equipment and systems.

D. All testing must be performed in the presence Project Manager and or his designated representative; his signature for verification of the test must appear on the schedule.

E. All testing must be performed in accord with the procedures set forth in Division 15 and other Sections of the Specifications where referenced. At completion of testing, the test reports shall be then submitted in triplicate to the Project Manager.

F. Make all specified tests on piping, ductwork and related systems as necessary.

G. Make sure operational and performance tests are made on seasonal equipment.

H. Complete all tests required by Code Authorities, such as health codes, building codes, and safety codes.

I. After test runs have been completed and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipeline strainers and filters shall be cleaned, air filters cleaned or replaced, valve and pump packing properly adjusted, belt tensions adjusted, drive guards secured in place, lubrication checked and replenished if required.

1.16 CLEANING AND FINISHING

A. Provide cleaning in accordance with the General Requirements of the Contract

B. Cleaning shall include but not be limited to removing grease, dirt, dust, stains, labels, fingerprints and other foreign materials from sight-exposed piping, ductwork, equipment, fixtures and other such items installed under Division 15 of the work. If finishes have been damaged, refinish to original condition and leave everything in proper working order and of intended appearance.

C. Clean HVAC Piping Systems in accordance with 15545 - Chemical Water Treatment.

D. Clean Domestic Water Systems in accordance with Section 15410 - Plumbing Piping.

1.17 WARRANTIES

A. Conform to Division 1: Provide a written warranty covering the entire mechanical work to be free from defective materials, equipment and workmanship for a period of two years after date of acceptance. During this period provide labor and materials as required to repair or provide labor and materials required to repair or replace defects. Provide certificates for such items of equipment, which have or are specified to have warranties in excess of one year.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 15010

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Nonshrink grout for equipment installations.
7. Field-fabricated metal equipment supports.
8. Concrete bases
9. Installation requirements common to equipment specification Sections.
10. Mechanical demolition.

B. Cutting and patching.

1. Touch up painting and finishing.

C. Pipe and pipe fitting materials are specified in piping system Sections.

1.02 RELATED SECTIONS

A. Drawings and general provisions of Contract, including General and the Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 15010 – Basic Mechanical Requirements

C. Section 05999 - Welding

D. Section 15190 - Mechanical Identification: Labeling and identifying mechanical systems and equipment is specified in Division 15 Section "Mechanical Identification."

1.03 DEFINITIONS

A. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

C. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

E. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

F. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.04 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Shop drawings detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment. Wood supports are only allowed in roof equipment curbs. Supports inside the building shall be constructed entirely of metal.

C. Prepare coordination drawings according to Division 1 Section "Submittals" to a 1/4 inch equals 1 foot scale or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:

1. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
2. Pump metal support details.

D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the Quality Assurance Article.

E. Floor x-rays and/or ground penetrating radar reports.

F. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawing.

G. Contractor shall submit fully dimensioned spool drawings for all welded piping work. Drawings shall indicate all weld types, sizes and materials to be used. The spool drawing size shall match the full size contract documents of either 24x36 or 34x44. Spool drawings shall be submitted in the latest version of AutoCAD (dwg) and the latest version of Adobe Acrobat (pdf). Adobe Acrobat files shall not contain security. Other file formats will not be accepted.

H. Field Test Reports: Written reports of each pressure tests specified in Division 15 Sections. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

1.05 QUALITY CONTROL

A. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing by the DIA Project Manager and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

B. Electronic Equipment Compliance:

1. Contractor warrants that all equipment, devices, items, systems, software, hardware, or firmware provided shall properly, appropriately, and consistently function and accurately process date and time data (including without limitation: calculating, comparing, and sequencing). This warranty supersedes anything in the Specifications or other Contract Documents which might be construed inconsistently. This warranty is applicable whether the equipment, device, item, system, software, hardware, or firmware is specified with or without reference to a manufacturer's name, make, or model number.

C. Unless specified otherwise, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored ductwork, pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Deliver ductwork and fittings with plastic sheeting to protect it from elements. Inspect duct liner for exposure to dirt and tears.

1.07 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Coordinate the installation of required supporting devices.

C. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work.

D. Coordinate connection of electrical services.

E. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces.

PART 2 – PRODUCTS

2.01 PIPE AND PIPE FITTINGS

A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.02 JOINING MATERIALS

A. Refer to individual piping system specification Sections in Division 15 for special joining materials not listed below.

B. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, except where thickness or specific material is indicated.
    a. Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.

C. Solder Filler Metal: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent) – Not industry standard, usually 5% antimony.

D. Brazing Filler Metals: AWS A5.8.

1. BCuP Series: Copper-phosphorus alloys.
2. BAg1: Silver alloy.

E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded. All welding rod is to be kept in a operable rod oven at all times.

2.03 PIPING SPECIALTIES

A. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Waterway Fittings: Dielectric fittings designed to effectively separate dissimilar metals exposed to water or other electrolytes, conforming to NSF and ASTM F492 standards for continuous use at temperatures up to 225 degrees F and pressures up to 300 psi. Fittings to have electro-zinc-plated steel casings providing for maintained exterior electrical continuity, threaded or flanged ends as applicable, and inert linings.
4. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150- or 300-psig minimum pressure to suit system pressures.
5. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
    a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.

2.04 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
   a. Metraflex Co.
   b. Pipeline Seal and Insulator, Inc.
   c. PSI-Thunderline/Link-Seal.
   d. Substitutions: Under provisions of Section 15010.
2. Sealing Elements: EPDM] [NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.05 SLEEVES

A. Galvanized-Steel Sheet: 0.0478-inch (18 gage) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.06 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory-packaged.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 15 specify piping installation requirements unique to the piping system.

B. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.

C. Install piping at indicated slope.

D. Install piping free of sags and bends.

E. Install piping plumb and at right angles and plumb or parallel to building walls. Diagonal runs are prohibited, except where indicated.

F. Install piping tight to slabs, beams, joists, columns, walls, and other building elements.

G. Install fittings for changes in direction and branch connections.

H. Install couplings according to manufacturer's printed instructions.

I. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping system Sections.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, rust, and debris from inside and outside of pipe and fittings before assembly.
3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
    a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
    b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
    c. Align threads at point of assembly.
    d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
    e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

J. Piping Connections: Except as otherwise indicated, make piping connections as specified below.

1. Install unions in piping 2 inches and smaller adjacent to each valve and at final connection to each piece of equipment having a 2-inch or smaller threaded pipe connection.
2. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.02 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Project Manager.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

D. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

E. Install equipment giving right-of-way to piping systems installed at a required slope.

F. Install equipment allowing for usage during operation of surrounding equipment at all portions of operations. In no instance shall an appurtenance block operation of any equipment (Example: A valve handle open position shall not block access to a PT plug).

3.03 PAINTING AND FINISHING

A. Refer to Division 9 Section "Painting" for field painting requirements. Paint color schedule shall conform to ASME A13.1-1996, “Scheme for the Identification of Piping Systems.”

B. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.04 CONCRETE PENETRATIONS

A. Refer Division 1 for core drilling and saw cutting requirements.

B. All penetrations required through completed concrete construction shall be core drilled or saw cut at minimum size required. All penetrations in concrete require an x-ray or ground penetrating radar to determine if the location is clear of reinforcing steel and embedded systems. Precautions shall be taken when drilling to prevent damage to structural concrete. The Contractor shall provide an interpretation of the x-rays or radar shot and obtain written acceptance from the DIA Project Manager before proceeding with drilling.

3.05 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use [3000-psi] <Insert other>, 28-day compressive-strength concrete and reinforcement as specified in DIVISION 3.

3.06 WELDING

A. Qualify welding processes and operators for structural steel according to AWS D1.1 Structural Welding Code - Steel. See Division 5 for additional requirements.

B. All welding shall be inspected in process by a contractor provided, Certified, Independent Testing Agency by an AWS certified welding inspector.

C. Qualify welding processes and operators for piping according to ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Refer to DIVISION 5 for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1 Structural Welding Code - Steel, as referenced in Part1.

3.08 DEMOLITION

A. Refer to DIVISION 1 for general demolition requirements and procedures.

B. Where pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

D. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping and associated supports indicated to be removed, provide a shutoff valve with plug or cap in pressurized systems and cap or plug remaining piping with same or compatible piping material. No piping shall be abandoned in place. Repair insulation.

2. Ducts to Be Removed: Remove portion of ducts and associated supports indicated to be removed and plug remaining ducts with same or compatible ductwork material. No ductwork shall be abandoned in place. Repair insulation.

3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

4. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

5. Repair floor, ceilings, roof, slabs from removed supports in accordance with Division 3, Division 5, and Division 9.

3.09 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.10 ELECTRIC WIRING

A. Furnish equipment requiring electrical connections to operate properly and deliver full capacity at electrical service available.

B. All control wiring to be in accordance with Manufacturer's recommendations; all wiring shall be color coded to facilitate checking.

C. Unless otherwise indicated, all mechanical equipment motors and controls shall be furnished, set in place, and wired in accordance with the schedule contained herein. Contractor should note that the intent of this electric wiring schedule is to have the Division 15 Contractor responsible for coordinating all control wiring as outlined, whether or not specifically called for by the Mechanical or Electrical Drawings and Specifications. Comply with the applicable requirements of Division 16 for electrical work of this Division 15, which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Division 15 Contractor shall refer to the Division 16 Specifications and plans for all power and control wiring and shall advise the Project Manager of any discrepancies prior to bidding.

Table 3.11-1

Item	Furnished By	Set By	Power Wiring	Control Wiring
Equipment Motors	15	15	16	15
Fused and Unfused Disconnect Switches, Thermal Overloads and Heaters	16	16	16	---
Control Relays and Transformers (See Note 1)	15	15	16	15
Pushbutton Stations Pilot Lights, Manual Switches, not carrying Load Currents	15	15	16	15
Thermostats, line voltage control components	15	15	---	15
Temperature Control Systems	15	15	16	15

NOTES:

a. * 15 = Mechanical Contractor Under Division 15 of the Work
b. * 16 = Electrical Contractor Under Division 16 of the Work
c. Control wiring is any voltage required to accomplish sequence specified. Contractor listed is responsible.
d. Control relays and control transformers shall be furnished under Division 15 except where furnishing such items are specifically required under Division 16 Specifications and/or Drawings.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 15050

SECTION 15072

MECHANICAL REMOVALS AND DEMOLITION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Removal of designated building equipment and fixtures.

B. Removal of designated construction.

C. Disposal of materials.

D. Identification of utilities.

1.02 RELATED SECTIONS

A. Division 1 for Summary of Work, Demolition, and Construction Facilities and Temporary Controls.

B. Section 15010 - Basic Mechanical Requirements.

1.03 REGULATORY REQUIREMENTS

A. Do not disable or disrupt building fire or life safety systems without 5 business days prior written notice and written acceptance of DIA Project Manager and DIA Life Safety Team.

B. Conform to procedures applicable when hazardous or contaminated materials are discovered.

1.04 SCHEDULING

A. Schedule Work to coordinate with work of other trades and new construction.

1.05 PROJECT CONDITIONS

A. Conduct demolition to minimize interference with adjacent and occupied building areas.

B. Cease operations immediately if structure appears to be in danger and notify DIA Project Manager. Do not resume operations until directed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 PREPARATION

A. Provide, erect, and maintain temporary[barriers at locations indicated.

B. Erect and maintain weatherproof closures for exterior openings.

C. Protect existing materials and systems, which are not to be demolished.

D. Notify affected utility companies before starting work and comply with their requirements.

E. Mark location and termination of utilities.

3.02 DEMOLITION

A. Disconnect remove,cap, and identify designated utilities within demolition areas.

B. Demolish in an orderly and careful manner. Remove all unused piping, ductwork or tubing back to source and cap. No piping, ductwork, or tubing is to be abandoned in place.

C. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

D. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

E. Remove temporary Work.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15072

SECTION 15135

GAUGES AND METERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Positive displacement meters.

B. Pressure gauges and pressure gauge taps.

C. Thermometers and thermometer wells.

D. Static pressure gauges.

E. Filter gauges.

1.02 RELATED SECTIONS

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15050 - Basic Mechanical Materials and Methods.

C. Section 15510 - Hydronic Piping: Installation of Thermometer wells and pressure gauge tappings.

D. Section 15975 - Digital Control Equipment.

E. Section 15985 - Sequence of Operation.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society of Mechanical Engineers (ASME)
   a. ASME - B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
   b. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi.
2. American Society for Testing of Materials (ASTM)
   a. ASTM D 2458 - Method of Flow Measurement by The Venturi Motor Tube.
   b. ASTM E 1 - Specification for ASTM Thermometers.
   c. ASTM E 77 - Verification and Calibration of Liquid-in-Glass Thermometers.
3. American Water Works Association (AWWA)
   a. AWWA C700 - Cold Water Meters - Displacement Type.
   b. AWWA C701 - Cold Water Meters - Turbine Type for Customer Service.
   c. AWWA C702 - Cold Water Meters - Compound Type.
   d. AWWA C706 - Direct Reading Remote Registration System for Cold Water

Meters.

e. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

4. Instrument Society of America (ISA)
   a. ISA RP 3.2 - Flange Mounted Sharp Edged Orifice Plates for Flow Measurement.
5. International Fire Code (IFC) with the Denver Amendments
6. International Building Code (IBC) with the Denver Amendments.
7. Underwriters' Laboratories (UL)
   a. UL 393 - Indicating Pressure Gauges for Fire and Protection Services.
   b. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.04 SUBMITTALS

A. Submittals For Review

1. Product Data: Provide list, which indicates use, operating range, total range and location for manufactured components.

B. Submittals At Project Closeout

1. Project Record Documents: Record actual locations of components and instrumentation.

C. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawing.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

1.06 EXTRA MATERIALS

A. Provide two bottles of red gauge oil for static pressure gauges.

B. Provide two pressure gauges with pulsation dampers and two dial thermometers.

PART 2 - PRODUCTS

2.01 PRESSURE GAUGES

A. Manufacturers:

1. Trerice.
2. Moeller.
3. Dietz.
4. U.S. Gauge.
5. Substitutions: In conformity with provisions of Section 15010.

B. Gauge: ASME B40.1 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

1. Case: Steel with brass bourdon tube.
2. Size: 3-1/2 inchdiameter.
3. Mid-Scale Accuracy: One percent.
4. Scale: Pounds per square inch.
5. Range: System design pressure should be in the middle 20% of the gauge range

2.02 PRESSURE GAUGE TAPPINGS

A. Needle Valve: Stainless Steel, 1/4 inch NPT for minimum 150 psig.

B. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

C. Syphon:[Steel, Schedule 40 or Bronze, 1/4 inch angle or straight pattern.

2.03 STEM TYPE THERMOMETERS

A. Manufacturers:
1. Trerice.
2. U.S. Gauge.
3. Moeller.
4. Dietz.
5. Substitutions: In conformity with provisions of Section 15010.

B. Thermometer: ASTM E 1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
1. Size: 9 inch scale.
2. Window: Clear Lexan.
3. Stem: 3/4 inch NPT brass.
4. Accuracy: ASTM E 77 2 percent.
5. Calibration: Degrees F.

2.04 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with extensions where necessary to clear insulation, and with cap and chain.

B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.05 TEST PLUGS

A. Manufacturer:
1. Peterson Equipment Co.
2. Substitutions: In conformity with provisions of Section 15010.

B. Test Plug: 1/4 inch or 1/2 inch brass or stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

C. Test Kit: Carrying case, internally padded and fitted containing one2-1/2 inch diameter pressure gauges, one gauge adapters with 1/8 inch probes, two 1-1/2 inch dial thermometers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide one pressure gauge per pump. Install taps before strainers and on suction and discharge of pumps and manifold to a single pressure gauge with an isolation valve for each leg of the manifold.

C. Install pressure gauges with pulsation dampers. Provide needle valve to isolate each gauge. Extend nipples to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Refer to Section 15952. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.

F. Coil and conceal excess capillary on remote element instruments.

G. Provide instruments with scale ranges selected according to service with largest appropriate scale.

H. Install gauges, thermometers and test plug in locations where there is an unobstructed field of view from a normal operating level. All portions of gauges and thermometers shall be easily read from a normal operating level. Locations of test plugs shall be treated as a gauges or thermometers for installation and field of view verification.

I. Install gauges and thermometers in vertical to 45 degrees off vertical.

J. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

K. Locate test plugs adjacent to control device sockets and where indicated.

3.02 SCHEDULES

A. Install meters, gauges and thermometers at a minimum in the locations listed in the schedules below and additional locations shown on the drawings.

B. Flow Meter Schedule

1. Locations:
    a. Chilled water system

C. Pressure Gauge Schedule

1. Locations:
   a. Pumps

D. Pressure Gauge Tapping Schedule

1. Locations:
   a. Control valves 3/4 inch and larger - inlets and outlets
   b. Chiller - inlets and outlets

E. Stem Type Thermometer Schedule

1. Locations:
   a. Headers to central equipment
   b. Chiller - inlets and outlets

F. Thermometer Socket Schedule

1. Locations:
   a. Control valves 1 inch and larger
   b. - inlets and outlets

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15135

SECTION 15140

SUPPORTS AND ANCHORS

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes the following hangers and supports for mechanical system piping and equipment:

1. Steel pipe hangers and supports.
2. Fastener systems.
3. Pipe stands.
4. Pipe positioning systems.
5. Equipment supports.

1.02 RELATED SECTIONS

A. Division 3: Concrete equipment bases.

B. Division 1: Firestopping; Joint seals for piping and duct penetration of fire rated assemblies.

C. Division 1: Painting.

D. Section 15010 - Basic Mechanical Requirements.

E. Section 15050 - Basic Mechanical Materials and Methods.

F. Section 15410 - Plumbing Piping.

G. Section 15510 - Hydronic Piping.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Welding Society (AWS):
   a. D1.1 - Structural Welding Code - Steel.
   b. D1.3 - Structural Welding Code - Sheet Steel.
2. ASME International (ASME):
   a. B31.9 - Building Services Piping.
3. Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualification".
4. ASTM International (ASTM):
   a. A36/A37M - Carbon Structural Steel.
   b. A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

c. C533 - Calcium Silicate Block and Pipe Thermal Insulation.
d. C552 -Cellular Glass Thermal Insulation.
e. C1107 - Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

5. The International Association of Plumbing and Mechanical Officials (IAPMO):
   a. PS42 - Pipe Alignment and Secondary Support Systems.
6. International Fire Code (IFC) with the Denver Amendments
7. International Building Code (IBC) with the Denver Amendments.
8. Manufacturers Standardization Society of The Valve and Fittings Industry Inc. (MSS SP):
   a. 58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
   b. 69 - Pipe Hangers and Supports - Selection and Application.
   c. 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
   d. 90 - Guidelines on Terminology for Pipe Hangers and Supports.
9. The Society for Protective Coatings (SSPC):
   a. PA1 - Paint Application Specification No. 1: Shop, Field , and Maintenance Painting of Steel.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Pipe stands. Include Product Data for components.
   3. Equipment supports.

C. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Refer to Section 15010 for coordination requirements.

E. “As Built” Plans shall be provided in electronic format in accordance with Section 15010.

F. Welding certificates.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1.
   2. AWS D1.3.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to

product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to PART 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

1. Anvil International

2. Substitutions: Under provisions of Section 15010.

C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.03 TRAPEZE PIPE HANGERS

A. As indicated on structural drawings.

2.04 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a.

b. Hilti, Inc.

c. Substitutions: Under provisions of Section 15010.

2.05 PIPE STAND FABRICATION

1. Pipe Stands, General: As indicated on structural drawings..

2.06 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.07 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 6/A36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 -EXECUTION

3.01 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as required and in accordance with spans and hanger rod sizes as detailed on structural construction drawings.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Use hangers with 1-1/2 inch minimum vertical adjustment.

D. Support vertical piping at every floor. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

E. At changes in pipe flow direction, install piping sufficiently spaced to allow pipe movement without crushing insulation.

F. Mechanical systems shall not share supports and/or hangers with any other systems.

G. Fire Proofing: Where hangers require removal of fire proofing, remove minimum amount of fire proofing for hanger attachment. Repair fire proofing per Technical Specifications. Refer to Division 7 of the Technical Specifications.

3.02 HANGER AND SUPPORT APPLICATIONS

A. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

B.

C. Horizontal-Piping Hangers and Supports: As indicated on structural drawings.

D. Vertical-Piping Clamps: As indicated on structural drawings. Building Attachments: As indicated on structural drawings.

E. Saddles and Shields: As indicated on structural drawings.

F. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.03 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Insert wedge type expansion shell or shield should be flush with concrete surface in which it is set. This requires the hole in the concrete to be of sufficient depth to accommodate total insertion. Install fasteners according to manufacturer's written instructions.

D. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface.

E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel as indicated on structural drawings. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

K. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180°.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.04 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.05 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangersand equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.06 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches

3.07 PAINTING

A. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in DIVISION 9.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

PART 4 -MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15140

SECTION 15190

MECHANICAL IDENTIFICATION

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe Markers.

E. Valve Chart and Schedule.

1.02 RELATED SECTIONS

A. Division 9 - Painting: Identification painting.

B. Section 15010 - Basic Mechanical Requirements.

C. Section 15050 - Basic Mechanical Materials and Methods.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society of Mechanical Engineers (ASME)
   a. ASME A13.1 - Scheme for the Identification of Piping Systems.
2. International Building Code (IBC) with the Denver Amendments
3. International Fire Code (IFC) with the Denver Amendments

1.04 SUBMITTALS

A. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

B. Include valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Product Data: Provide manufacturers catalog literature for each product required.

D. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

1.05 PROJECT RECORD DOCUMENTS

A. Record actual locations of tagged valves.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers:

1. W.H. Brady Co.
2. Panduit Corp.
3. Seton Name Plate Corp.
4. Marking Services, Inc.
5. Substitutions: Under provisions of Section 15010.

2.02 MATERIALS

A. Color: Unless specified otherwise, conform with ASME A13.1.

B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background color.

C. Metal Tags: Brass or aluminum, with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

D. Chart: Typewritten letter size list in anodized aluminum frame.

E. Stencils: With clean cut symbols and letters of 2-1/2 inch size.

F. Stencil Paint: In accordance with Division 9, semi-gloss enamel.

PART 3 -EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 9 for stencil painting.

3.02 INSTALLATION

A. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners and adhesive.

B. Metal Tags: Install with corrosive-resistant chain.

C. Stencil Painting: Apply in accordance with Division 9.

D. Plastic Pipe Markers: Install in accordance with manufacturer's instructions.

E. Controls: Identify control panels and major control components outside panels with plastic nameplates. Key to control schematics.

F. Valves Identification:

1. Identify all valves, including fire protection valves, in main and branch piping located inside the building. Use tags secured with brass 'S' hooks or brass chains.

2. Stamp tags with a unique prefix to identify system to which applied, followed by a number (Example: CW-1, CW-2, etc.). In general, prefix shall match system abbreviations used on drawings where applicable.

3. Provide a typewritten listing of valves including: valve identification number, location, function, normal position, service, and area served. Mount list as specified and directed. Include additional copy in operation and maintenance manuals.

4. Show valve tag designations on the project record document drawings, including schematic flow diagrams where included with construction documents.

5. Contractor shall prepare and install where directed, in aluminum frames with clear plastic protective cover, a valve location diagram in the form of a series of flow diagrams with each automatic or manually actuated control or shut-off valve clearly identified in sequence with its individual valve tag number. Automatic control valves shall be tagged to match designations shown on the temperature control drawings, and the specified valve charts shall be installed adjacent to valve location diagrams.

G. Piping: Identify piping, concealed or exposed, with plastic pipe markers. Tags may be used on ½" or smaller diameter non-insulated piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and "T", at each side of penetration of structure or enclosure, and at each obstruction.

H. Ductwork:

1. Identify ductwork with plastic nameplates or stenciled painting. Identify as to air handling unit number, and area served.

2. Install duct markers with on air ducts in the following color codes:
   a. Green: For cold-air of general supply ducts.
   b. Yellow: For hot-air supply ducts.
   c. Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
   d. ASME A13.1 Colors and Designs: For hazardous material exhaust.
   e. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

3. Stenciled Duct Marker Option: Stenciled markers, showing service and direction of flow, may be provided instead of laminated-plastic duct markers, at Installer's option, if lettering larger than 1 inch (25 mm) high is needed for proper identification because of distance from normal location of required identification.

4. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system and/or each side of a penetration of structure or enclosure and at each obstruction and at air-handling equipment.

3.03 EQUIPMENT

A. Equipment: Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates or stencil painting. Small devices, such as in-line pumps, may be identified with metal tags. At a minimum, the nameplate shall contain the following information:

1. Equipment Tag
2. Equipment location
3. Service Area
4. Flowrate (cfm/gpm)
5. Capacity (btuh/kw)
6. <Equipment owner>

(nameplate example capacity and Owner not shown)

B. Equipment and terminal devices above ceiling: provide adhesive backed plastic nameplate on ceiling grid support directly below equipment identifying unit tag and temperature control node number.

1. Example:

VAV-01 NODE 067

C. Color code as follows:

1. Green - HVAC equipment.
2. Yellow – Heating only equipment
3. Red - Fire dampers/smoke dampers.
4. Orange - Plumbing valves/equipment.
5. Blue - Heating/cooling valves.
6. Brown – Energy reclamation equipment and components.
7. ASME A13.1 Colors and Designs: For hazardous material exhaust.
8. Letter Size\color: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering. Lettering color shall be black or white. White shall be used on dark backgrounds.

D. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

E. Include signs for the following general categories of equipment:

1. Pumps, compressors, chillers, condensers, and similar motor-driven units.
2. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

F. Stenciled Equipment Sign Option: Stenciled signs may be provided instead of laminated-plastic equipment signs, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

G. Install access panel markers with screws on equipment access panels.

3.04 VALVE CHART AND SCHEDULE

A. Provide valve chart and schedule in aluminum frame with clear plastic shield. Install at location as directed.

3.05 PIPING IDENTIFICATION SCHEDULE

A. Pipe identification and color coding for general-use piping systems shall be in accordance with the following schedule:

Classification	Band Color	Stenciled Legend
Chilled Water Supply	Green	Ch. Water Supp.
Chilled Water Return	Green	Ch. Water Ret.
Condenser Water Supply	Green	Cond. Water Supp.
Condenser Water Return	Green	Cond. Water Ret.
Refrigerant Hot Gas	Green	Refr. Hot Gas
Refrigerant Liquid	Green	Refr. Liq.
Refrigerant Suction	Green	Refr. Suction
Refrigerant Relief	Yellow	Refr. Relief

PART 4 -MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15190

SECTION 15245

VIBRATION ISOLATION

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. Inertia bases.

B. Vibration isolation.

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Division 3 - Concrete: Placement of isolators in floating floor slabs.

1.03 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Division 3: Supply of concrete for placement by this Section.

1.04 RELATED SECTIONS

A. Division 3 - Cast-in-Place Concrete.

B. Section 15010 - Basic Mechanical Requirements.

C. Section 15050 - Basic Mechanical Materials and Methods.

D. Section 15140 - Supports and Anchors.

E. Section 16142 - Electrical Connections for Equipment

1.05 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
   a. ASHRAE - Guide to Average Noise Criteria Curves.
2. International Building Code (IBC) with the Denver Amendments
3. International Fire Code (IFC) with the Denver Amendments

1.06 QUALITY ASSURANCE

A. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.

1.07 SUBMITTALS

A. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

B. Product Data: Provide schedule of vibration isolator type with location and load on each.

C. Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

D. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

1.08 PROJECT RECORD DOCUMENTS

A. Record actual locations of hangers including attachment points.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers:

1. Mason Industries.
2. Amber/Booth Co.
3. Vibration Mountings & Controls, Inc.
4. Substitutions: Under provisions of Section 15010.

2.02 INERTIA BASES

A. Structural Bases:

1. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
2. Construction: Welded structural steel with gusseted brackets, supporting equipment and motor with motor slide rails.

B. Concrete Inertia Bases:

1. Mass: Minimum of 1.5 times weight of isolated equipment.
2. Construction: Structured steel channel perimeter frame, with gusseted brackets and anchor bolts, adequately reinforced, concrete filled.
3. Connecting Point: Reinforced to connect isolators and snubbers to base.
4. Concrete: Reinforced 3,000 psi concrete.

2.03 VIBRATION ISOLATORS

A. Closed Spring Isolators (Type A):

1. Spring Isolators:
   a. Code: Color code springs for load carrying capacity.
2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.

3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Spring diameter not less than 80% of compressed height at rated load.

4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.

B. Spring Hanger (Type C):

1. Spring Isolators:
   a. Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Spring diameter not less than 80% of compressed height at rated load.

3. Housings: Incorporate rubber hanger with threaded insert.

4. Misalignment: Capable of 20 degree hanger rod misalignment.

C. Neoprene Pad Isolators (Type D):

1. Rubber or neoprene waffle pads.
   a. 30 durometer.
   b. Minimum 1/2 inch thick.
   c. Maximum loading 40 psi.
   d. Height of ribs shall not exceed 0.7 times width.

2. Configuration: Single layer.

D. Curb-Mounted Isolation Base (Type E):

1. Spring Isolators: Provide spring isolators (type A) as specified above. Static deflection shall be as scheduled in Part 3 of this section.

2. Frame: Provide extruded aluminum frame with continuously welded corners.

3. Gaskets: Provide neoprene gaskets for joints between isolation base and manufacturer's roof curb, and between equipment and isolation base.

4. Weather Seal: Provide continuous flexible EPDM weather seal between upper and lower base frames.

E. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.

F. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install isolation for motor driven equipment.

C. Bases:

1. Set steel bases for one-inch clearance between housekeeping pad and base.

2. Set concrete inertia bases for 2-inch clearance between housekeeping pad and base.

3. Adjust equipment level.

D. Install spring hangers without binding.

E. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

F. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

G. Provide pairs of horizontal limit springs on fans with more than 6.0-inch static pressure, and on hanger supported, horizontally mounted axial fans.

H. Support piping connections to isolated equipment resiliently [for scheduled distance.] [to nearest flexible pipe connector.] [as follows:]

1. Up to 4 Inch Diameter: First three points of support.
2. 5 to 8 Inch Diameter: First four points of support.
3. 10 inch Diameter and Over: First six points of support.
4. Select three hangers closest to vibration source for minimum 1.0-inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0-inch static deflection or 1/2 static deflection of isolated equipment.

I. Connect wiring to isolated equipment with flexible hanging loop.

3.02 MANUFACTURER'S FIELD SERVICES

A. Inspect isolated equipment after installation and submit report. Include static deflections.

3.03 PIPE ISOLATION SCHEDULE

Pipe Size (inches)	Isolated Distance from Equipment (pipe diameters)
1	120
2	90
3	80
4	75
6	60
8	60
10	54
12	50
16	45
24	38

3.04 EQUIPMENT ISOLATION SCHEDULE

Isolated Equipment	Base	Type	Static Deflection
Chillers	Concrete Pad	D	0.2" (provide 3/4" thick pads)
Piping	N/A	C	0.5"
Pumps	Cocnrete Pad	D	1”

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15245

SECTION 15260

PIPING INSULATION

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15140 - Supports and Anchors: Pipe insulation shields and protection saddles

C. Section 15510 – Hydronic Piping: Placement of hangers and hanger inserts.

D. Section 15535 - Refrigerant Piping: Placement of inserts.

1.03 RELATED SECTIONS

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15050 - Basic Mechanical Materials and Methods.

C. Section 15190 - Mechanical Identification.

1.04 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society for Testing and Materials (ASTM):
    a. A666 – Austentic Stainless Steel, Strip, Plate, and Flat Bar.
    b. B209/B209M – Aluminum and Aluminum-Alloy Sheet and Plate.
    c. C195 – Mineral Fiber Thermal Insulating Cement.
    d. C196 – Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
    e. C449/C449M – Mineral Fiber Hydraulic-Setting Thermal Insulating and Finish Cement.
    f. C533 – Calcium Silicate Block and Pipe Thermal Insulation.
    g. C534 – Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
    h. C547 – Mineral Fiber Preformed Pipe Insulation.
    i. C552 – Cellular Glass Block and Pipe Thermal Insulation.
    j. C553 – Mineral Fiber Blanket and Felt Insulation for Commercial and Industrial Applications.
    k. C578 - Preformed, Block Type Cellular Polystyrene Thermal Insulation.

l. C610 - Expanded Perlite Block and Pipe Thermal Insulation.

m. C612 – Mineral Fiber Block and Board Thermal Insulation.

n. C921 – Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

o. C1126 – Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.

p. E84 – Test Method for Surface Burning Characteristics of Building Materials.

2. International Building Code (IBC) with the Denver Amendments.

3. International Fire Code (IFC) with the Denver Amendments

1.05 SUBMITTALS

A. Submit product description, list of materials and thickness for each service, and locations.

B. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

C. Shop Drawings: Show fabrication and installation details for the following:

1. Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.

2. Attachment and covering of heat trace inside insulation.

3. Insulation application at pipe expansion joints for each type of insulation.

4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5. Removable insulation at piping specialties and equipment connections.

6. Application of field-applied jackets.

D. Samples: For each type of insulation and jacket. Identify each Sample, describing product and intended use. Submit Samples in the following sizes:

1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.

2. Sheet Form Insulation Materials: 12 inches square.

3. Jacket Materials: 12 inches long by NPS 2.

4. Manufacturer's Color Charts: Show the full range of colors available for each type of field-applied finish material indicated.

E. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

F. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

G. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

1.06 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing materials identical to those

specified in this Section according to ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products under provisions of Section 15010 and Division 1.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Insulation Manufacturers:

1. CertainTeed Manson.
2. Johns Manville.
3. Knauf Fiber Glass.
4. Owens-Corning Fiberglas.
5. Rock Wool Manufacturing.
6. USG Interiors.
7. Substitutions: Under provisions of Section 15010.

2.02 INSULATION

A. Type A: Glass fiber insulation; ASTM C 547; maximum `k' value of 0.24 at 75 degrees F; noncombustible.

1. Minimum Service Temperature: 0 degrees F.
2. Maximum Service Temperature: 400 degrees F.
3. Maximum Moisture Absorption: 0.2 percent by volume.

B. Type B: Cellular glass; ASTM C 552:

1. 'K' value: 0.40 at 75 degrees F.
2. Maximum Water Vapor Transmission: 0.1 perm.

C. Type F: Hydrous calcium silicate; ASTM C 533; rigid white; asbestos free:

1. 'K' value: ASTM C 177 and C 518; 0.44 at 300 degrees F.
2. Maximum Service Temperature: 1200 degrees F.
3. Density: 13 lb/cu ft; compressive strength (block) 200 PSI with 5% compression at 1-1/2" thickness.
4. Tie with 16 gage stainless steel wire loops with twisted ends, spaced 12 inches on center.

D. Type H: Polyethylene foam; ASTM D 1056 or D 1667; flexible, closed cell, polyethylene, slit tubing.

1. 'K' Value: ASTM C 177; 0.25 at 75 degrees F.
2. Minimum Service Temperature: -90 degrees F.
3. Maximum Service Temperature: 212 degrees F.
4. Density: ASTM 1667; 2 lb/cu ft.
5. Maximum Moisture Absorption: 1.0 percent by volume.
6. Moisture Vapor Transmission: ASTM E 96; 0.01 perm inches.
7. Maximum Flame Spread: ASTM E 84; 25.
8. Maximum Smoke Developed: ASTM E 84; 50.
9. Connection: Contact adhesive.

E. Type I: Cellular foam; ASTM C 534; flexible, cellular elastomeric, molded or sheet.

1. Maximum 'K' Value: ASTM C 177 or C 518; 0.28 at 75 degrees F.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 220 degrees F.
4. Maximum Moisture Absorption: ASTM D 1056; 3.0 percent (pipe) by volume, 2.0 percent (sheet) by volume.
5. Maximum Moisture Vapor Transmission: ASTM E 96; 0.20 perm inches.
6. Maximum Flame Spread: ASTM E 84; 25.
7. Maximum Smoke Developed: ASTM E 84; 50.
8. Connection: Waterproof vapor barrier adhesive.

2.03 JACKETS

A. General: ASTM C921, Type 1, unless otherwise indicated.

B. Vapor Retarder Jacket: AP-T PLUS white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secured with self-sealing longitudinal laps and butt strips or AP Jacket with outward clinch expanding staples coated with vapor barrier mastic as needed.

C. PVC Plastic Jacket: ASTM C 921, one piece molded type fitting covers and sheet material, off white color. Secure with tacks, pop rivets, and pressure-sensitive tape of matching color.

1. Factory-fabricated fitting covers manufactured from 30-mil-thick, high-impact, ultraviolet-resistant PVC.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 150 degrees F.
4. Moisture Vapor Transmission: ASTM E 96; 0.002 perm inches.
5. Maximum Flame Spread: ASTM E 84; 25.
6. Maximum Smoke Developed: ASTM E 84; 50.
7. Minimum Thickness: 20 mil.
8. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.

D. Aluminum Jacket: ASTM B 209, 3003 alloy, H-14 temper.

1. MinimumThickness: 0.024-inch sheet.
2. Finish: Embossed.
3. Joining: Longitudinal slip joints and 2-inch laps.
4. Moisture Barrier: 1-mil-thick, heat-bonded polyethylene and kraft paper.
5. Fittings: 0.016-inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; .015-inch thick aluminum.
7. Painted finish, 0.016 inch thick.

2.04 ACCESSORIES

A. Insulation Bands: 3/4 inch wide; 0.015-inch thick galvanized steel.

B. Metal Jacket Bands: 3/8 inch wide; 0.015-inch thick aluminum.

C. Insulating Cement: ASTM C 195; hydraulic setting mineral wool.

D. Finishing Cement: ASTM C 449.

E. Fibrous Glass Cloth: Untreated; 9 oz/sq yd weight.

F. Adhesives: Compatible with insulation.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

B. Install materials after piping has been tested and approved.

3.03 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

E. Apply multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

H. Keep insulation materials dry during application and finishing.

I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

J. Apply insulation with the least number of joints practical.

K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.

1. Apply insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches (300 mm) from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation

material manufacturer to maintain vapor retarder.

N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

O. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.

2. Circumferential Joints: Cover with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches (100 mm) o.c.

3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches (40 mm). Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.

a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.

4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.

5. At penetrations in jackets for thermometers and pressure gauges, fill and seal voids with vapor-retarder mastic.

P. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

Q. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.

1. Firestopping and fire-resistive joint sealers are specified in DIVISION 7.

R. Floor Penetrations: Apply insulation continuously through floor assembly.

1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.04 INSTALLATION

A. Install materials in accordance with manufacturer's instructions and N.I.C.A. standards.

B. Continue insulation with vapor barrier through penetrations.

C. In exposed piping, locate insulation and cover seams in least visible locations.

D. On insulated piping with vapor barrier, insulate fittings, valves, flanges, strainers, flexible connections, and expansion joints. Insulation and vapor barrier shall be continued without interruption at penetrations, horizontal and vertical supports.

E. Provide an insert, not less than 6 inches long, of same thickness and contour as adjoining insulation, between support shield and piping, but under the finish jacket, on piping 2 inches diameter or larger, to prevent insulation from being crushed at support points. Inserts shall be calcium silicate or other heavy density insulating material suitable for the planned temperature range. Factory fabricated inserts may be used. Inserts shall also be provided (on both sides) where vertical supports are installed. Sheet metal shields shall be used on cul-sil blocks.

F. Jackets:

1. Indoor, Concealed Applications: Insulated pipes conveying fluids above ambient temperature shall have standard jackets, with vapor barrier, factory-applied or field-applied. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass cloth and adhesive. PVC jackets may be used if in accordance with specified flame spread and smoke developed limitations.
2. Indoor, Concealed Applications: Insulated dual-temperature pipes or pipes conveying fluids below ambient temperature shall have vapor barrier jackets, factory-applied or field-applied. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe, and finish with glass cloth and vapor barrier adhesive.
3. Indoor, Exposed Applications: For pipe exposed in mechanical equipment rooms or in finished spaces, insulate as for concealed applications. Finish with reinforced white kraft and aluminum foil laminates

G. Where staples are used to secure insulation covering for systems requiring vapor barrier, the staples shall be sealed with a vapor barrier mastic.

3.05 SCHEDULE

A. Piping Systems:

Piping System	Run-Outs [b]	To 1.5"	2" to 4"	5 - 6"	8" and Larger
Chilled Water (40-55 °F)	1.5"	1.5"	1.5"	1.5"	1.5"
Refrigerant or Brine (<40 °F)	1.5"	1.5"	1.5"	1.5"	1.5"
Condenser Water	1.5"	1.5"	1.5"	1.5"	1.5"
Refrigerant Liquid	1.5"	1.5"	1.5"	1.5"	1.5"

[b] Provisions for runouts (not to exceed 12 feet in length) apply to branch runs up to 2 inches in size extending to individual terminal units.

[c] Thicknesses shown are based on use of insulation with thermal resistivity in the range of 4.0 to 4.6 h-sq ft-degrees F/Btu per inch of thickness; adjust as required for insulations having greater or lower thermal resistivity values. For piping exposed to exterior, increase indicated thicknesses by 1/2 inch.

PART 4 -MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15260

SECTION 15280

EQUIPMENT INSULATION

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. Equipment insulation.

B. Covering.

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Placement of inserts and insulation shields.

1.03 RELATED SECTIONS

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15050 - Basic Mechanical Materials and Methods.

C. Section 15190 - Mechanical Identification.

1.04 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society for Testing of Materials (ASTM)
    a. ASTM E 84 - Surface Burning Characteristics of Building Materials.
    b. ASTM B 209 - Aluminum and Aluminum-Alloy Sheet and Plate.
    c. ASTM C 177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
    d. ASTM C 195 - Mineral Fiber Thermal Insulation Cement.
    e. ASTM C 335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
    f. ASTM C 449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.
    g. ASTM C 518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
    h. ASTM C 533 - Calcium Silicate Block and Pipe Thermal Insulation.
    i. ASTM C 534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
    j. ASTM C 552 - Cellular Glass Block and Pipe Thermal Insulation.
    k. ASTM C 553 - Mineral Fiber Blanket and Felt Insulation.
    l. ASTM C 612 - Mineral Fiber Block and Board Thermal Insulation.
    m. ASTM C 640 - Corkboard and Cork Pipe Thermal Insulation.
    n. ASTM C 921 - Properties of Jacketing Materials for Thermal Insulation.

o. ASTM D 1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.

p. ASTM E 96 - Water Vapor Transmission of Materials.

2. International Building Code (IBC) with the Denver Amendments

3. International Fire Code (IFC) with the Denver Amendments

1.05 QUALITY ASSURANCE

A. Insulation and Covering: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E 84.

1.06 SUBMITTALS

A. Submit product description, list of materials and thickness for equipment scheduled.

B. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Section 15010 and Division 1.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers:

1. CertainTeed Manson.
2. Johns Manville.
3. Knauf Fiber Glass.
4. Owens-Corning Fiberglass.
5. Rock Wool Manufacturing.
6. USG Interiors.
7. Substitutions: Under provisions of Section 15010.

2.02 FLEXIBLE GLASS FIBER (TYPE FGF)

A. Insulation: ASTM C553; flexible, noncombustible.

1. `K' value : ASTM C335, 0.24 at 75 degrees F.
2. Maximum service temperature: 350 degrees F.
3. Maximum moisture absorption: 0.2 percent by volume.
4. Density: 2.25 lb/cu ft.

B. Vapor Barrier Jacket

1. ASTM C921, kraft paper reinforced with glass fiber yarn and bonded to aluminized film or vinyl.
2. Moisture vapor transmission: ASTM E96; 0.04 perm.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

C. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.

D. Vapor Barrier Lap Adhesive: Compatible with insulation.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.03 CELLULAR FOAM (TYPE CF)

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. `K' value: ASTM C177 or C518; 0.28 at 75 degrees F.
2. Minimum service temperature: -40 degrees F.
3. Maximum service temperature: 220 degrees F.
4. Maximum moisture absorption: ASTM D1056; 3.0 percent (pipe) by volume, 1.0 percent (sheet) by volume.
5. Moisture vapor transmission: ASTM E96; 0.20 perm inches.
6. Maximum flame spread: ASTM E84; 25.
7. Maximum smoke developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.

B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.04 JACKETS

A. Aluminum Jacket: ASTM B209.

1. Thickness: 0.020 to 0.025 inch sheet.
2. Finish: Embossed.
3. Joining: Longitudinal slip joints and 2-inch laps.
4. Metal Jacket Bands: 3/8 inch wide; 0.015-inch thick aluminum.

2.05 ACCESSORIES

A. Insulation Bands: 3/4 inch wide; 0.015-inch thick galvanized steel.

B. Insulating Cement: ASTM C 195; hydraulic setting mineral wool.

C. Finishing Cement: ASTM C 449.

D. Fibrous Glass Cloth: Untreated; 9 oz/sq yd weight.

E. Adhesives: Compatible with insulation.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install materials in accordance with manufacturer's instructions and N.I.C.A. standards.

B. Do not insulate factory insulated equipment.

C. On exposed equipment, locate insulation and cover seams in least visible locations.

D. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

F. Insulated dual temperature equipment or cold equipment containing fluids below ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.
2. Finish with glass cloth and vapor barrier adhesive.
3. Insulate entire system.
4. Where staples are used to secure insulation covering requiring vapor barrier, the staples shall be sealed with a vapor barrier mastic.

G. For insulated equipment containing fluids above ambient temperature:

1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.
2. Finish with glass cloth and adhesive.
3. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
4. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.

H. Inserts and Shields:

1. Application: Piping 1-1/2 inches diameter or larger.
2. Shields: Galvanized steel between hangers and inserts.
3. Insert location: Between support shield and equipment and under the finish jacket.

4. Insert configuration: minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.

5. Insert material: ASTM C640 cork, hydrous calcium silicate insulation, or other heavy density insulating material suitable for the planned temperature range.

I. Finish insulation at supports, protrusions, and interruptions.

J. For equipment in mechanical equipment rooms or in finished spaces, finish with PVC jacket and fitting covers.

K. Cover glass fiber, cellular glass, or cellular foam] insulation with metal mesh and finish with heavy coat of insulating cement.

L. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.

M. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.

3.03 TOLERANCE

A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.04 INSULATION SCHEDULE

A. Equipment Insulation:

EQUIPMENT INSULATION SCHEDULE

Equipment Type	Thickness (Inches)	Type	Finish
Chilled Water Pump Bodies	1”	FGF	PVC Jacket
*Chiller Cold Surfaces	1”	CF	N/A

*Not Factory Insulated

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15280

SECTION 15410

PLUMBING PIPING

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. Pipe and pipe fittings.

B. Valves.

C. Domestic water piping system.

1.02 RELATED SECTIONS

A. Section 05999 - Welding

B. Division 9 - Painting.

C. Section 15010 - Basic Mechanical Requirements.

D. Section 15050 - Basic Mechanical Materials and Methods.

E. Section 15140 - Supports and Anchors.

F. Section 15190 - Mechanical Identification.

G. Section 15245 - Vibration Isolation.

H. Section 15260 - Piping Insulation.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society of Mechanical Engineers
    a. ASME - Boiler and Pressure Vessel Code.
    b. ASME Sec. 9 - Welding and Brazing Qualifications.
    c. ASME - Boiler and Pressure Vessel Code.
    d. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800.
    e. ASME B16.3 - Malleable Iron Threaded Fittings.
    f. ASME B16.4 - Cast Iron Threaded Fittings Class 125 and 250.
    g. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings
    h. ASME B31.8 – Gas Transmission and Distribution Piping Systems.
    i. ASME B31.9 - Building Service Piping.
2. American Society for Testing and Materials (ASTM):

a. ASTM A 53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
b. ASTM A 74 - Cast Iron Soil Pipe and Fittings.
c. ASTM A 234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
d. ASTM B 32 - Solder Metal.
e. ASTM B 88 - Seamless Copper Water Tube.
f. ASTM B 251 - Wrought Seamless Copper and Copper-Alloy Tube.
g. ASTM C 14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
h. ASTM C 443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
i. ASTM C 564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
j. ASTM F1545 - 97(2009) Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges
k. ASTM D 2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
l. ASTM D 2683 - Socket-Type Polyethylene Fillings for Outside Diameter-Controlled Polyethylene Pipe.
m. ASTM F 477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

3. American Water Works Association (AWWA):
   a. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
   b. AWWA C110 - Ductile - Iron and Gray - Iron Fittings 3 in. through 48 in., for Water and Other Liquids.
   c. AWWA C111- Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.
   d. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
   e. AWWA C651 - Disinfecting Water Mains.
   f. M6 - Water Meters - Selection, Installation, Testing, and Maintenance.
4. American Welding Society (AWS):
   a. AWS A5.8 - Brazing Filler Metal.
5. Cast-Iron Soil Pipe Institute (CISPI):
   a. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
6. International Building Code (IBC) with the Denver Amendments
7. International Fire Code (IFC) with the Denver Amendments
8. National Certified Pipe Welding Bureau (NCPWB):
   a. NCPWB - Procedure Specifications for Pipe Welding.

1.04 SUBMITTALS

A. Product Data: Provide data on valves and accessories only. Provide manufacturers catalog information. Indicate valve data and ratings.

B. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

C. Welders Certificate: Include welders certification of compliance with ASME SEC 9 and section 05999 - Welding

D. Contractor shall submit fully dimensioned spool drawings for all welded piping work. Drawings shall indicate all weld types, sizes and materials to be used. The spool drawing size shall match the full size contract documents of either 24x36 or 34x44. Spool drawings shall be submitted in either the latest version of AutoCAD (dwg) or the latest version of Adobe Acrobat (pdf). Adobe Acrobat files shall not contain security. Other file formats will not be accepted.

E. Pneumatic Leak Test for water systems:

1. Contractor shall submit drawings and procedures of the pneumatic leak test to the DIA Mechanical Engineer no later that two weeks prior to testing. Contractor may not proceed with tests unless approved in writing by the DIA Mechanical Engineer or DIA Mechanical Inspector.

F. Disinfection and other Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

1.05 PROJECT RECORD DOCUMENTS

A. Record actual locations of valves.

1.06 OPERATION AND MAINTENANCE DATA

A. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.07 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welders Certification: In accordance with ASME Sec 9.

D. Unless specified otherwise, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.

1.08 REGULATORY REQUIREMENTS

A. Perform Work in accordance with City and County of Denver plumbing code.

B. Conform to code for installation of backflow prevention devices.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Section 15010 and Division 1.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.10 EXTRA MATERIALS

A. Provide two repacking kits for each type and size valve.

PART 2 - PRODUCTS

2.01 WATER PIPING, ABOVE GRADE

A. Copper Tubing: ASTM B 88, Type L, hard drawn.

1. Fittings: ASME B 16.22, wrought copper and bronze.
2. Joints: ASTM B 32, solder, Grade 95TA.
3. .

2.02 FLANGES, UNIONS, COUPLINGS AND MECHANICAL JOINT RESTRAINT

A. Pipe Size 2 Inches and Under:

1. Ferrous pipe: 150 psig malleable iron threaded unions.
2. Copper tube and pipe: 150 psig bronze unions with soldered joints.

B. Dielectric Waterway Fittings: Dielectric fittings designed to effectively separate dissimilar metals exposed to water or other electrolytes, conforming to NSF and ASTM F1545 standards for continuous use at temperatures up to 225 degrees F and pressures up to 300 psi. Fittings to have electro-zinc-plated steel casings providing for maintained exterior electrical continuity threaded or flanged ends as applicable, and inert linings. Provide "ClearFlow" units as manufactured by Perfection Corporation or approved substitute.

C. Mechanical Joint Restraint for Piping: Mechanical joint restraint shall be incorporated in the design of the follower gland and shall include a restraining mechanism which, when actuated, imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. Flexibility of the joint shall be maintained after burial. Glands shall be manufactured of ductile iron conforming to ASTM A 536-80. Restraining devices shall be of ductile iron heat treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to AWWA A21.11 and AWWA C153/A21.53 of latest revision. Twist-off nuts, sized same as tee-head bolts, shall be used to insure proper actuating of restraining devices. The mechanical joint restraint device shall have a working pressure of at least 250 psi with a minimum safety factor of 2:1 and shall be EBAA Iron, Inc., SERIES 1100 MEGALUG or approved substitute.

2.03 WATER SERVICE VALVES

A. Acceptable Manufacturers - Valves

1. Subject to conformance with specified requirements, products of the following

manufacturers are acceptable:

a. Gate, Globe, Plug, Drain, Hose Bibbs - Crane, Hammond, Jenkins, Milwaukee, Powell, Stockham.

b. Ball Valves - Apollo, Bray, Crane, Milwaukee, Nibco, Jenkins, Stockham,.

c. Butterfly Valves – Bray, Nibco, Norris, Posi-Seal, Keystone/Tyco.

B. Gate Valves

1. Up to 2 Inches: Bronze body, rising stem and handwheel, inside screw, single wedge or disc, solder or threaded ends.

C. Globe Valves

1. Up to 2 Inches: Bronze body, rising stem and handwheel, inside screw, renewable composition disc, solder or screwed ends, with backseating capacity.

D. Ball Valves

1. Up to 2 Inches: Bronze body, stainless steel full-port ball, teflon seats and stuffing box ring, lever handle and balancing stops, solder or threaded ends with union.

E. Plug Valves

1. Up to and including 2 Inches: Bronze body, bronze tapered plug, non-lubricated, teflon packing, threaded ends.

F. Butterfly Valves

1. Cast Iron Resiliently Seated Butterfly Valves 2" to 12": ASTM-A 126 Class B cast iron body to fit between ANSI Class 150 flanges, 250 psi bi-directional shutoff rating, lug style butterfly valve, extended neck, polished aluminum/bronze disc, EPDM replaceable seat rated for 250 degrees F, bi-directional stem seal, one-piece 316 or 416 SS stem, bronze upper and lower inboard bearings. Valves shall be installed by use of cap screws; threaded rod not acceptable. Tyco Keystone Figure 221/222 or equal.

G. Flow Controls

1. Construction: Brass or bronze body with union on inlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.

2. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psig.

H. Swing Check Valves

1. Up to 2 Inches: Bronze 45 degree swing disc, solder or screwed ends.

2. Over 2 Inches: Iron body, bronze trim, 45 or 22-degree swing disc, renewable disc and seat, flanged ends.

I. Spring Loaded Check Valves

1. Iron body, bronze trim, spring loaded, renewable composition disc, screwed, wafer, or flanged ends.

J. Strainers

1. Size 2 inch and Under: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

2. Size 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

3. Size 5 inch and Larger: Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

K. Water Pressure Reducing Valves

1. Manufacturers:
   a. Watts Regulator.
   b. Cash Valve Manufacturing Company.
   c. Substitutions: Under provisions in Section 15010.

2. Up to 2 Inches: Bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded or soldered, and single union ends.

3. Over 2 Inches: Cast iron body, bronze fitted, elastomer diaphragm and seat disc, flanged.

L. Relief Valves

1. Manufacturers:
   a. Amtrol, Inc.
   b. Crane Company.
   c. Watts Regulator Company.
   d. Substitutions: Under provisions in Section 15010.

2. Bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

PART 3 -EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Provide dielectric fittings wherever jointing dissimilar metals.

B. Route piping in orderly manner and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space. Refer to Section 15010 for coordination requirements.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide clearance for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 8 installer.

H. Slope water piping and arrange to drain at low points.

I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

J. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting. Refer to Division 9.

K. Install valves with stems upright or horizontal, not inverted.

L. Provide one plug cock wrench for every ten plug cocks sized 2 inches and smaller, minimum of one. Provide each plug cock sized 2-1/2 inches or larger with a wrench with set screw.

M. Vents less than six inches above the flood level rim of the fixture shall be installed with approved drainage fittings and materials, and grade to drain.

N. Lever handle valves: Install valve handle so that the handle opens in the direction of fluid flow.

3.03 APPLICATION

A. Provide and install unions downstream of valves and at equipment or apparatus connections.

B. Provide and install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

C. Provide and install ball or butterfly valves for shut-off and to isolate all equipment, isolate connections to existing piping mains, part of systems as indicated, and/or vertical risers.

D. Provide and install [globe] [ball] [butterfly] valves for throttling, bypass, or manual flow control services.

E. Provide and install spring loaded check valves on discharge of water pumps.

F. Provide and install flow controls in water recirculating systems where indicated.

3.04 ERECTION TOLERANCES

A. Slope water piping and arrange to drain at low points.

3.05 TESTING - PIPING SYSTEMS

A. Perform all tests in the presence of the authorized City representative when required. Contractor shall provide inspector 48-hour prior notice of test; also notify DIA Project Manager.

B. Test soil, waste, and vent and roof drainage and drain systems with a minimum of 10 foot hydrostatic head or in accordance with local and state codes governing plumbing and drainage work.

C. Hydrostatic Leak Test:

1. Perform hydrostatic leak test on all piping systems prior to making final connections to fixtures and equipment.

2. Hydrostatic Leak Test Procedure:
   a. Leak test procedures shall comply with ASME B31.9.
   b. Fill piping systems with clear water, vent all air, and pressurize at 150% of operating pressure, (but not less than 100 psi or more than the pipe rating pressure) for 15 minutes. Test fails if leakage is observed, or pressure drop exceeds 5% of test pressure.

D. No piping or joint shall be left untested. All leaks shall be repaired and the piping system shall be re-tested until satisfactory results are obtained.

E. Pneumatic Leak Test

1. General: Pneumatic leak tests shall only be used on piping with restricted access, piping exposed to freezing conditions, or where water leakage would damage critical DIA operational equipment. Contractor shall submit a written request for test in accordance with the SUBMITTALLS paragraph of this specification section.

2. Pneumatic Test Procedure:
   a. Contractor shall submit safety plan for pneumatic testing prior to test.
   b. General: Compressed gas poses the risk of sudden release of stored energy. For that reason, pneumatic testing shall be used only within the following limitations.
      1) The piping system does not contain cast iron pipe or plastic pipe subject to brittle failure.
      2) The system does not contain soldered or solvent cement joints over NPS 2.
      3) The test pressure does not exceed 150 psig.
   c. Test Medium: The gas shall be nonflammable and nontoxic.
   d. Preliminary Test. Prior to application of full pneumatic test pressure, a preliminary test of not more than 10 psig shall be applied to reveal possible major leaks. Pneumatic Test Pressure:
      1) Except as limited in 2) below, the test pressure shall not exceed 1.25 times the design pressure. Pressure shall be applied in several stages, allowing time for the system to reach equilibrium at each stage.
      2) The test pressure shall not exceed the maximum allowable pneumatic test pressure for any vessel, pump, valve, or other component in the system under test.
   e. Examination for Leakage: After the preliminary test, pressure shall be raised in stages of not more than 25% up to full pneumatic test pressure, allowing time for equalization of strains and detection of major leaks at each stage. Following the application of test pressure for at least 10 minutes, the pressure may be reduced to design pressure and examination shall be made for leakage of the piping. Leaks may be detected by soap bubble, halogen gas, scented gas, test gage monitoring, ultrasonic, or other suitable means. If leaks are found, pressure shall be vented, appropriate repair or replacement shall be made, and the pneumatic test repeated until no leakage is found.
   f. Contractor shall measure the surface temperature of the pipe for the duration of testing. The pneumatic test will be deemed successful only when the test pressure can be held at a constant pipe surface temperature for a period of no less than 10 continuous minutes. Record of the pipe temperatures and pressures during the duration of the test shall be submitted to the DIA Project Manager following completion of the test.

F. Testing shall be witnessed by DIA Mechanical Inspector and Project Manager or Designated Representative.

G. Repair piping systems which fail required piping test, by disassembly and reinstallation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

H. Drain test water from piping systems after testing and repair work that has been completed.

I. Prepare written report of testing procedures and result. Submit in accordance with Section 15010.

PART 4 -MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15410

SECTION 15510

HYDRONIC PIPING

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. Pipe and pipe fittings for the following systems including glycol/water solution piping for freeze protection where indicated on the drawings:

1. Chilled water piping system.
2. Condenser water piping system.
3. Equipment drains and overflows.

B. Valves:

1. Ball valves.
2. Butterfly valves.
3. Check valves.

1.02 RELATED SECTIONS

A. Section 05999 - Welding

B. Division 9 - Painting.

C. Section 15010 - Basic Mechanical Requirements.

D. Section 15121 - Piping Expansion Compensation.

E. Section 15140 - Supports and Hangers.

F. Section 15190 - Mechanical Identification.

G. Section 15245 - Vibration Isolation.

H. Section 15260 - Piping Insulation.

I. Section 15515 - Hydronic Specialties.

J. Section 15545 - Chemical Water Treatment: Pipe cleaning.

K. Section 16142 - Electrical Connections for Equipment

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society for Testing and Materials (ASTM):

a. ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
b. ASTM A 234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
c. ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings
d. ASTM A 536 - Ductile Iron Castings
e. ASTM B 32 - Solder Metal.
f. ASTM B 75 - Seamless Copper Tube.
g. ASTM B 88 - Seamless Copper Water Tube.
h. ASTM B 152 - Copper Sheet, Strip, Plate and Rolled Bar.
i. ASTM B 584 - Copper Alloy Sand Castings for General Applications.
j. ASTM D 1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
k. ASTM D 2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
l. ASTM D 2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
m. ASTM D 2996 - Filament-Wound Reinforced Thermosetting Resin Pipe.
n. ASTM D 2310 - Machine-Made Reinforced Thermosetting Resin Pipe.
o. ASTM D 2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
p. ASTM D 2467 - Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
q. ASTM D 2680 - Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite-Sewer Piping.
r. ASTM D 2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
s. ASTM D 2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
t. ASTM D 2855 - Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
u. ASTM D 3309 - Polybutylene (PB) Plastic Hot-and Cold-Water Distribution Systems.
v. ASTM F 477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
w. ASTM F 708 - Design and Installation of Rigid Pipe Hangers.
x. ASTM F 845 - Plastic Insert Fittings for Polybutylene (PB) Tubing.
y. ASTM F 876 - Crosslinked Polyethylene (PEX) Tubing.
z. ASTM F 877 - Crosslinked Polyethylene (PEX) Plastic Hot and Cold - Water Distribution Systems.

2. American Society of Mechanical Engineers (ASME) :
   a. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   b. ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
   c. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
   d. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   e. ASME B31.5 - Refrigeration Piping.
   f. ASME B31.9 - Building Services Piping.
3. American Welding Society (AWS):
   a. AWS A5.8 - Brazing Filler Metal.
   b. AWS D1.1 - Structural Welding Code.

4. American Water Works Association (AWWA):
    a. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
    b. AWWA C110 - Ductile - Iron and Grey -Iron Fittings 3 in. through 48 in., for Water and Other Liquids.
    c. AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Grey-Iron Pressure Pipe and Fittings.
    d. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
5. International Building Code (IBC) with the Denver Amendments
6. International Fire Code (IFC) with the Denver Amendments
7. Manufacturers Standardization Society (MSS):
    a. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
    b. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
    c. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.04 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded connections to valves, equipment or other apparatus.

C. Use non-conducting dielectric waterway fittings or insulating flanges whenever jointing dissimilar metals in piping systems. Dielectric fittings shall have end connections that match the adjoining pipe. Dielectric unions shall not be used.

D. Provide pipe hangers and supports in accordance with ASTM B31.9 unless indicated otherwise.

E. Use ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.

F. Use butterfly valves for throttling, bypass, or manual flow control services.

G. Use spring loaded check valves on discharge of pumps where more than one pump supplies water to a common header.

H. Butterfly valves shall be lug type.

I. Use 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

1.05 SUBMITTALS

A. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.

C. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in SECTION 15050.

D. Welders Certificate: Include welders certification of compliance with ASME SEC 9 and section 05999 - Welding

E. Contractor shall submit fully dimensioned spool drawings for all welded piping work. Drawings shall indicate all weld types, sizes and materials to be used. The spool drawing size shall match the full size contract documents of either 24x36 or 34x44. Spool drawings shall be submitted in either the latest version of AutoCAD (dwg) or the latest version of Adobe Acrobat (pdf). Adobe Acrobat files shall not contain security. Other file formats will not be accepted.

F. Pneumatic Leak Test:

1. Contractor shall submit drawings and procedures of the pneumatic leak test to the DIA Mechanical Engineer no later that two weeks prior to testing. Contractor may not proceed with tests unless approved in writing by the DIA Mechanical Engineer or DIA Mechanical Inspector.

G. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

1.06 PROJECT RECORD DOCUMENTS

A. Record actual locations of valves, piping and anchors. Submit drawings on a single CD-ROM in latest AutoCAD format.

1.07 OPERATION AND MAINTENANCE DATA

A. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing the work of this section with minimum five years] experience.

C. Welders: Certify in accordance with ASME SEC 9.

1.09 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME SEC 9 [and applicable state labor regulations].

C. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

D. Unless specified otherwise, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Section 15010 and Division 1

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage. Collect and save installation instructions for DIA Project Managers use.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 EXTRA MATERIALS

A. Provide two repacking kits for each size and valve type.

PART 2 - PRODUCTS

2.01 CHILLED WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A 53, Schedule 40, 0.375 inch wall for sizes 12 inch and over, black.

1. Fittings: ASTM B 16.3, malleable iron or ASTM A 234, forged steel welding type.
2. Joints: Screwed , for pipe 2 inch and under; AWS D1.1 welded for pipe over 2 inch size.

2.02 CONDENSER WATER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A 53, Schedule 40, 0.375 inch wall for sizes 12 inch and over, black.

1. Fittings: ASTM B 16.3, malleable iron or ASTM A 234, forged steel welding type.
2. Joints: Screwed , for pipe 2 inch and under; AWS D1.1 welded for pipe over 2 inch size.

2.03 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A 53, Schedule 40 galvanized.

1. Fittings: Galvanized cast iron, or ASTM B 16.3 malleable iron.
2. Joints: Threaded.

2.04 PIPE HANGERS AND SUPPORTS

A. Conform to requirements of Section 15140.

2.05 FLANGES, UNIONS, COUPLINGS, AND MECHANICAL JOINT RESTRAINTS

A. Unions for Pipe 2 Inches and Under:

1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe Over 2 Inches:

1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Gaskets: 1/16 inch thick non-asbestos preformed gaskets, aramid fibers with nitrile (NBR) binder; Durlon "8500 Green", Garlock "IFG 5500", or approved equal.

C. Dielectric Waterway Fittings: Dielectric fittings designed to effectively separate dissimilar metals exposed to water or other electrolytes, conforming to NSF and ASTM F492 standards for continuous use at temperatures up to 225 degrees F and pressures up to 300 psi. Fittings to have electro-zinc-plated steel casings providing for maintained exterior electrical continuity, threaded as applicable, and inert linings. Provide "ClearFlow" units as manufactured by Perfection Corporation or approved substitute.

2.06 ACCEPTABLE MANUFACTURERS - VALVES

A. Subject to conformance with specified requirements, products of the following manufacturers are acceptable:

1. Check, Plug, Drain
   a. Crane
   b. DeZurik
   c. Hammond
   d. Jenkins
   e. Meuller Flow Technologies
   f. Milwaukee
   g. Powell
   h. Stockham
   i. Substitutions: Under provisions of Section 15010.
2. Ball Valves
   a. Apollo-Conbraco
   b. Bray
   c. Crane
   d. Jamesbury
   e. Jenkins
   f. Milwaukee
   g. Nibco
   h. Stockham
   i. Substitutions: Under provisions of Section 15010.
3. Butterfly Valves
   a. Bray
   b. Jamesbury
   c. Nibco

d. Norris
e. Posi-Seal
f. Substitutions: Under provisions of 15010.

2.07 VALVES REQUIRING ACTUATORS OR POSITIONERS

A. For valves to be equipped with electrical or pneumatic actuators or positioners, the valves and the devices required to mechanically position valves shall be supplied as work of Section 15952 of these specifications, with the valves installed in piping systems as work of this Section. Installation of actuators (where not integrally assembled with valve bodies), including furnishing and installation of any brackets, mountings, or other fabrications necessary for physically mounting actuator/positioner devices, shall be performed as work of Section 15952.

2.08 BALL VALVES

A. Up to and Including 2 Inches: Bronze two piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, threaded ends .

B. Over 2 Inches: Cast steel body, 316 stainless steel ball, teflon seat and stuffing box seals, lever handle, or gear drive handwheel for sizes 10 inches and over, flanged.

C. Operating pressure rating shall be 300 psig OWG non-shock at 230 degrees F.

2.09 HIGH PERFORMANCE BUTTERFLY VALVES

A. Sizes 2" through 12": Carbon steel body, 150 lb full ANSI rated bi-directional, lug style butterfly type, bi-directional dead-end pressure rating of 285 psi, and temperature rating of -20 to 300 degrees F continuous use. Construction features to include 316 SS electroless nickel plated eccentric rotating disc, dynamic sealed, PTFE seal ring, 17-4 PH (ASTM A 564 Cond. H1075 or H1100) stainless steel shaft, TFE chevron stem packing, SS/DU TFE impregnated bearings, and EPDM seat backing O-ring. Unit shall be drilled and tapped for isolation and removal of downstream piping and shall be factory pressure tested to 110% of pressure rating. Valves shall be installed by use of cap screws; threaded rod not acceptable. Bray series 40/41 or equal.

B. Sizes 14" through 36": Carbon steel body, 150 lb full ANSI rated, lug style butterfly type, uni-directional dead-end pressure rating of 285 psi, and temperature rating of -20 to 300 degrees F continuous use. Construction features to include 316 SS electroless nickel plated eccentric rotating disc, integrally cast disc position stop, PTFE seal ring, 17-4 PH (ASTM A 564 Cond. H1075 or H1100) stainless steel shaft, PTFE chevron stem packing, 316 stainless steel/nitride DU impregnated bearings, and EPDM seat backing O-ring. Unit shall be drilled and tapped for isolation and removal of downstream piping and shall be factory pressure tested to 110% of pressure rating. Valves shall be installed by use of cap screws; threaded rod not acceptable. Bray series 40/41 or equal.

C. Operator: 2" through 6" to have a 10-position lever handle; throttling valves to have infinite position lever handle with adjustable 2-way memory stop kit. Provide handwheel and gear drive for valves 8" and larger.

2.10 SWING CHECK VALVES

A. Up to and Including 2 Inches: Bronze 45 degree swing disc, stainless steel pin, screwed ends, renewable seat. Operating pressure rating 125 psig steam working pressure, 200 psig non-shock OWG.

B. Over 2 Inches: Iron body, bronze trim, 45 degree swing disc, renewable disc and seat, flanged ends. Pressure rating 150 psig at 340 degrees F, minimum.

2.11 SPRING LOADED CHECK VALVES

A. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, threaded lug ends.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Hot and Chilled Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded and flanged joints.

B. Condenser Water: Schedule 40 steel pipe with welded and flanged joints.

3.02 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

1. Shutoff Duty: Ball and butterfly valves.
2. Throttling Duty: Butterfly valves.

B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

C. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

3.03 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Provide piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps. Protect threads in a similar manner.

E. After completion, fill, clean, and treat systems. Refer to Section 15545.

3.04 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install condenser water piping to ASME B31.9. Install chilled water piping to ASME B31.5.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Sleeve pipe passing through partitions, walls and floors.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 15121.

H. Inserts: Refer to Section 15140.

I. Pipe Hangers and Supports:

1. Install in accordance with Section 15140.
2. Support horizontal piping as scheduled.
3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each side of each horizontal elbow. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Provide copper plated hangers and supports for copper piping.
8. Prime coat exposed steel hangers and supports. Refer to Division 9. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 15260.

K. Slope piping and arrange systems to drain at low points; refer to Part 1 system description. Use eccentric reducers to maintain bottom of pipe level.

L. Provide capped air vents at all high points except as otherwise indicated; refer to Section 15515.

M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

N. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Division 9.

O. Install manual valves with stems upright or horizontal, not inverted. Stems for motorized valves shall be installed in upright position except where otherwise specifically indicated on the drawings.

3.05 CLEANING, FLUSHING, AND INSPECTING

A. Clean and flush system, with clear water, of all dirt, metal chips, sand, and foreign matter. After flushing, remove, clean, and replace all strainer baskets or screens. Inspect each run of each system for completion of joints, supports, accessory items, and obvious leaks.

B. Examine and inspect piping in accordance with ANSI B31.1, Chapter VI.

C. Refer to Section 15545.

3.06 LEAK TESTING

A. Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed, wherever feasible, and remove control devices before testing. Subject entire piping systems to leak tests, either as a whole, or in sections; but leave no part untested.

B. Test gauges shall have a range that provide for the test pressure to be in the middle third of the gauge scale.

C. Contractor shall provide written notification to the DIA Project Manager/Engineer and DIA Inspector at least 48 hours before performing leak test. Perform all tests in the presence of the authorized City representative.

D. Hydrostatic Leak Test:

1. Perform hydrostatic leak test on all piping systems.
2. Hydrostatic Leak Test Procedure:
    a. Leak test procedures shall comply with ASME B31.9.
    b. Fill piping systems with clear water, vent all air, and pressurize at 150% of operating pressure, (but not less than 100 psi) for 2 hours. Test fails if leakage is observed, or pressure drop exceeds 5% of test pressure.

E. Testing shall be witnessed by DIA Mechanical Inspector and Project Manager or Designated Representative.

F. Repair piping systems which fail required piping test, by disassembly and reinstallation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

G. Drain test water from piping systems after testing and repair work that has been completed.

H. Prepare written report of testing procedures and result. Submit in accordance with Section 15010.

I. After completion, fill, clean, and treat systems. Refer to Section 15545.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15510

SECTION 15515

HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Air vents.

B. Strainers.

C. Pump suction fittings.

D. Flow switches

E. Combination fittings.

F. Flow indicators and controls.

G. Relief valves.

1.02 RELATED SECTIONS

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15050 - Basic Mechanical Materials and Methods.

C. Section 15510 - Hydronic Piping.

D. Section 15545 - Chemical Water Treatment: Pipe Cleaning.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

1. American Society of Mechanical Engineers (ASME):
   a. ASME - Boilers and Pressure Vessel Codes, SEC 8-D-Rules for Construction of Pressure Vessels.
2. International Building Code (IBC) with the Denver Amendments
3. International Fire Code (IFC) with the Denver Amendments

1.04 SUBMITTALS

A. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component rough-in requirements, service sizes, and finishes. Include product description, model, dimensions and weight.

B. Submit inspection certificates for pressure vessels from authority having jurisdiction.

C. "As Built" Plans shall be provided in the same format as described above. Each set shall be equipped with a plan holder equal to "Stacor Plan Clamps" for the appropriate size drawing.

1.05 OPERATION AND MAINTENANCE DATA

A. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Section 15010 and Division 1

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 MAINTENANCE SERVICE FOR GLYCOL-PROTECTED SYSTEMS

A. Perform project visit, 30 days after system startup, to make glycol fluid concentration analysis on site with refractive index measurement instrument. Provide written report of findings to maintenance personnel, covering corrective actions needed including analysis and amounts of glycol or water added as part of Contract work. Include pH analysis of system contents and perform work required to adjust pH to a level of 8.0 or higher, and add inhibitors needed to maintain pH.

1.08 EXTRA MATERIALS

A. Provide one extra 10 gallon drum of propylene glycol.

PART 2 - PRODUCTS

2.01 AIR VENTS

A. Manufacturers:

1. Amtrol, Inc.
2. Bell & Gossett ITT.
3. Taco Inc.
4. Substitutions: Under provisions of Section 15010.

B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

C. Float Type: Brass body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve. Minimum ratings not less than 250 degrees F and 150 psi working pressure.

D. Washer Type: Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.02 STRAINERS

A. Manufacturers:

1. Aurora Pump.
2. Armstrong Machine Works.
3. Conbraco Industries, Inc.
4. Dunham-Bush, Inc.
5. Hoffman ITT.
6. Clark-Reliance Corp.
7. A. C. Keckley.
8. Mueller Steam Specialty.
9. Spirax/Sarco.
10. Substitutions: Under provisions of Section 15010.

B. Size 2 inch and Under: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger: Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.03 PUMP SUCTION FITTINGS

A. Manufacturers:

1. Aurora Pump.
2. Bell & Gossett ITT.
3. Taco Inc.
4. Substitutions: Under provisions of Section 15010.

B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning. Pressure drop at maximum pump flow shall not exceed 2 psig.

C. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

2.04 FLOW SWITCHES

A. Manufacturers:

1. Honeywell, Inc.
2. Watts Regulator.
3. Johnson Control.

4. Potter-Roemer Inc.

5. Substitutions: Under provisions of Section 15010.

B. Brass construction, threaded for insertion into piping system, packless, with paddle with removable segments, vapor proof electrical compartment with switches.

2.05 PRESSURE AND TEMPERATURE PLUGS

A. Manufacturers:

1. Duro Instrument Co.

2. Trerice Co.

3. Universal.

4. Weksler.

5. Substitutions: Under provisions of Section 15010.

B. Stainless steel combination pressure-temperature test plugs with neoprene valve core where shown on the drawings

PART 3 - EXECUTION

3.01 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer's instructions to provide intended performance.

B. Provide manual air vents at system high points and as indicated.

C. Provide pump suction fitting on suction side of base mounted centrifugal pumpswhere indicated. Remove temporary strainers after cleaning systems.

D. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.

E. Install pressure and temperature plugs in locations that allow for use during full range of motion of all surrounding valve handles.

F. Refer to section 15140 for support of pump fittings.

G. Provide isolation valves on water inlet to terminal heating units such as radiation, unit heaters, and fan coil unit.

H. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

I. Pipe relief valve outlet to nearest floor drain.

J. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

K. Clean and flush glycol system before adding glycol solution.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15515

SECTION 15535

REFRIGERANT PIPING AND SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and liquid indicators.

D. Valves.

E. Strainers.

F. Check valves.

G. Pressure relief valves.

H. Filter-driers.

I. Solenoid valves.

J. Expansion valves.

K. Receivers.

L. Flexible connections.

1.02 RELATED SECTIONS

A. Division 8 - Access Doors.

B. Division 9 - Painting.

C. Section 15010 - Basic Mechanical Requirements.

D. Section 15050 - Basic Mechanical Materials and Methods.

E. Section 15260 - Piping Insulation.

F. Section 15280 - Equipment Insulation.

G. Section 15742 - Air Cooled Refrigerant Condensers.

H. Section 15785 - Computer Room Air Conditioning Units.

I. Section 15790 - Air Coils.

J. Section 15985 - Sequence of Operation.

K. Section 16142 - Electrical Connections for Equipment

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
   a. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
   b. ASHRAE 34 - Number Designation of Refrigerants.
2. American Society of Mechanical Engineers (ASME):
   a. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   b. ASME B31.5 - Refrigeration Piping.
   c. ASME B31.9 - Building Services Piping.
   d. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   e. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes.
   f. ASME SEC 8D - Boilers and Pressure Vessels Code, Rules for Construction of Pressure Vessels.
3. American Refrigerants Institute (ARI):
   a. ARI 495 - Refrigerant Liquid Receivers.
   b. ARI 710 - Liquid Line Dryers.
   c. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter-Driers.
   d. ARI 750 - Thermostatic Refrigerant Expansion Valves.
   e. ARI 760 - Solenoid Valves for Use With Volatile Refrigerants.
4. American Society for Testing of Materials (ASTM)
   a. ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   b. ASTM A 234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
   c. ASTM B 88 - Seamless Copper Water Tube.
   d. ASTM B 280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
   e. ASTM F 708 - Design and Installation of Rigid Pipe Hangers.
5. American Welding Society (AWS):
   a. AWS A5.8 - Brazing Filler Metal.
   b. AWS D1.1 - Structural Welding Code, Steel.
6. International Building Code (IBC) with the Denver Amendments
7. International Fire Code (IFC) with the Denver Amendments
8. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
   a. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
   b. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
   c. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

9. Underwriters' Laboratories (UL):
    a. UL 429 - Electrically Operated Valves.

1.04 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with ASTM B31.5 unless indicated otherwise.

C. Liquid Indicators:
    1. Use line size liquid indicators in main liquid line leaving condenser.
    2. If receiver is provided, install in liquid line leaving receiver.
    3. Use line size on leaving side of liquid solenoid valves.

D. Valves
    1. Use service valves on suction and discharge of compressors.
    2. Use gage taps at compressor inlet and outlet.
    3. Use gage taps at hot gas bypass regulators, inlet and outlet.
    4. Use check valves on compressor discharge.
    5. Use check valves on condenser liquid lines on multiple condenser systems.

E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.

F. Strainers:
    1. Use line size strainer upstream of each automatic valve.
    2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
    3. On steel piping systems, use strainer in suction line.
    4. Use shut-off valve on each side of strainer.

G. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.

H. Permanent Filter-Driers:
    1. Use in low temperature systems.
    2. Use in systems utilizing hermetic compressors.
    3. Use filter-driers for each solenoid valve.

I. Replaceable Cartridge Filter-Driers:
    1. Use vertically in liquid line adjacent to receivers.
    2. Use filter-driers for each solenoid valve.
    3. Provide isolation valves and bypass valve for each filter-drier.

J. Solenoid Valves:

1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
2. Use in liquid line of single or multiple evaporator systems, upstream of each expansion valve.
3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.

K. Receivers:

1. Use on systems 5 tons and larger, sized to accommodate pump down charge.
2. Use on systems with long piping runs.

L. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.05 SUBMITTALS

A. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes, line capacities and estimated line pressure drops.

B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.

C. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Test Reports: Indicate results of leak test, acid test.

E. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

1.06 PROJECT RECORD DOCUMENTS

A. Record exact locations of equipment and refrigeration accessories on record drawings.

1.07 OPERATION AND MAINTENANCE DATA

A. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.08 QUALIFICATIONS

A. Installer: Company specializing in performing the work of this section with minimum of three years experience.

B. Design piping system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Colorado.

1.09 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.

C. Welders Certification: In accordance with ASME SEC 9.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc. (or other testing agency acceptable to the authority having jurisdiction) as suitable for the purpose specified and indicated.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Section 15010 and Division 1.

B. Deliver and store piping and specialties in shipping containers with labeling in place.

C. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

D. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.11 MAINTENANCE MATERIALS

A. Provide two refrigeration oil test kits each containing everything required to conduct one test.

B. Provide two containers each with 25 pounds of associated refrigerant.

C. Provide two filter-dryer cartridges of each type.

PART 2 - PRODUCTS

2.01 PIPING

A. Copper Tubing: ASTM B 280, Type ACR hard drawn [or annealed].

1. Fittings: ASME B16.22 wrought copper.
2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

B. Copper Tubing to 7/8 inch OD: ASTM B 88, Type K, annealed.

1. Fittings: ASME B16.26 cast copper.
2. Joints: Flared.

C. Steel Pipe: ASTM A 53, Schedule 40, or STD Weight class, black.

1. Fittings: ASTM A 234, forged steel welding type.
2. Joints: AWS D1.1, welded.

D. Pipe Supports and Anchors: Refer to Section 15140.

2.02 REFRIGERANT

A. Refrigerant: ASHRAE 34;

1. R-123: Dichloro,trifluoroethane

2.03 MANUFACTURERS

A. Subject to conformance with specifications requirements, products of the following manufacturers are acceptable for use.

1. Henry Valve Co.
2. Parker-Hannifin Corp.
3. Sporlan Valve Co.
4. Alco Controls Div.
5. Automatic Switch Co.
6. Substitutions: Under provisions of Section 15010.

2.04 MOISTURE AND LIQUID INDICATORS

A. Indicators: Double port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum working pressure of 500 psig, and maximum temperature of 200 degrees F.

2.05 VALVES

A. Diaphragm Packless Valves: UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psig and maximum temperature of 275 degrees F.

B. Packed Angle Valves: Forged brass, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psig and maximum temperature of 275 degrees F.

C. Ball Valves: Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psig and maximum temperature of 300 degrees F.

D. Service Valves: Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psig.

2.06 STRAINERS

A. Straight Line or Angle Line Type: Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psig.

B. Straight Line, Non-Cleanable Type: Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure of 500 psig.

2.07 CHECK VALVES

A. Globe Type: Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum working pressure of 500 psig and maximum temperature of 300 degrees F.

B. Straight Through Type: Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psig and maximum temperature of 275 degrees F.

2.08 PRESSURE REGULATORS

A. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psig range, for maximum working pressure of 500 psig.

2.09 PRESSURE RELIEF VALVES

A. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard 400 psig setting; selected to ASHRAE 15.

2.10 FILTER-DRIERS

A. Replaceable Cartridge Angle Type: Shell: ARI 710, UL listed, steel, removable cap, for maximum working pressure of500 psig.

1. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina, ARI 730 rating for 2,500 tons].

2.11 SOLENOID VALVES

A. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly, with flared, solder, or threaded ends; for maximum working pressure of 500 psig. Stem shall permit manual operation in case of coil failure.

B. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box [with actuation light].

C. Electrical Characteristics: 120 volts, single phase, 60 Hz.

2.12 EXPANSION VALVES

A. Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, mechanical pressure limit (maximum operating pressure MOP feature), adjustable superheat setting, replaceable inlet strainer, with replaceable capillary tube and remote sensing bulb and remote bulb well.

B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.13 ELECTRONIC EXPANSION VALVES

A. Valve:

1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.

2. Capacity: Nominal 2500 tons.

3. Electrical Characteristics: 12 VA, 12 volts DC.

B. Evaporation Control System:

1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.

2. Electrical Characteristics: 12 VA, 115 volts, single phase, 50/60 Hz.

C. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space.

D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Inserts: Refer to Section 15140 – Supports and Anchors.

G. Pipe Hangers and Supports: Refer to Section 15140 – Supports and Anchors.

H. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

I. Provide clearance for installation of insulation and access to valves and fittings.

J. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Division 8.

K. Flood piping system with nitrogen when brazing.

L. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.

M. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Division 9.

N. Insulate piping and equipment; refer to Section 15260 – Piping Installation and Section 15280 – Equipment Installation.

O. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

P. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

Q. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

R. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

S. Fully charge completed system with refrigerant after testing.

T. Provide electrical connection to solenoid valves. Refer to Section 16142 – Electrical Connections for Equipment.

U. Lever handle valves: Install valve handle so that the handle opens in the direction of fluid flow.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection and testing.

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test system with dry nitrogen to 200 psig. Perform final tests at 27 inches vacuum and 200 psig using electronic leak detector. Test to no leakage. Submit test report in accordance with Section 15010.

D. System testing shall be witnessed by DIA Mechanical Inspector, DIA Project Manager and/or a DIA appointed representative. Provide a written request for testing a minimum of 72 hours prior to test.

3.04 SCHEDULES

A. Pipe Hanger Spacing:

Pipe Size (inches)	Maximum Hanger Spacing (Feet)	Hanger Rod Diameter (inches)
1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	10	5/8
8 to 12	14	7/8

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15535

SECTION 15540

HVAC PUMPS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes the following:

1. Separately coupled, base-mounted, double-suction centrifugal pumps.

1.02 RELATED SECTIONS

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15050 - Basic Mechanical Materials and Methods.

C. Section 15140 - Supports and Anchors

D. Section 15245 - Vibration Isolation.

E. Section 15260 - Piping Insulation.

F. Section 15280 - Equipment Insulation.

G. Section 15510 - Hydronic Piping.

H. Section 15515 - Hydronic Specialties.

I. Section 16142 - Electrical Connections for Equipment: Electrical characteristics and wiring connections.

J. Section 16480 - Motor Controllers.

K. Section 16486 - Electric Motors.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. ASME International (ASME):
   a. B16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.
2. ASTM International (ASTM):
   a. A36/A36M - Carbon Structural Steel.
   b. A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. B584 - Copper Alloy Sand Castings for General Applications.
3. Hydraulic Institute (HI):

a. 1.1-1.5 - Centrifugal Pumps for Nomenclature, Definitions, Application and Operation (ANSI).

b. 2.1-2.5 - Vertical Pumps for Nomenclature, Definitions, Application and Operation (ANSI).

4. National Fire Protection Association (NFPA):

a. NFPA 70 - National Electrical Code.

5. Underwriters' Laboratories (UL):

a. UL 778 - Motor Operated Water Pumps.

1.04 PERFORMANCE REQUIREMENTS

A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.05 SUBMITTALS

A. General: Submit the following in accordance with SECTION 15050.

B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve and electrical characteristics and connection requirements. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.

C. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

1. Wiring Diagrams: Power, signal, and control wiring.

D. Millwright's Certificate: Certify that base mounted pumps have been aligned.

E. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to DIVISION 1.

C. Manufacturer: Company specializing in manufacture, assembly, and field performance of pumps with minimum of five years experience.

D. Alignment: Base mounted pumps shall be aligned by qualified millwright.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.07 OPERATION AND MAINTENANCE DATA

A. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.08 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc. (or other testing agency acceptable to the authority having jurisdiction) as suitable for the purpose specified and indicated.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Section 15010 and Division 1.

B. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

C. Store pumps in dry location.

D. Retain protective covers for flanges and protective coatings during storage. Maintain in place until installation.

E. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

F. Comply with pump manufacturer's written rigging instructions.

1.10 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in DIVISION 3.

1.11 EXTRA MATERIALS

A. Provide one set of mechanical seals for each pump.

B. Provide 2 sets of cartridges for each side-stream filter.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to conformance with specified requirements, products of the following manufacturers are acceptable.

1. Fairbanks Morse Pump.
2. ITT/Allis Chalmers.
3. Bell & Gossett.
4. Buffalo Forge.
5. Goulds Pumps.
6. Peerless Pump.
7. Aurora Pump.

8. Paco Pump.

9. Substitutions: Under provisions of Section 15010.

B. Radiated noise shall not exceed:

1. NC 45 – Maintenance Facilities

2.02 SEPARATELY COUPLED, BASE-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 200oF.

B. Pump Construction:

1. Casing: Horizontally split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, Class 125 flanges. Casing supports shall allow removal and replacement of impeller without disconnecting piping.

2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.

3. Pump Shaft: Stainless steel.

4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.

5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.

6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

C. Shaft Coupling:

1. Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor,EPDM coupling sleeve for variable-speed applications.

2. Grid Type Couplings: Flexible grid couplings with either horizontally split cover, vertically split cover, or full spacer design.

D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

E. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

F. Motor: Premium efficiency, variable speed compatible, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in DIVISION 16.

G. Refer to Drawing Package for Capacities and Characteristics:

2.03 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 175-psig300-psig pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gauge ports with integral check valve, and orifice for flow measurement.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to SECTION 15050.

B. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.

C. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

D. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

E. Install anchor bolts to elevations required for proper attachment to supported equipment.

F. Cast-in-place concrete materials and placement requirements are specified in DIVISION 3.

3.03 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

E. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.

F. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.04 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in [HI 1.1-1.5] [HI 2.1-2.5].

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.05 CONNECTIONS

A. Piping installation requirements are specified in other DIVISION 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install [check valve and throttling] [triple-duty] valve on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gauges on pump suction and discharge, at integral pressure-gauge tapping, or install single gauge with multiple input selector valve.

I. Ground equipment according to DIVISION 16.

J. Connect wiring according to DIVISION 16.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions.

C. Check piping connections for tightness.

D. Clean strainers on suction piping.

E. Perform the following startup checks for each pump before starting:

3.07 VERIFY BEARING LUBRICATION

A. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

B. Verify that pump is rotating in the correct direction.

C. Prime pump by opening suction valves and closing drains, and prepare pump for operation.

D. Start motor.

E. Open discharge valve slowly.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train DIA Project Manager's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to DIVISION 1.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15540

SECTION 15545

CHEMICAL WATER TREATMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section includes Cleaning of piping systems for the following:

1. Chilled-water piping (closed-loop system).
2. Condenser water piping (open system).

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 15510 - Hydronic Piping: Placement of water coupon rack, by-pass (pot) feeder.

1.03 RELATED SECTIONS

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15050 - Basic Mechanical Materials and Methods.

1.04 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society for Testing and Materials (ASTM):
   a. D859 - Test Method for Silica in Water.
   b. D1066 - Practice for Sampling Steam
   c. D1067 - Test Methods for Acidity or Alkalinity of Water.
   d. D1068 - Test Methods for Iron in Water.
   e. D1126 - Test Method for Hardness in Water.
   f. D3370 - Practices for Sampling Water for Closed Conduits.
2. International Building Code (IBC) with the Denver Amendments
3. International Fire Code (IFC) with the Denver Amendments
4. National Electrical Manufacturers Association (NEMA):
   a. 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
5. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code.
6. Underwriters Laboratories (UL):
   a. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   b. 486B - Wire Connectors for Use with Aluminum Conductors.

C. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

D. Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposed disposal.

E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project Site.

F. Maintenance Data: For pumps, agitators, filters, system controls, and accessories to include in maintenance manuals specified in SECTION 15050.

1.05 OPERATION AND MAINTENANCE DATA

A. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum of five years documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

B. Installer Qualifications: An experienced installer who is an authorized representative of the chemical treatment manufacturer for both installation and maintenance of chemical treatment equipment required for this Project with minimum of three years experience.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.07 REGULATORY REQUIREMENTS

A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for to public sewage systems.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc. (or other testing agency acceptable to the authority having jurisdiction) as suitable for the purpose specified and indicated.

1.08 MAINTENANCE SERVICE

A. Furnish service and maintenance of treatment systems for one year from Date of Substantial Completion.

B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

C. Provide laboratory and technical assistance services during this maintenance period.

D. Include two-hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.

E. Provide on site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

1.09 MAINTENANCE MATERIALS

A. Provide sufficient chemicals for treatment and testing during warranty period.

1.10 WARRANTY

A. Warranty of all equipment described in this Section shall meet warranty requirements of Section 15010 - Basic Mechanical Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to conformance with specified requirements, products and services of the following manufacturers are acceptable:

1. H-O-H Chemicals, Inc.
2. Summit Laboratories.
3. Nalco.
4. Chem Aqua.
5. Substitutions: Under provisions of 15010.

2.02 MATERIALS

A. System Cleaner:

1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripoly phosphate.
2. Biocide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quarternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

PART 3 - EXECUTION

3.01 PREPARATION

A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in open position during cleaning.

C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

A. Concentration:

1. As recommended by manufacturer.

B. Chilled Water Systems:

1. Circulate for 48 hours, then drain systems as quickly as possible.
2. Refill with clean water, circulate for 24 hours, then drain.

3. Refill with clean water and repeat until system cleaner is removed.

C. Use neutralizer agents on recommendation of system cleaner supplier and approval of DIA Project Manager.

D. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.

E. Remove, clean, and replace strainer screens.

F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15545

SECTION 15684

CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Chiller package.

B. Charge of refrigerant and oil.

C. Controls and control connections.

D. Chilled water connections.

E. Condenser water connections.

1.02 RELATED SECTIONS

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15050 - Basic Mechanical Materials and Methods.

C. Section 15245 - Vibration Isolation.

D. Section 15260 - Piping Insulation

E. Section 15510 - Hydronic Piping.

F. Section 15540 - HVAC Pumps.

G. Section 15952 - Controls and Instrumentation.

H. Section 15990 - Testing, Adjusting, and Balancing.

I. Section 16142 - Electrical Connections for Equipment: Electrical characteristics and wiring connections.

J. Section 16480 - Motor Controllers.

K. Section 16486 - Electric Motors.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Refrigeration Institute (ARI):
    a. ARI 370 - Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment.
    b. ARI 550/590 - Water Chilling Packages Using the Vapor Compression Cycle.

c. ARI 560 - Absorption Water Chilling and Water Heating Packages.

d. ARI 575 - Method of Measuring Machinery Sound within an Equipment Space.

2. American Society for Testing and Materials (ASTM):
   a. ASTM C534 - Preformed Flexible Electrometric Cellular Thermal Insulation in Sheet and Tabular Form.
   b. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
3. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
   b. ASHRAE 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks.
   c. ASHRAE Guideline 3 - Reducing Emission of Halogenated Refrigerants in Refrigeration and Air-Conditioning Equipment and Systems.
4. ASME International (ASME):
   a. ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division
5. Green Seal (1001 Connecticut Ave., NW, Suite 827, Washington, DC 20036; 202-872-6400; www.greenseal.org) (GS):
   a. GS 1 - Environmental Standard for Electric Chillers.
6. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
7. International Building Code (IBC) including the Denver Amendments
8. International Electrotechnical Commission (IEC):
   a. IEC 947-4-1 - Part 4: Contactors and Motor Starters: Section 1, "Electromechanical Contactors and Motor Starters."
9. International Fire Code (IFC)
10. National Electrical Manufacturers Association (NEMA):
    a. NEMA 250 - Enclosure for Electrical Equipment (1,000 Volts Maximum).
    b. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
    c. I NEMA CS 2 - Controllers, Contactors, and Overload Relays, Rated Not More than 2,000Vac or 750Vdc.
    d. NEMA ICS 6 - Enclosures.
    e. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
11. National Fire Protection Association (NFPA):
    a. NFPA 31 - Installation of Oil-Burning Equipment.
    b. NFPA 54 - National Fuel Gas Code.
    c. NFPA 70 - National Electrical Code.
12. Underwriters Laboratories Inc. (UL):
    a. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
    b. UL 486B - Wire Connectors and Soldering Lugs for Use with Aluminum Conductors.
    c. UL 1995 - Heating and Cooling Equipment.

1.04 PERFORMANCE REQUIREMENTS

A. This section is based on specific selections of equipment. These selections relate to the selection of related equipment 15540 - HVAC Pumps. In substituting equipment, ensure that performance selection a criterion matches that specified or that the selection of related equipment is acceptable or is revised to suit.

1.05 SUBMITTALS

A. Submittals For Review

1. Product Data: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.

2. Shop Drawings (required only for equipment other than the selections shown on drawing layouts and specified in detail by manufacturer/model number in equipment schedules):

a. Show proposed physical layout of equipment relative to the space in which it is to be installed, to demonstrate:

1) Coordination of piping, duct, venting and electrical connections (as applicable) in relationship to adjacent work and building elements.

2) Acceptable clearances for servicing and maintaining equipment to be installed, including adjacent equipment not specified by this Section.

B. Submittals For Information

1. Test Reports: Indicate energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperature.

2. Manufacturer's Certificate: Certify that components of package not furnished by manufacturer have been selected in accordance with manufacturer's requirements.

C. Submittals At Project Closeout

1. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble- shooting guide.

D. “As Built” Plans shall be provided in the same format and manner as described above. Each set shall be quipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

1.06 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc. (or other testing agency acceptable to the authority having jurisdiction) as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Deliver, store, handle and protect products under provisions of Section 15010 and Division 1

B. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

C. Protect units from physical damage. Leave factory shipping covers in place until installation.

1.08 WARRANTY

A. Provide a five year warranty to include coverage for complete chiller package as manufactured and delivered to site including materials and labor.

1.09 EXTRA MATERIALS

A. Provide two containers of lubricating oil and refrigerant.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to conformance with specified requirements, products of the following manufacturers are acceptable:

1. Trane, model CDHF.
2. Substitutions: Under provisions of Section 15010.

2.02 MANUFACTURED UNITS

A. Provide factory assembled and tested, packaged, water cooled, liquid chillers consisting of dual, variable-speed centrifugal compressors, compressor motor, condenser[s], evaporator, refrigeration accessories, instrument and control panel including gages and indicating lights, auxiliary components and accessories, disconnecting means, and motor starters. Construction and ratings shall be in accordance with ARI 550.

B. Units shall have Energy Efficiency Rating not less than prescribed by ASHRAE 90A.

C. Conform to ARI 550 code for testing and rating of centrifugal chillers.

D. Conform to UL 465 code for construction of centrifugal chillers and provide UL label.

E. Conform to ASME SEC 8 for construction and testing of centrifugal chillers.

F. Conform to ASHRAE 15 code for construction and operation of centrifugal chillers.

2.03 COMPRESSORS

A. Compressor Casing: Cast iron, horizontally or vertically split with machined passages, leak tested with refrigerant trace gas to 45 psig. Provide sight glass for monitoring compressor rotation.

B. Impellers: Single or multi-stage, in-line design, fully shrouded, statically and dynamically balanced, tested to 20 percent over operating speed, mounted on heat treated forged or rolled steel shaft, nonferrous, labyrinth seals between stages.

C. Guide Vanes: Modulating radial blade dampers, on each stage, with externally mounted electric operator, suitable for capacity reduction to 10 percent of specified load without hot gas bypass when supplied with design entering water quantity and 71 degrees F design temperature entering condenser water.

D. Bearings: Babbitt lined sleeve bearings, self aligning, pressure lubricated.

E. Gear Box: Double helical design, symmetrical and center supported by spherically seated, self aligning bearing, arranged for inspection without disassembly.

F. Motor: Hermetically sealed, variable speed, low slip induction type. Refer to Section 16486 - Electric Motors.

G. Lubrication: Direct drive, positive displacement oil pump, with oil cooler, pressure regulator, oil filters, thermostatically controlled oil heater, and motor controls 1/4 hp motor. Interlock to start before chiller motor and run after motor is shut down. Provide sight glass for monitoring oil level.

H. Refrigerant: Site-charge unit with HCFC-123.

2.04 EVAPORATOR

A. Provide evaporator of shell and tube type, seamless or welded steel construction with cast iron or fabricated steel heads, seamless copper tubes or red brass tubes with integral fins, rolled or silver brazed into tube sheets. Space tube support sheets approximately 2.5 ft.

B. Design, test, and stamp refrigerant side for 45 psig working pressure and water side for 150 psig working pressure, in accordance with ASME SEC 8.

C. Provide water boxes, gasketed-flange-connected to heat exchanger, with tapped drain and vent connections, and flanged or mechanical joint connections arranged to permit inspection of tubes from either end without disturbing refrigerant system.

D. Insulate evaporator and cold surfaces with 0.75 inch minimum thick flexible insulation with maximum K value of 0.28.

E. Provide thermometer wells for temperature controller and low temperature cutout, and connections for flow switch or for differential pressure flow detector.

F. Provide refrigerant chambers with baffles to distribute entering liquid and separate liquid from leaving gas.

G. Provide combination rupture disc/relief valve on shell as specified and in accordance with ASHRAE 15.

H. Construction and materials shall conform to ASME SEC 8.

2.05 CONDENSERS

A. Provide condensers of shell and tube type, seamless or welded steel construction with cast iron or fabricated steel heads, seamless copper tubes or red brass tubes with integral fins, rolled or silver brazed into tube sheets. Space tube support sheets approximately 2.5 ft.

B. Design and stamp refrigerant side for 450 psig working pressure, test refrigerant side at 45 psig psig; design, test and stamp water side for 150 psig working pressure; in accordance with ASME SEC 8.

C. Provide water boxes, gasketed-flange-connected to heat exchanger, with tapped drain and vent connections, and flanged or mechanical joint connections arranged to permit inspection of tubes from either end without disturbing refrigerant system.

D. Provide combination rupture disk/relief valve on shell as specified and in accordance with ASHRAE 15.

E. Provide baffles to ensure even distribution of incoming gas and to concentrate non-condensible gases.

F. Provide thermometer wells for temperature monitoring, and connections for differential pressure flow detector.

G. Construction and materials shall conform to ASME SEC 8.

2.06 RUPTURE DISK / RELIEF VALVE

A. Provide 3-inch combination rupture disk/relief valves as manufactured by BSB or approved substitute. Assembly shall be designed to protect chiller from overpressure by a rupture disk with limited venting achieved by a downstream reclosing valve. Rupture disk to open at 15 psig, and reclose at pressure not lower than 13 psig.

1. Leak Tightness: Factory test to ensure tightness to better than 10^{-6} atmospheres.
2. Materials:
   a. JRS Disk Assembly: 316 stainless steel body with nickel disk.
   b. Valve: Nickel plated carbon steel body with stainless steel valve plug, spring, retainer, and spring button.
   c. O-rings: Viton or Neoprene.
3. Disk Interspace: To be atmospherically vented through tapping allowing for DIA Project Manager's installation of pressure alarm or monitoring capability. Refer to manufacturer's recommendations.
4. Installation: Assembly to be installed direct between ANSI 150 pipe flanges, using bolts of adequate length. Where necessary, provide adapter flange to accommodate differences between valve size and equipment nozzles.

2.07 PURGE SYSTEM

A. Provide purge system incorporating a low temperature refrigeration system to automatically remove non-condensibles, water and air.

B. System discharge shall be maximum 0.60 pound of refrigerant per pound of air discharged.

2.08 CONTROLS

A. On or near chiller, mount steel control panel containing solid state, fully automatic operating and safety controls.

B. Control panel shall be touch-pad equipped (color), microprocessor-based unit that can provide complete stand-alone system control and monitoring.

C. Control panel and adaptive frequency drive shall adapt to the operating ranges and specific characteristics of the chiller, while optimizing chiller efficiency by coordinating compressor motor speed and inlet guide vane position.

D. Chiller control panel shall include a BAS communication card for full functionality and communication abilities.

E. The chiller and chiller control panel shall be interoperable with systems provided by others or already installed to the extent indicated on the Drawings. BACnet IP gateways specified shall be capable of complete interoperation between the system and BAS, including all system operating functions and system programming. Central Plant BAS Contact:

1. Central Plant BAS Contact:
   a. Johnson Controls Inc, - Luke McMillan, 303-229-8510, Luke.McMillan@jci.com

F. Language: Chiller shall communicate over BACnet IP Ethernet network.

G. Provide the following safety controls arranged so that operating any one will shut down machine and require manual reset:

1. Low evaporator refrigerant temperature.
2. High condenser refrigerant pressure.
3. Low oil pressure.
4. High oil temperature.
5. High motor current.
6. High motor temperature.
7. Low refrigerant (evaporator) pressure.
8. High bearing temperature.

H. Provide the following safety controls arranged so that operating any one will shut down machine and automatically reset:

1. Low chilled water temperature.
2. Chilled water flow switch.
3. Condenser water flow switch.

I. Provide the following devices on control panel:

1. Manual Switches:
   a. Machine off-auto switch.
   b. Oil pump switch (manual or automatic).
   c. Purge pump switch (manual-off-auto).
   d. Machine selector switch to allow load, unload, hold or automatic operation.
2. Manual Set Point Adjustments:
   a. Leaving chilled water temperature.
   b. Current demand limit.
3. Status Lights:
   a. Chilled water flow proven.
   b. Cooling required.
   c. Unit running.
   d. Unit loading.
   e. Unit unloading.
   f. Manual reset required.
   g. Remote chilled water set point active.
   h. Remote current water set point active.
4. Setpoint and Temperature Display:
   a. Chilled water set point.
   b. Current limit set point.
   c. Entering evaporator water temperature.
   d. Leaving evaporator water temperature.
   e. Entering condenser water temperature.
   f. Leaving condenser water temperature.

5. Dial Type Pressure Gages.
    a. Evaporator refrigerant pressure.
    b. Condenser refrigerant pressure.
    c. Low oil pressure (oil sump).
    d. High oil pressure (oil supply).

J. Provide the following operating controls:

1. Adjustable thirty minute off timer prevents compressor from short cycling.
2. Demand limit device to manually set maximum current infinitely between 40 percent and 100 percent of full load amperes.
3. Automatic start which determines demand for chilled water from proof of chilled water flow and temperature differential between chilled water set point and supply temperature.

2.09 PERFORMANCE

A. Centrifugal Water Chillers: As shown on the drawings.

2.10 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: As shown on the drawings.

B. Disconnect Switch: Factory mount disconnect switch in remote mounted starter control panel

2.11 STARTER/ADAPTIVE FREQUENCY DRIVE

A. Remote mount, NEMA 1 type enclosure, containing a medium voltage, air cooled, microprocessor based pulse wide modulation (PWM) adaptive frequency drive (AFD). The AFD shall include a line starter contactor and current limiting power fuses with a lockable, non-load break isolation switch. line starter contactor

B. Enclosure shall be designed for top or bottom cable entry with front access. Door, interlocked with circuit breaker, and shall accommodate padlock.

C. Mount the following devices within enclosure:

1. Disconnect switch on line side with fuses.
2. High interrupting capacity circuit breaker with ground fault protection.
3. Pilot relays to start and stop compressor on signal from chiller control panel.
4. Electronic overload provides overload protection, protects compressor motor from distribution system irregularities, and provides motor current signal to chiller capacity control module.
5. Control power transformer.
6. Fused control circuits for control circuit, oil pump motor, oil heater, and purge control unit.
7. Contactor interlocks for communication between starter and control panel.
8. Capacitors, one per phase, to correct power factor to minimum 95 percent.
9. Fused disconnect and starter for oil pump.
10. Relay for remote mounted emergency shut-down switch.

D. Provide the following devices on starter door:

1. Starter fault trip indicator and reset.
2. Overload trip indicator and reset.
3. Distribution fault trip indicator and reset.
4. Ground fault trip indicator and reset.
5. Ammeters, one per phase.
6. Voltmeters, one per phase.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide for connection to electrical service. Refer to Section 16142 - Electrical Connections for Equipment.

C. Provide for connection of electrical wiring between starter and chiller control panel, oil pump, and purge unit. Refer to Section 16142 - Electrical Connections for Equipment.

D. Align chiller on concrete foundations, sole plates, and sub-bases. Level, grout, and bolt in place.

E. Install units on vibration isolation. Refer to Section 15245 - Vibration Isolation.

F. Provide evaporator connections to chilled water piping. Refer to Section 15510 - Hydronic Piping.

1. On inlet, provide:
   a. Thermometer well for temperature controller.
   b. Thermometer well and thermometer.
   c. Strainer.
   d. Nipple and flow switch.
   e. Flexible pipe connecter.
   f. Pressure gage.
   g. Shut-off valve.
2. On outlet, provide:
   a. Thermometer well and thermometer.
   b. Flexible pipe connecter.
   c. Pressure gage.
   d. Shut-off.

G. Furnish and install necessary auxiliary water piping for oil cooling units and purge condensers.

H. Insulate evaporator and cold surfaces. Refer to Section 15280 – Equipment Isolation.

I. Provide condenser connection to condenser water piping. Refer to Section 15510 - Hydronic Piping.

1. On inlet, provide:

a. Thermometer well for temperature controller.
b. Thermometer well and thermometer.
c. Strainer.
d. Nipple and flow switch.
e. Flexible pipe connecter.
f. Pressure gage.
g. Shut-off valve.

2. On outlet, provide:
a. Thermometer well and thermometer.
b. Flexible pipe connecter.
c. Pressure gage.
d. Shut-off valve.

J. Arrange piping for easy dismantling to permit tube cleaning.

K. Provide piping from chiller rupture disc to outdoors. Size as recommended by manufacturer.

3.02 MANUFACTURER'S FIELD SERVICES

A. Engage a factory-authorized service representative to perform start-up service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and start-up checks according to manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gauges are installed.
4. Operate water chiller for run-in period according to manufacturer's written instructions.
5. Check bearing lubrication and oil levels.
6. Verify that refrigerant pressure relief is vented outside.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during water chiller start-up and shutdown.
9. Verify and record performance of chilled- and condenser-water flow and low-temperature interlocks.
10. Verify and record performance of water chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Provide services of factory trained representative for minimum two days to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct DIA Project Manager on operation and maintenance.

E. Supply initial charge of refrigerant and oil.

F. Prepare a written start-up report that records results of tests and inspections.

G. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

3.03 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate system operation and verify specified performance. Refer to Section 15990 - Testing, Adjusting, and Balancing.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15684

SECTION 15855

AIR HANDLING UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Modular Packaged air handling units.

B. Roof Curbs.

1.02 RELATED SECTIONS

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15050 - Basic Mechanical Materials and Methods.

C. Section 15245 - Vibration Isolation.

D. Section 15410 - Plumbing Piping: Equipment drains.

E. Section 15890 - Ductwork.

F. Section 15910 - Ductwork Accessories: Flexible duct connections.

G. Section 16142 - Electrical Connections for Equipment: Electrical characteristics and wiring connections.

H. Section 16480 - Motor Controllers.

I. Section 16486 - Electric Motors.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Bearing Manufacturers Association (ABMA):
   a. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   b. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
2. Air Movement and Control Association International, Inc. (AMCA):
   a. AMCA 99 - Standards Handbook.
   b. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
   c. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
   d. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
   e. AMCA 500 - Test Methods for Louver, Dampers, and Shutters.
3. Air-Conditioning and Refrigeration Institute (ARI):
   a. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.

b. ARI 430 - Central-Station Air-Handling Units.
c. ARI 435 - Application of Central-Station Air-Handling Units.
d. ARI 610 - Central System Humidifiers.

4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. 33 - Methods of Testing Forced Circulation Air Cooling and Air Heating Coils.
   b. 62 - Ventilation for Acceptable Indoor Air Quality.
5. International Building Code (IBC) with the Denver Amendments
6. International Fire Code (IFC) with the Denver Amendments
7. National Electrical Manufacturers Association (NEMA):
   a. NEMA MG1 - Motors and Generators.
8. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code.
   b. 90A - Installation of Air Conditioning and Ventilating Systems.
   c. 90B - Installation of Warm Air Heating and Air Conditioning Systems.
9. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. Duct Cleanliness for New Construction.
   b. HVAC Air Duct Leakage Test Manual.
   c. HVAC Duct Construction Standards - Metal and Flexible.
10. Underwriters Laboratories Inc. (UL):
    a. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
    b. 486B - Wire Connectors for Use with Aluminum Conductors.
    c. 586 - High-Efficiency, Particulate, Air Filter Units.
    d. 1995 - Heating and Cooling Equipment.
    e. 900 - Test Performance of Air Filter Units.

1.04 SUBMITTALS

A. Product Data:

1. Provide literature, which indicates dimensions, weights, capacities, ratings, fan performance, gages and finishes of materials, and electrical characteristics and connection requirements.
2. Provide data for filter media, filter performance data, filter assembly, and filter frames.
3. Provide fan curves with specified operating point clearly plotted.
4. Submit sound power level data for both fan outlet and casing radiation at rated capacity.
5. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

B. Shop Drawings (required only for equipment other than the selections shown on drawing layouts and specified in detail by manufacturer/model number in equipment schedules):

1. Show proposed physical layout of equipment relative to the space in which it is to be installed, to demonstrate:
   a. Coordination of piping, duct, venting and electrical connections (as applicable) in relationship to adjacent work and building elements.
   b. Acceptable clearances for servicing and maintaining equipment to be installed, including adjacent equipment not specified by this Section.

C. Operation and Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

D. Warranty: Special warranty specified in this Section.

E. "As Built" Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to "Stacor Plan Clamps" for the appropriate size drawings.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle and protect products under provisions of Section 15010 and Division 1.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.06 WARRANTY

A. Warranty of all equipment described in this Section shall meet warranty requirements of Section 15010 - Basic Mechanical Requirements.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of self-contained air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from Date of Substantial Completion.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of filters for each unit.
2. Fan Belts: One set of belts for each unit.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to conformance with specified requirements, products of the following manufacturers are acceptable:

1. AAON
2. Energy Labs
3. Engineered Air
4. Governaire.

5. McQuay.
6. Rupp
7. Temtrol.
8. Trane.
9. York.
10. Substitutions: Under provisions of Section 15010.

2.02 GENERAL DESCRIPTION

A. Configuration: Fabricate with fan plus accessories, including:
   1. Filter section.
   2. Cooling coil section.

B. Performance Base: 5500 ft. altitude conditions.

C. Fabrication: Conform to AMCA 99

D. Performance: As indicated on the Drawings.

2.03 CASING

A. Construction: Fabricate on channel base and drain pan of welded steel coated externally with manufacturers standard paint finish. Assemble sections with gaskets and bolts.
   1. Outside Casing:
      a. Galvanized Steel: 16 gage.
   2. Inside Casing:
      a. Galvanized Steel: 24 gage.
   3. Floor Plate:
      a. Galvanized Steel: 10 gage.

B. Insulation: 2 inch thick, R-13 minimum foam insulation.

C. Finish: Unpainted.

D. Inspection Doors: 10 x 10 inch, of galvanized steel for flush mounting, with gasket, latch, and handle.

E. Weatherproof Casing Finish: Seal fixed joints with flexible weather tight sealer. Seal removable joints with closed-cell foam gasket. Provide cap strips over roof flanges. Provide rain caps and gaskets on access doors.

F. Lights: Provide in accessible sections suitable for damp locations with wire guards, factory wired to weatherproof switch mounted on casing exterior.

G. Drain Pans: Construct from double thickness galvanized steel with welded corners. Cross break and pitch to drain connection. Provide drain pans under cooling coil section.

H. Bottom Inlet Units: Provide steel or aluminum walking grate on structural supports.

I. Strength: Provide structure to brace casings for suction pressure of 8 inch wg, with maximum deflection of L/240 ratio. L is defined as the height of a panel..

J. Radiated noise for air handling units shall not exceed:

1. NC 45 – Maintenance Facilities

2.04 FANS

A. Type: double width, double inlet, centrifugal type fan.

B. Performance Ratings: Conform to AMCA 210 .

C. Sound Ratings: AMCA 301; tested to AMCA 300

D. Bearings: Self-aligning, grease lubricated, ball or roller bearings with lubrication fittings extended to exterior of casing with copper tube and grease fitting rigidly attached to casing.

E. Mounting: Locate fan and motor internally on welded steel base coated with corrosion resistant paint. Factory mount motor on slide rails. Provide access to motor, drive, and bearings through removable casing panels or hinged access doors. Mount base on vibration isolators.

F. Supply Fan Performance: As indicated on the Drawings.

G. Sound Ratings: ARI 260. Sound power levels from supply and return openings of the unit shall not exceed the following:

	63 Hz	125 Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
Supply	100	98	97	91	87	83	79	72
Return	90	88	93	85	80	77	72	65

2.05 BEARINGS AND DRIVES

A. Bearings: ABMA 11, L-50 life at 400,000 hours pillow block type, self-aligning, grease-lubricated roller bearings.

B. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

C. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Variable and adjustable pitch sheaves for motors 15 hp and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate horsepower rating of the motor.

D. Belt Guard: Fabricate to SMACNA Standard; 12 gage thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.06 SUPPLEMENTAL CONDENSATE DRAIN SYSTEMS

A. Wherever units equipped for cooling service are installed above facilities such as electrical power equipment, computer equipment, data server or telecommunications equipment, or other electrical or electronic equipment susceptible to malfunction if exposed to water, Contractor shall provide a water level detection device in the drain pan to serve as additional

protection against leakage, overflow, or other failure of the primary drain pan normally comprising a part of the air conditioning equipment.

1. The water level detection device (float-type with dry contacts for BAS connection) shall conform to UL 508 and shall shutoff the air handling unit in the event that the primary drain is blocked. The device shall be installed in the equipment-supplied drain pan, located at a point higher than the primary drain line connection and below the overflow rim of the drain pan.

2.07 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: As indicated on the Drawings.

B. Motor: Open drip proof, premium efficiency.

C. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

2.08 COILS

A. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.

B. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.

C. Eliminators: Three break of galvanized steel, mounted over drain pan.

D. Fabrication:

1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
2. Fins: Aluminum.
3. Casing: Die formed channel frame of galvanized steel.

E. Water Cooling Coils:

1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

F. Water Cooling Coil Ratings: As indicated on the Drawings.

2.09 FILTERS

A. Filter Box: Section with filter guides, access doors from both sides, for side loading.

B. Filter Media: UL 900 listed, Class I or Class II, approved by authorities.

A. Flat or Angle: Arrangement with 2 inch deep disposable panel filters, MERV 8.

C. Filter Gauges: 2 inch diameter diaphragm actuated dial in metal case, with static pressure tips.

2.10 ELECTRICAL REQUIREMENTS

A. Work of this section includes:

1. Factory or field installed motor controllers for all motors. Refer to Sections 16142 - Electrical Connections for Equipment and 16480 - Motor Controllers.

2. Furnishing and installation of a main disconnect switch, which will interrupt all power serving the packaged air handling assembly. This switch will comprise a single point of connection for the power supply feeder installed under Division 16.

   a. For equipment designated by the manufacturer as requiring a maximum fuse size or circuit protection ampere rating, the main disconnect switch shall be a fusible switch or circuit breaker conforming to manufacturer's specified limitations. Where no limitations are imposed, main disconnect shall be an unfused switch or acceptable substitute.

3. Furnishing and installation of all required wiring extending from the main disconnect to the components requiring power, in accordance with Division 16 specifications. Include all protective devices required for circuits developed for unit requirements.

2.11 ROOF CURB

A. Roof Curb: 14 inch high (top of finish roof to top of curb) of galvanized steel with continuously welded seams, and factory installed nailer strip.

2.12 CONTROLS REQUIREMENTS

A. A new application specific controller shall be installed on this unit for full controllability and reporting to the BAS. See SECTION 15952 – CONTROLS AND INSTRUMENTATION.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install units level and plumb.

B. Anchor units to structure.

C. Install seismic restraints.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other DIVISION 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Water Coil Connections: Comply with requirements in SECTION 15510 - HYDRONIC PIPING. Connect to supply and return coil with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

B. Install piping adjacent to unit to allow service and maintenance.

C. Duct Connections: Duct installation requirements are specified in SECTION 15890 - DUCTWORK. Drawings indicate the general arrangement of ducts. Connect supply and return ducts to self-contained air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in SECTION 15910 - DUCTWORK ACCESSORIES.

D. Ground equipment according to DIVISION 16.

E. Electrical Connections: Comply with requirements in DIVISION 16.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15855

SECTION 15890

DUCTWORK

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. Metal ductwork.

B. Duct cleaning

1.02 RELATED SECTIONS

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15050 - Basic Mechanical Materials and Methods.

C. Section 15140 - Supports and Anchors: Sleeves.

D. Section 15910 - Ductwork Accessories.

E. Section 15930 - Air Terminal Units.

F. Section 15940 - Air Inlets and Outlets.

G. Section 15990 - Testing, Adjusting and Balancing.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society for Testing and Materials (ASTM):
   a. A36A/A36M - Carbon Structural Steel.
   b. A90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
   c. A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   d. A366/A366M - Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality.
   e. A480/A480M - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   f. A525 - General Requirements for Steel Sheet, Zinc- Coated (Galvanized) by the Hot-Dip Process.
   g. A527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
   h. A568 - Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.
   i. ASTM A 569 - Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.
   j. A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

k. B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
l. B209M - Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
m. C411 - Test method for Hot-Surface Performance of High-Temperature Thermal Insulation.
n. C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
o. C916 - Adhesives for Duct Thermal Insulation.
p. C920 - Elastomeric Joint Sealants.
q. C1071 - Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
r. E84 - Test Method for Surface Burning Characteristics of Building Materials.
s. G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

2. American Welding Society (AWS):
   a. D1.1 - Structural Welding Code - Steel.
   b. D1.2 - Structural Welding Code - Aluminum.
   c. D9.1 - Sheet Metal Welding Code.
3. International Building Code (IBC) with the Denver Amendments
4. International Fire Code (IFC) with the Denver Amendments
5. National Air Duct Cleaners Association (1518 K St., NW, Suite 503, Washington, DC 20005; 202-737-2926; www.nadca.com) (NADLA):
   a. 1992-01: Mechanical Cleaning of Nonporous Air Conveyance System Components.
6. National Fire Protection Association (NFPA):
   a. 90A - Installation of Air Conditioning and Ventilating Systems (ANSI).
   b. 90B - Installation of Warm Air Heating and Air Conditioning Systems (ANSI).
   c. 91 - Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying.
   d. 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.
   e. 96 - Ventilation Control and Fire Protection of Commercial Cooking Operations (ANSI).
7. The North American Insulation Manufacturers Association (NAIMA):
   a. AH124 - Fibrous Glass Duct Liner Standard.
8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. Duct Cleanliness for New Construction.
   b. HVAC Air Duct Leakage Test Manual.
   c. HVAC Duct Construction Standards - Metal and Flexible.
9. Underwriters Laboratories Inc. (UL):
   a. 181 - Factory-Made Air Ducts and air Connectors.
   b. 723 - Test for Surface Burning Characteristics of Building Materials.

1.04 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes permitted except by written permission of the DIA Mechanical Engineer. Size round ducts installed in place of rectangular ducts in accordance with SMACNA or ASHRAE table of equivalent rectangular and round ducts.

1.05 SUBMITTALS

A. Product Data: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration for duct materials duct connectors.

B. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

C. Coordination Drawings: Reflected ceiling plans, AutoCAD-generated and drawn] to [1/4 inch equals 1 foot] [1/8 inch equals 1 foot] scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. “As Built” Plans shall be provided in the same format as described above. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

1.06 PROJECT RECORD DOCUMENTS

A. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.07 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

B. Maintain one copy of document on site.

1.08 REGULATORY REQUIREMENTS

1.09 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures during and after installation of duct sealants.

1.10 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

B. Medium Pressure: Three pressure classifications: 3 inch WG positive or negative static pressure and velocities less than 4,000 fpm, 4 inch WG positive static pressure and velocities greater than 2,000 fpm, 6 inch WG positive static pressure and velocities greater than 2,000 fpm.

C. Main duct pressure classification shall be determined by supply fan total static pressure + one inch water column.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products under provisions of Section 15010 and Division 1.

PART 2 -PRODUCTS

2.01 MATERIALS

A. General: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Steel Ducts: ASTM A 525or ASTM A 527 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 oz per sq ft for each side in conformance with ASTM A 90.

C. Aluminum Ducts: ASTM B 209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.

D. Flexible Ducts:

1. Medium- or High-Pressure Duct System Applications: UL Class 1, rated for 10 inches WG positive and negative pressure and 4000 fpm air velocity, constructed as interlocking spiral of galvanized steel or aluminum. Insulation to be 1-inch thick fiberglass, maximum K-value of 0.23 at 75°F, covered with fire-retardant polyethylene or aluminized vapor barrier jacket.

E. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

F. Fasteners: Rivets, bolts, or sheet metal screws.

G. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic.

H. Hanger Rod: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.02 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated, but not less than 1" WG positive and negative pressures.

B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide [air foil] turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

D. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Duct Construction Standards. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

E. Provide standard 45 degree lateral wye takeoffs.

F. 90 degree conical tee connections (spin-in fittings) may only be used downstream of a VAV terminal.

2.03 MANUFACTURED DUCTWORK AND FITTINGS

A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards -Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. SMANCA Type 1 offset transitions shall not be allowed without written approval from DIA Mechanical Engineer or DIA Mechanical Inspector.

C. Flat Oval Ducts: Machine made from round spiral lockseam duct with light reinforcing corrugations; fittings manufactured of at least two gages heavier metal than duct.

2.04 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

C. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75% solids.

D. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use O.

E. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Construct, install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, unless otherwise indicated.

C. Refer to drawings for interpretation of duct dimensions shown on plans (whether outside or net inside clear dimensions). Where duct sizes are indicated as inside clear dimensions, maintain inside sizes for ducts with insulation lining.

D. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

E. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.

F. Install ducts with fewest possible joints.

G. Install fabricated fittings for changes in directions, size, and shape and for connections.

H. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

I. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

J. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

K. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

L. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

M. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

N. Use double nuts and lock washers on threaded rod supports.

O. Cloth backed duct tape shall not be used.

P. Connect terminal units to supply ducts [directly or] with one foot maximum length of flexible duct. Do not use flexible duct to change direction.

Q. Connect flexible ducts to metal ducts with adhesive and draw bands plus sheet metal screws. Secure with not less than 3 sheet metal screws per joint.

R. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system at the end of each work shift. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

S. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

T. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

U. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

V. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant.

W. Paint interiors of metal ducts that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in DIVISION 9.

3.02 DUCTWORK APPLICATION SCHEDULE

A. General: All ductwork shall be medium pressure.

AIR SYSTEM	DUCTWORK MATERIAL
Medium Pressure Supply	Galvanized Steel
Return and Relief	Galvanized Steel, Aluminum

3.03 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

1. For pressure classes lower than 2-inch wg, seal transverse joints.

B. Seal ducts before external insulation is applied.

3.04 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Provide hangers and supports in accordance with Chapter 4 of SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct material specified.

C. Provide a support with twelve inches of the end of a duct run, not including flexible duct.

D. Support vertical ducts at maximum intervals of 16 feet and at each floor.

E. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

F. Install concrete inserts before placing concrete.

G. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.05 CONNECTIONS

A. Make connections to equipment with flexible connectors according to SECTION 15910 - DUCTWORK ACCESSORIES.

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 CLEANING AND PROTECTION

A. Clean ductwork internally, unit-by-unit as it is installed, of dust and debris. Clean external surfaces of foreign substances, which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

B. Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.

C. Temporary Closure: At ends of ducts, which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of

polyethylene film or other covering, which will prevent entrance of dust and debris until time connections are to be completed.

D. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

E. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Create other openings to comply with duct standards.
2. Disconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling sections to gain access during the cleaning process.

F. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

G. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.

H. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

I. Cleanliness Verification:

1. Visually inspect metal ducts for contaminants.
2. Where contaminants are discovered, re-clean and reinspect ducts.

3.07 TESTING FOR LEAKAGE

A. For high pressure ductwork, after system is completed, test for duct leakage in accordance with SMACNA "High Pressure Duct Standards - 3rd Edition, Chapter 10 - Testing for Leakage." Repair leaks and repeat tests until total leakage is less than 1% of system design air flow.

3.08 FINAL CLEANING

A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment, which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

B. Clean duct systems with high power vacuum machines. Protect equipment, which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

3.09 CLEANING EXISTING SYSTEMS

A. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Use existing service openings where possible.
2. Create other openings to comply with duct standards.
3. Disconnect flexible ducts as needed for cleaning and inspection.
4. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
5. Remove and reinstall ceiling sections to gain access during the cleaning process.

B. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97% collection efficiency for 0.3-micron size (or larger) particles.
2. When venting vacuuming system to the outside, use filtration to contain debris removed from HVAC system, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.

7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.

4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Provide operative drainage system for washdown procedures.

7. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.

F. Cleanliness Verification:

1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.

2. Visually inspect metal ducts for contaminants.

3. Where contaminants are discovered, re-clean and reinspect ducts.

G. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10% of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15890

SECTION 15910

DUCTWORK ACCESSORIES

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. Fire dampers

B. Duct access doors.

C. Flexible duct connections.

D. Volume control dampers.

1.02 RELATED SECTIONS

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15050 - Basic Mechanical Materials and Methods.

C. Section 15245 - Vibration Isolation.

D. Section 15890 - Ductwork.

E. Section 15930 - Air Terminal Units: Pressure regulating damper assemblies.

F. Section 16142 - Electrical Connections for Equipment: Electrical characteristics and wiring connections.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. Air Movement and Control Association International, Inc. (AMCA):
   a. AMCA 500D - Laboratory Methods for Testing Dampers for Rating.
   b. AMCA 511 - Certified Ratings Program for Air Control Devices.
2. American Society for Testing and Materials (ASTM):
   a. ASTM A480/A480M - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   b. ASTM A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   c. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
   d. ASTM B209M - Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
   e. ASTM B221 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   f. ASTM B221M - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
   g. ASTM E84 - Test Method for Surface Burning Characteristics of Building

Materials.

h. ASTM E477 - Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

3. American National Standards Institute (ANSI):
   a. ANSI 90A - Installation of Air Conditioning and Ventilating Systems (ANSI).
   b. ANSI 90B - Installation of Warm Air Heating and Air Conditioning System (ANSI).
4. International Building Code (IBC) with the Denver Amendments
5. International Fire Code (IFC) with the Denver Amendments
6. National Fire Protection Association (NFPA):
   a. NFPA 92A - Smoke Control Systems.
   b. NFPA 92B - Smoke Control Systems in Atria, Covered Malls, and Large Areas.
   c. NFPA 70 - National Electrical Code.
   d. NFPA 101 - Life Safety Code.
7. The North American Insulation Manufacturers Association (NAIMA):
   a. NAIMA AH116 - Fibrous Glass Duct Construction Standards.
8. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
   a. SMACNA HVAC Duct Construction Standards - Metal and Flexible.
9. Underwriters Laboratories Inc. (UL):
   a. UL 33 - Heat Responsive Links for Fire-Protection Service
   b. UL 181 - Factory-Made Air Ducts and Air Connectors.
   c. UL 555 - Fire Dampers.
   d. UL 555C - Ceiling Dampers.
   e. UL 555S - Smoke Dampers.
   f. Fire Resistance Directory.

1.04 SUBMITTALS

A. Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors and hardware used. Include electrical characteristics and connection requirements.

B. Fire, Smoke, and Combination Fire Smoke Dampers: Submit manufacturer's product data.

1. Include UL ratings for leakage class (I, II, or III), velocity (2000, 3000, or 4000 fpm), differential pressure (4, 6, or 8 inches WG) and elevated temperature (250 or 350 degrees F).
2. Indicate materials, construction, and dimensions.
3. Verify conformance to NFPA, UL, and applicable building code.
4. Include pressure drop data for air flow in either direction for all damper sizes in accordance with AMCA 500-D test figures 5.2 (Ducted Inlet, Free Outlet), 5.3 (Ducted Inlet, Ducted Outlet) and 5.5 (Free Inlet, Free Outlet).
5. Include a copy of UL Installation Instructions.

C. Damper access and identification label product data a sample.

D. "As Built" Plans shall be provided in the same format and manner as described above. Each se shall be equipped with a plan holder equal to "Stacor Plan Clamps" for the appropriate size drawings.

1.05 PROJECT RECORD DOCUMENTS

A. Record actual locations of access doors.

1.06 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc. (or other testing agency acceptable to the authority having jurisdiction) as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products under provisions of Section 15010 and Division 1.

B. Protect dampers from damage to operating linkages and blades.

PART 2 -PRODUCTS

2.01 FIRE DAMPERS

A. Manufacturers: Subject to compliance with specified requirements, products of the following manufacturers are acceptable.

1. Air Balance, Inc.
2. Greenheck Fan Corp.
3. Louvers & Dampers, Inc.
4. Mestek, Inc.
5. Pottorff; a division of PCI Industries, Inc.
6. Prefco Products, Inc.
7. Ruskin Mfg. Co.
8. Substitutions: Under provisions of Section 15010.

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Standards and Testing: Combination fire dampers shall be qualified to and listed under the following Underwriters' Laboratories standards:

1. UL 555 (Sixth Edition), Listing R13317, for [1-1/2 Hour] [3 Hour] Fire Endurance.

D. Dampers shall meet requirements for fire dampers in accordance with:

1. NFPA 90A, 92A, 92B, and 101, as applicable.
2. Applicable Building Codes.

E. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.

F. Source Quality Control

2.02 FACTORY TESTS: FACTORY CYCLE DAMPER AND ACTUATOR ASSEMBLIES TO ASSURE PROPER OPERATION.DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:
   a. American Warming and Ventilating.
   b. CESCO Products.
   c. Ductmate Industries, Inc.
   d. Flexmaster U.S.A., Inc.
   e. Greenheck.
   f. McGill AirFlow Corporation.
   g. Nailor Industries Inc.
   h. Ventfabrics, Inc.
   i. Ward Industries, Inc.
   j. Substitutions: Under provisions of Section 15010.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Provide number of hinges and locks as follows:
   a. Less Than 12 Inches Square: Secure with two sash locks.
   b. Up to 18 Inches Square: Two hinges and two sash locks.
   c. Up to 24 by 48 Inches: Three hinges and two compression latches.
   d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

1. Manufacturers:
   a. Flexmaster U.S.A., Inc.
   b. Substitutions: Under provisions of Section 15010.
2. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

F. Access doors with sheet metal screw fasteners are not acceptable.

2.03 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:

1. Duro Dyne Corp.
2. Ventfabrics, Inc.
3. Ward Industries, Inc.
4. Substitutions: Under provisions of Section 15010.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

1. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Select metal compatible with ducts.

C. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200°F.

2.04 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 15890 for duct construction and pressure class.

B. Provide duct access doors for inspection and cleaning at fire dampers Provide minimum 8 x 8 inch size for hand access, 24 L x 24 W (or duct width minus three inches, whichever is larger) inch size for shoulder access, and as indicated. Review locations with DIA Project Manager prior to fabrication.Installation of Fire, Fire/Smoke, and Smoke Dampers:

1. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
2. Install fire dampers in accordance with NFPA 92A and 92B, as applicable.
3. Demonstrate re-setting of fire dampers to DIA Project Manager's representative.
4. Install dampers in accordance with manufacturer's UL Installation Instructions, labeling, and NFPA 90A at locations indicated on the drawings or required by Authority Having Jurisdiction. Any damper installation that is not in accordance with the manufacturer's UL Installation Instructions must be approved prior to installation.
    a. Dampers must be accessible to allow inspection, adjustment, and replacement of components. The Contractor shall furnish any access doors in ductwork or plenums required to provide this access, and arrange for any access doors required in walls, ceilings, or other general building construction.
    b. Install dampers square and free from racking.
    c. The Contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.

d. Do not compress or stretch the damper frame into the duct or opening.

e. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.

f. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.

g. Install connections to actuators; refer to Section 15952.

h. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.

C. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.

D. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

E. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

3.03 LABELING

A. Provide identification and access labels for all fire dampers, smoke dampers and combination fire smoke dampers.

B. Labels shall be plastic with pressure-sensitive, permanent-type, self-adhesive back. Font shall be Arial, with a minimum text height of half an inch. Font color shall be red, background color shall be white.

C. Identification labels shall be located on the damper sleeve or frame on both side of the damper. The label shall indicate “FIRE DAMPER”.

D. Access labels shall be provided to indicate locations for access to reset and maintain the damper. The label shall indicate “FIRE DAMPER ACCESS”.

1. Access label location shall be as follows:

a. Damper in continuous duct with duct access within 12 inches of the damper:

1) Locate label on duct access door.

PART 4 -MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15910

SECTION 15940

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

1.02 RELATED SECTIONS

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15050 - Basic Mechanical Materials and Methods.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets (ANSI).
2. Air Movement and Control Association International, Inc. (AMCA):
   a. AMCA 500 - Test Method for Louvers, Dampers and Shutters.
3. Air Diffusion Council (ADC)
   a. ADC 1062 - Certification, Rating and Test Manual.
4. Air-Conditioning and Refrigeration Institute (ARI):
   a. ARI 650 - Air Outlets and Inlets.
5. International Building Code (IBC) with the Denver Amendments
6. International Fire Code (IFC) with the Denver Amendments
7. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
   a. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
8. National Fire Protection Association (NFPA):
   a. NFPA 70 - National Electrical Code.
   b. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.04 SUBMITTALS

A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

B. "As Built" Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to "Stacor Plan Clamps" for the appropriate size drawings.

1.05 PROJECT RECORD DOCUMENTS

A. Record actual locations of air outlets and inlets.

1.06 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

B. Test and rate louver performance in accordance with AMCA 500.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers:

1. Titus.
2. Metal-Aire.
3. Krueger
4. Price Industries
5. Substitutions: Under provisions of Section 15010.

2.02 DIFFUSERS, REGISTERS, AND GRILLES

A. Refer to schedules shown on the drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install diffusers, registers, and grilles level and plumb.

C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

D. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop.

Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify DIA Project Manager for a determination of final location.

E. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

F. Install diffusers to ductwork with air tight connection.

G. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

H. Paint ductwork visible behind air outlets and inlets matte black. Refer to Division 9.

3.03 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15940

SECTION 15952

CONTROLS AND INSTRUMENTATION

PART 1 -GENERAL

1.01 WORK INCLUDED

A. The Central Utility Plant's Building Automation System (BAS) is based upon the following setup:

1. Johnson Controls, Metasys Extended Architecture
   a. Protocol: BACnet IP or MS/TP (Application Specific)
2. Local Contacts:
   a. Project Manager: Luke McMillan, 303-229-8510, Luke.McMillan@jci.com
   b. Preconstruction: Steve Nixon, 303-868-5587, steve.r.nixon@jci.com

B. All new equipment shall be interoperable with systems provided by others or already installed to the extent indicated on the Drawings. BACnet gateways specified shall be capable of complete interoperation between the system and BAS, including all system operating functions and system programming.

C. Provide all labor, equipment, and material necessary for complete and fully operational temperature control system, as shown on the drawings, point schedules, and as specified herein.

D. Provide necessary materials and fieldwork necessary to connect control components factory-supplied as part of equipment controlled, unless specified otherwise. Generally, self-contained valves, filter gages, liquid level controllers, and similar instruments are not to be installed under this Section.

E. The automatic temperature control system shall be electronic direct digital control (DDC) type, with electric and electronic components. Unless otherwise specified, all controls shall be fully proportioning. Proportional/integral (PI) and proportional/integral/derivative (PID) control shall be utilized where specified. The system shall be complete in every respect and shall be put into operation, tested, and adjusted under operating conditions.

F. The control system shall include all control devices, valves, dampers, operators, thermostats, control panels, and control wiring and conduit as specified and required to fulfill the intent of the specifications and the sequence of operation. Coordinate all work with the equipment suppliers and the Division 16 installer.

G. Provide all completion services specified hereinafter, including final system performance verification, to insure the system functions as specified in the Sequence of Operations.

H. Instruction of Owner's Personnel: Upon completion of the system demonstration, instruct the Owner's operating personnel in the proper operation and maintenance of the control system provided under this Section.

I. Refer to Division 15 sections for requirements for interfacing controls and instrumentation with mechanical equipment and systems; interface work included as work of this Section.

J. Conform to Division 16 sections for raceways, cables and conductors, terminations and splices, boxes, cabinets, supports, hangers, seals, and other applicable requirements governing the installation of the electrical components of the controls systems.

1.02 RELATED WORK

A. Section 15010 - Basic Mechanical Requirements: for miscellaneous piping, materials and methods, and general requirements.

B. Section 15985 - Sequence of Operation: For overall system operation

C. Section 16142 - Electrical Connections for Equipment: Installation and connection of all power wiring. Power wiring shall be defined as follows:

1. Wiring of power feeds through all disconnect starters and variable speed controllers to electric motors.
2. 120 VAC Emergency power feeds to all critical BAS and/or temperature control panels.
3. 120 VAC wiring to DDC/VAV terminal units without fan motors or heaters as scheduled. Required voltage to DDC/VAV boxes with fan motors and/or heaters shown on Electrical Plans.
4. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by the BAS Contractor.

1.03 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. Air Movement and Control Association (AMCA):
   a. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
2. American National Standards Institute (ANSI)
   a. American National Standards Institute (ANSI) publication C57.13, Requirements for Instrument Transformers
   b. ANSI MC96.1-Temperature Measurement Thermocouples.
3. American Society of Mechanical Engineers (ASME)
   a. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure fittings.
   b. ASME MC85.1 - Terminology for Automatic Control.
4. American Society for Testing of Materials (ASTM):
   a. ASTM B 32 - Solder Metal.
   b. ASTM B 280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
   c. ASTM D 1693 - Environmental Stress - Cracking of Ethylene Plastics.
5. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
   a. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning.
6. Electronic Industries Association (EIA) Publications:
   a. RS-232-C-69: Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange.

b. RS-422-A-78: Electrical Characteristics of Balanced Voltage Digital Interface Circuits.

c. RS-423-A-78: Electrical Characteristics of Unbalanced Voltage Digital Interface Circuits.

7. International Building Code (IBC) with the Denver Amendments

8. International Fire Code (IFC) with the Denver Amendments

9. Military Standards (MIL):
   a. MIL-STD-461, Electronic Interface Characteristic Requirements for Equipment.
   b. MIL-F-18280 - Fittings, Flareless Tube, Fluid Connection
   c. MIL-S-29175 - Switch, Thermostatic, Low Voltage, Non- (Setback/ Setup) and Setback/Setup, Limiting: Heating, Cooling and Heating-Cooling
   d. FS-GG-G-76 - Gages, Pressure and Vacuum, Dial Indicating (for Air, Steam, Oil, Water, Ammonia, Chloro- Fluorohydrocarbon Gases, and Compressed Gases).

10. National Electrical Manufacturers Association (NEMA):
    a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
    b. NEMA DC 3 - Low-Voltage Room Thermostats
    c. NEMA EMC1 - Energy Management Systems Definitions.

11. National Fire Protection Association (NFPA):
    a. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

12. Underwriters' Laboratories: Provide electrical components and assemblies which have been UL listed and labeled.

1.04 SYSTEM DESCRIPTION

A. System Architecture: The control system shall be a network of fully independent direct digital controllers. The controllers shall be interconnected via a multiplexed digital data trunk. Data available to any one controller shall be available to all controllers on the trunk. Each main controller may supervise a sub-network of lower level direct digital controllers. Sensor input devices and output devices may be connected to either the main or lower level direct digital controllers. Operator interface shall be via a prompting system using an English language format on a color monitor. A hard-copy printer shall be furnished to provide a permanent record of all alarm occurrences. Operator interface and bulk data storage shall be through a PC based CPU. The PC will allow a user to interface with the network via dynamic color graphics. Each mechanical system, building floor plan, and control device will be depicted by point-and-click graphics.

1.05 QUALITY ASSURANCE

A. Control System Manufacturer: Shall have a complete engineering, sales, installation, and service organization in operation within the area for a period of not less than five years.

B. Electrical and Mechanical Installation: Shall be by trained electricians and mechanics in the continuous employment of an installer whose normal business is the installation of automatic temperature control systems. This installer shall have been in continuous operation in this business for a period of not less than five years. Installations by wholesalers, installers, or any firm whose normal business is not that of furnishing and installing automatic temperature control systems will not be permitted.

C. Interoperability With Existing System: The BAS shall be fully interoperable, and backward compatible with the existing Building Automation Systems (BAS).

D. Acceptable Manufacturers/Installers: Products of the following manufacturers shall be used:

Central Plant HVAC Johnson Controls, Inc.

E. Regulatory Requirements: Control wiring and pneumatic piping shall comply with all applicable codes and regulations.

1.06 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 15010.

B. Submit the following in accordance with DIVISION 1 Sections:

1. Product Data: Submit for all components.
2. Control system schematic diagrams: Submit schematic diagrams for each system controlled. The diagram should be arranged similar to the graphic display provided at the operator workstation. Diagrams shall include all input and output points, uniquely identified, as well as all virtual or software calculated points required by the system. The sequence of operation for each system shall appear on its respective control schematic diagram.
3. System architecture diagram: Submit an overall system architecture, or riser diagram which indicates controller arrangement with respect to each other, and their method of communication, i.e., which communicate over Ethernet, MS/TP, PTP, etc.
4. Schedules: Submit control valve schedule indicating valve size, line size, design flow, pressure drop at design flow, percentage open at design flow and valve coefficient.
5. A list of the color graphic screens to be provided. For each screen, provide a conceptual layout of pictures and data, and show or explain which other screens can be directly accessed.
6. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
7. “As Built” Plans shall be provided in the same format and manner as described above.

1.07 PROJECT RECORD DOCUMENTS

A. Accurately record actual location of control components, including panels, thermostats, and sensors.

B. Revise shop drawings to reflect actual installation and operating sequences.

C. Include data specified in "Submittals" in final "Record Documents" form.

D. At completion of work, submit report of checkout of automatic control system.

1. Provide control diagrams for each system.
2. Include manufacturer's installation instructions.

1.08 OPERATION AND MAINTENANCE DATA

A. Prior to system demonstration by Contractor, submit three copies of operation and maintenance manuals.

B. Include Operating Instructions for: Starting, stopping, adjustment, and regulation.

C. Inspection and Maintenance Instructions, Including: Schedules and procedures for equipment replacement, adjustments, cleaning and cleaning materials, protection, testing, calibration and calibration tolerances.

D. Operating Instructions, Including: Equipment characteristics and operating procedures.

E. Maintenance Instructions and Procedures: Schedule of routine maintenance, maintenance procedures, and trouble-shooting.

F. Parts list and recommended spare parts list.

G. Warranty arrangements.

H. Include interconnection wiring diagrams for complete field installed system with identified and numbered system components and devices.

I. Include keyboard illustrations and step-by-step procedures indexed for each operator function.

1.09 SEQUENCING AND SCHEDULING

A. Sequence and schedule work under the provisions of Division 1.

B. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

C. Coordinate work under provisions of Division 1 and ensure system is completed and commissioned by Date of Substantial Completion.

D. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

1.10 WARRANTY

A. Warranty of all equipment described in this Section shall meet warranty requirements of Section 15010 - Basic Mechanical Requirements.

B. All system components furnished under this contract shall be guaranteed against defective design, materials, and workmanship for the full warranty time which is standard with the manufacturer, but in no case less than two (2) years from the date of system acceptance.

1.11 MAINTENANCE SERVICE

A. Furnish service and maintenance of automatic controls system for one year from Date of Substantial Completion.

B. Provide complete service of controls systems, including callbacks. Make minimum of two complete normal inspections of approximately eight hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

1.12 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project-developed software and documentation shall become the property of the Owner. These include, but are not limited to:

1. Project graphic images.
2. Record drawings.

3. Project database.

4. Project-specific application programming code.

5. All documentation.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide control products in sizes and of capacities indicated, conforming to manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for the applications indicated.

B. System capabilities and requirements specified herein are intended to describe the ultimate capability of the BAS, even though all such functions may not be utilized initially. Refer to the Sequence of Operation and Control Object Schedule.

2.02 COMMUNICATION

A. The Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the inter-network.

B. All controllers shall have a communication port for connections with the operator interface devices.

C. Communication services over the Internet work shall result in operator interface and value passing that is transparent to the Internet work architecture as follows:

1. Connection of an operator interface device to any one controller on the Internet work will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the Internet work.

2. All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the Internet work. This value passing shall he automatically performed by a controller when a reference to a object name not located in that controller is entered into the controller's database. An operator/installer shall not he required to set up any communication services to perform Internet work value passing.

D. The time clocks in all controllers shall be automatically synchronized daily via the inter-network. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the inter-network.

2.03 CUSTOM APPLICATION CONTROLLERS

A. Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset such as outside air or space temperature are exempt from this requirement. Each of these panels shall meet the following requirements.

1. The Custom Application Controller shall have sufficient memory to support its operating system, database, and programming requirements.

2. Data shall be shared between networked Custom Application Controllers.

3. The operating system of the Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.

4. Controllers that perform scheduling shall have a real-time clock.

5. The Custom Application Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
   a. Assume a predetermined failure mode.
   b. Generate an alarm notification.

6. The Custom Application Controller shall communicate with other objects on the inter-network using the Read (Execute and Initiate) and Write (Execute and Initiate) Property services.

B. Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type. If input points are not universal, 10% of each type is required. If outputs are not universal, 10% of each type is required. A minimum of one spare is required for each type of point used. Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional controller boards or point modules shall be required to implement use of these spare points

C. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free for future use.

D. Communication:

1. Each Custom Application Controller shall reside on a network using the BACnet MS/TP Data Link/ Physical layer protocol.

2. The controller shall provide a service communication port using Data Link/ Physical layer protocol for connection to a hand-held workstation.

E. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at -40 to 150 degrees F.

2. Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 32 to 120 degrees F.

F. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips - or to a termination card connected by a ribbon cable.

G. Memory: The Custom Application Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

H. Immunity to Power and Noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.

2.04 MAJOR EQUIPMENT COMMUNICATION CARDS

A. The following list of major equipment installed as part of this project shall contain a communication card that allows full functionality, control, feedback and communication with the BAS system furnished by equipment manufacturer, and connected and mapped by controls contractor.

1. Water Cooled Chillers
2. Hydronic Pump Variable Frequency Drives

B. Communication Card Specifications:

1. General: Operability with Johnson Controls, Inc. Metasys Extended Architecture.
2. Specific Systems:
   a. Chiller Protocol: BACnet IP
   b. VFD Protocol: BACnet MS/TP

2.05 INPUT/OUTPUT INTERFACE

A. Hardwired inputs and outputs may tie into the system through Building or Custom Application.

B. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller. Inputs and outputs shall be arranged on interchangeable modules or circuit boards to allow the replacement of a damaged module or board without replacing the entire controller.

C. Binary inputs shall allow the monitoring of On/Off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices, and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.

D. Pulse Accumulation Input Objects: This type of object shall conform to all the requirements of binary input objects, and also accept up to 10 pulses per second for pulse accumulation.

E. Analog inputs shall allow the monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with - and field-configurable to - commonly available sensing devices.

F. Binary outputs shall provide for On/Off operation, or a pulsed low- voltage signal for pulse width modulation control. Binary outputs on Building and Custom Application Controllers shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.

G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on Building or Custom Application Controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.

H. Tri-State Outputs: Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct mounted heating coils, zone dampers, radiation, etc.). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

I. Input/Output points shall be universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point with appropriate properties. Application Specific Controllers are exempted from this requirement.

J. System Object Capacity: The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.06 POWER SUPPLIES AND LINE FILTERING

A. Control transformers shall be UL Listed. Furnish Class 2 current-limiting type, or furnish over-current protection in both primary and secondary circuits for Class 2 service per NEC requirements. Limit connected loads to 80% of rated capacity.

1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100 microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection, and shall be able to withstand a 150% current overload for at least 3 seconds without trip-out or failure.

2. Unit shall operate between 32 F and 120 degrees F. EM/RF shall meet FCC Class B.

B. Power Line Filtering: Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:

1. dielectric strength of 1,000 volts minimum.

2. response time of 10 nanoseconds or less.

3. transverse mode noise attenuation of 65 dB or greater.

4. common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

2.07 AHU CHILLED WATER FLOW CONTROL VALVES

A. Air Handling Unit (AHU) Chilled Water Control Valves shall be Flow Control Industries Delta P valves as indicated on drawings. Substitutions not allowed.

B. Valves and actuators shall be for normally-open operation as shown on the drawings or as required by the operating sequences.

C. Refer to Electric and Electronic Operators section below for control valve actuators.

2.08 AUTOMATIC CONTROL VALVES (CHILLED AND CONDENSER WATER)

A. Sizes 6 inches and over chilled water and condenser water control valves shown on the drawings shall be high performance butterfly valves.

B. Refer to Section 15510, 2.09 for High Performance Butterfly Valve specifications.

C. Refer to Electric and Electronic Operators section below for control valve actuators.

2.09 ELECTRIC AND ELECTRONIC OPERATORS

A. Operators provided for each automatic valve or damper shall be of sufficient capacity to operate the valve or damper under all conditions, as specified, against system pressure encountered. Each operator shall be fully proportioning or 2-position type as required by the operating sequence and drawing package, and shall include travel limit stops and controls as required to prevent over-travel. Operators shall be provided with spring-return for normally-

closed or normally-open position on power interruption as indicated on the drawings and/or in the operating sequences. All proportioning operators shall be provided with positive positioning devices or indicators. Damper operating speeds shall be selected or adjusted so that the operators will remain in step with the controller without hunting, regardless of load variations.

B. Operators acting in sequence with other valve or damper operators shall be capable of adjustment of the control operating span as required for the operating characteristics of the system.

C. Electric and electronic modulating operators used for other than VAV-box operators, shall be hydraulic or oil-immersed gear train type.

D. Actuators require a field mounted controller and connection to the BAS.

2.10 CONTROL WIRING

A. Electrical Wiring: Provide in accordance with Section 16120 as required for the temperature control system, including electrical interlock wiring. Comply with the National Electrical Code, local codes, and Division 16 of these specifications.

B. Internal control wiring for equipment shall be provided by the manufacturers of that equipment.

2.11 CONTROL PANELS

A. All controllers, relays, switches, etc, for equipment located within equipment rooms shall be mounted in enclosed metallic control panels with hinged, locking doors. Indicating devices and pressure differential devices shall be mounted on the face of the control panel door. All control devices for equipment located in exposed areas subject to outside weather conditions, shall be mounted inside weatherproof enclosures. Nameplates shall be provided beneath each panel-mounted control device describing the function of the device.

B. Provide UL listed cabinets for use with line voltage devices.

C. All pneumatic devices within the panel shall be factory pre-piped. A "pneumatic terminal" numbering system shall be applied to all pneumatic lines within each panel with aforementioned numbers matching pneumatic terminals shown on the as-built control diagrams.

D. All electrical devices within the panel shall be pre-wired to terminal strips, with all inter-device wiring within the panel completed prior to installation of the system. A terminal numbering system shall be applied to all wires within each panel, with the numbers matching the wiring terminals shown on the as-built control diagrams.

2.12 CONTROL TRANSFORMERS

A. Provide control transformers as required for a complete and fully operational control system.

B. Transformers to have adequate capacity for all connected controls. Input and output voltages to be as required for the control power voltage available, and the voltages required by the control components.

2.13 ELECTRONIC TEMPERATURE SENSORS

A. All temperature sensors, unless otherwise indicated on the drawings, shall be thermistors having a resistance of 10,000 ohms at 21 degrees C (70 degrees F), an accuracy of 0.3 degrees C (0.5 degrees F) or better throughout the temperature range of 0 to 100 degrees C

(32 to 212 degrees F). Averaging temperature sensors shall be used to measure the temperature of mixed air streams in ductwork. The averaging sensors shall include a continuous sensing element of sufficient length to permit mounting in accordance with the drawings.

B. Sensors shall be twisted pair devices for connection into the controller.

C. Thermowells shall be Series 300 stainless steel.

2.14 ELECTRONIC PRESSURE SENSORS AND TRANSDUCERS

A. Pressure sensors shall be designed to withstand up to 150% of rated pressure. For all differential pressure sensors, provide 3-valve manifolds for isolation and nulling. For absolute pressure sensors, provide one isolation valve and a means for nulling, including nulling valves as required. Sensors on all liquid lines shall be protected by pigtail siphons installed between sensor and fluid line.

B. Electronic pressure transducers shall provide a proportional output signal of 0-10 VDC (or 2-10 VDC), or 4-20 ma DC over the span of the transducer element. Accuracy shall be +/-1 percent, full scale or better, and repeatability shall be +/- 0.5 percent, full scale.

C. The effect of ambient temperature shall be less than 3.5 percent of full scale over the temperature range of 50 to 104 degrees F. The effect of variations in line voltage shall be less than 1 percent for a 10 percent change in the nominal line voltage.

D. The span of the transducers shall not exceed three times the measured differential pressure. The anticipated differential pressure to be measured shall be in approximately the center of the transducer span.

E. Sensors shall be twisted pair devices for connection into the controller.

F. Approved Products for air Differential Pressure:

1. Ashcroft RXLdp.
2. Dwyer, Series 607.
3. Setra Systems, Model 264.

G. Approved Products for water Differential Pressure:

1. Setra C230.
2. Viatran 276/376.

H. Approved Products for Gauge Pressure:

1. Ashcroft Model K1.
2. Viatran Model 247/347.

2.15 RELAYS

A. Control relays shall be UL Listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage suitable for application.

B. Time delay relays shall be UL Listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable (200% (minimum) from set point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

C. Override timers shall be spring-wound line voltage UL Listed, contact rating and configuration as required by application. Provide 0-to-6-hour calibrated dial unless otherwise specified; suitable for flush mounting on control panel face, located on local control panels or where shown.

D. Current transmitters.

1. AC current transmitters shall be self-powered combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, internal zero and span adjustment, and (1% full scale accuracy at 500 ohm maximum burden.

2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA Recognized.

3. Unit shall be split-core type for clamp-on installation on existing wiring.

E. Current transformers.

1. AC current transformers shall be UL/CSA Recognized and completely encased (except for terminals) in approved plastic material.

2. Transformers shall be available in various current ratios and shall be selected for (1% accuracy at 5 A full scale output.

3. Transformers shall be fixed-core or split-core type for installation on new or existing wiring, respectively.

F. Voltage transmitters.

1. AC voltage transmitters shall be self-powered single loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.

2. Ranges shall include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, with (1% full-scale accuracy with 500 ohm maximum burden.

3. Transmitters shall be UL/CSA Recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1 requirements.

G. Voltage transformers.

1. AC voltage transformers shall be UL/CSA Recognized, 600 VAC rated, complete with built-in fuse protection.

2. Transformers shall be suitable for ambient temperatures of 4 to 55|C 40 to 130|F and shall provide (0.5% accuracy at 24 VAC and a 5 VA load.

3. Windings (except for terminals) shall be completely enclosed with metal or plastic material.

H. Current switches: Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

2.16 WATER FLOW SENSING ELEMENTS

A. Full profile, insertion type electromagnetic flow meter consisting of an electromagnetic averaging sensor and a converter unit.

B. Approved Product: McCrometer, FPI Mag 395L

C. Sensor:

1. The flow-sensing element shall be of an electromagnetic multi point averaging type design and factory calibrated to traceable standards, such as NIST. Installation of the averaging sensor shall be accomplished under flowing conditions through a 2-inch tap via a full port ball valve or corporation stop into the pipe. Profiling or site calibration shall not be required. Measuring electrodes and reference ground electrodes shall be constructed of 316 stainless steel. Sensor shall have an epoxy coating over stainless steel to help from attack of UV, chemical resistance and excess buildup.

D. Converter:

1. The flow meter converter shall be microprocessor based with a keypad for instrument set up and LCD displays for totalized flow, flow rate engineering units and velocity or totalized flow. The converter shall power the flow-sensing element and provide a galvanically isolated 4-20mA output for flow, and a flow proportional output. It shall be possible, in the test mode; to easily set the converter outputs to any desired value within their range. The 4-20mA scaling, time constants, pipe size, flow proportional output, engineering units and test mode values shall be easily set via the keypad and display. Two separate fully programmable alarm outputs shall be provided to indicate high/low flow rates, empty pipe, fault conditions, reverse flow and over-range conditions. The converter shall periodically perform self-diagnostics and display any resulting error messages. All set up data and totalizer values may be protected by a password.

E. Sensor Cable:

1. The sensor cable is 20 feet of multi-conductor; abrasive resistant, polyurethane jacketed cable flexible to -40°F. The sensor cable shall be permanently bonded to the sensor. Additional sensor cable, up to 250 feet shall be available as an option.

F. Mounting Hardware:

1. Stainless steel retaining rods, of sufficient length, shall be provided for the smooth installation of the electromagnetic averaging sensor. Shorter stainless steel retaining rods shall also be provided for the continuous operation of the electromagnetic averaging sensor. In order to provide stable and secure sensor placement, the sensor shall be capable of compression up to 450 PSI for use in low pressure metal pipes.

G. Additional Specifications:

1. Accuracy: ±1% of reading ±0.03 ft/sec
2. Linearity: 0.3% of range
3. Repeatability: 0.20% of range
4. Reverse Flow Indication: Yes
5. Power Requirements: AC

2.17 CENTRAL PLANT OPTIMIZATION SYSTEM (CPO 30)

A. Central Plant Optimization System shall consist of an electronic digital controller from one or more of the above, configured as approved, fully compatible with the network standards of this specification and with the associated equipment supplied. This project shall be connected to the existing JCI CPO 30 controller program installed under the controls replacement project. Data from the new chillers, pumps and pump VFD's, and associated BAS field points shall be monitored and sequenced through algorthims from CPO 30 and controlled via the existing Metasys BAS to optimize the energy usage of the plant.

B. Central Plant Optimization System shall include the following:

1. All required hardware/software to meet the requirements of the drawings and these

specifications.

2. Web-based troubleshooting and reporting functionality and service so that performance is verified and reported quarterly and performance faults are annunciated and promptly corrected during the warranty period.

3. Any optimization system that does not provide ongoing measurement and verification of optimized performance is not acceptable.

4. Optimization algorithms shall inform the BAS of optimal states, speeds and setpoints without the use of PID loops and without hunting.

C. Central Plant Optimization controller: Modular, comprising processor board with programmable, random-access memory and local operator access.

1. Controller monitors and processes information for optimized control and provides information and optimized settings to the DDC system that executes commands.

2. Optimization controller resides on the main BACnet network with DDC system panels.

D. Dual mode operation capability

1. Optimization software shall exist exclusive of the BAS and have the ability to operate in two modes: standard BAS (automation) mode and optimized mode.

2. The software shall include a provision for transitioning from one mode to the other without interruption of chiller plant functionality while the plant is operating.

E. Remote Monitoring and Fault Detection

1. Central Plant Optimization System shall be installed and configured to provide a secure persistent internet connection using the VPN capabilities of the building's firewall and network management facilities to achieve the remote monitoring requirement.

2. CPO system points and trending shall be remotely monitored by CPO provider.

3. When the CPO remote monitoring service team detects a fault or views equipment operating at less that optimal performance (ie. Sensor error or VFD in 'Hand'), a fault notification shall be sent to the building operator with a description of the operating or performance anomaly.

4. Plant system and equipment trend data shall be captured at 5 minute intervals and stored remotely on a secured server for a minimum of 1 year. Data shall be accessible via a standard web browser.

5. Provide quarterly plant efficiency reports that summarize performance, provide graphical representation of key operating statistics and include a summary of any plant issues that are negatively impacting efficiency and need to be resolved.

F. Performance Verification and Report Generation

1. Web-based software shall provide real-time and cumulative metrics comparing standard BAS mode of operation (base case model) with optimized mode of operation (actual measurement) indicating, but not limited to: KWH savings, CO2 savings, and Dollar savings.

2. Web-based software shall continuously display a trend graph showing the simulated efficiency of the standard BAS mode and the current, actual, measured efficiency in kw/ton.

3. System shall include graphical displays of plant operating data for a period of 1 year to assist in fault diagnosis and resolution which shall be accessible via a standard web browser.

4. Provide quarterly plant efficiency reports that summarize performance, provide graphical

representation of key operating statistics and include a summary of any plant issues that are negatively impacting efficiency and need to be resolved.

5. Measurement & Verification system shall display at a minimum:
   a. Baseline energy of plant in 30 second intervals (displayed in kW/Ton)
   b. Energy savings with Optimization in 30 second intervals (displayed in kW/Ton)
   c. Energy savings per month and per year
   d. Dollar savings per month and per year
   e. CO2 reduction per month and per year
   f. Chiller Plant Operating Efficiency in kW/Ton (real-time)
   g. Total Plant kW usage (real-time)
   h. Tons of chiller water being provided by plant (real-time)
   i. Real-Time percentage savings over the baseline (real-time)

G. CPO shall utilize software and programming that is based on the Equal Marginal Performance Principle (EMPP) of system optimization through Demand Based Control techniques. The CPO shall variably control quantity of equipment run, motor speed, and chilled water output temperature according to the EMPP. The CPO shall do the following

1. Receive data about the system performance and loads from the BAS.
2. Calculate chilled water pump speed using the valve orifice method and integrate chilled water temperature set point control to pump control for optimal system performance.
3. Use the natural efficiency curve of the chillers to determine, based on load and leaving condenser water temperature, the optimal number of chillers to run.
4. Utilize the EMPP and power relationships between the cooling towers, condenser pumps, and chillers to determine the optimal number of pumps and towers to run, as well as what speed to run the motors.
5. Compute and return to the BAS system new equipment speeds and set points every 30 seconds, and shall change values less than 2 percent of full range per 30-second monitoring cycle.

PART 3 -EXECUTION

3.01 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

B. The Contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

C. The Contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate - or if any discrepancies occur between the plans and the Contractor's work, and the plans and the work of others - the Contractor shall report these discrepancies to the Engineer and shall obtain written instructions for any changes necessary to accommodate the Contractor’s work with the work of others.

3.02 PROTECTION

A. The Contractor shall protect all work and material from damage by its work or employees, and shall be liable for all damage thus caused.

B. The Contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted. The Contractor shall protect any material that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.03 COORDINATION

A. Site:

1. Where the mechanical work will be installed in close proximity to, or will interfere with work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. If the Contractor installs its work before coordinating with other trades, so as to cause any interference with work of other trades, the Contractor shall make the necessary changes in its work to correct the condition without extra charge.

2. Coordinate and schedule work with all other work in the same area, or with work which is dependent upon other work, to facilitate mutual progress.

B. Test and Balance:

1. The Contractor shall furnish all tools necessary to interface to the control system for test and balance purposes.

2. The Contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.

3. In addition, the Contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.

4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.

C. Life Safety:

1. Interfere with building fire alarm systems in place for lockout on the event there is a fire in the zone served by this AHU.

2. Duct smoke detectors required for air handler shutdown are supplied under Division 16. The Contractor shall interlock smoke detectors to air handlers for shutdown as described in the sequence of operation.

3. The Contractor shall interlock smoke dampers and actuators required for duct smoke isolation to the air handlers as described in the sequence of operation.

4. Control of fire/smoke dampers and actuators required for fire rated walls shall be by Division 16. The Contractor shall provide control air, if required, to the dampers.

D. Coordination with Controls Specified in Other Sections or Divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the Contractor as follows:

1. Each supplier of a controls product is responsible for the configuration, programming, startup, and testing of that product to meet the sequence of operation.

2. The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other sections or divisions of this specification.

3. The Contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.

4. The Contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.04 GENERAL WORKMANSHIP

A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).

D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.05 FIELD QUALITY CONTROL

A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

3.06 WIRING

A. All control and interlock wiring shall comply with national and local electrical codes and Division 16 of this specification. Where the requirements of this section differ with those in Division 16, the most stringent requirements shall apply.

B. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway per NEC and Division 16 requirements.

C. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)

D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used, provided that cables are UL Listed for the intended application. For example, cables used in ceiling plenums shall be UL Listed specifically for that purpose.

E. All wiring in mechanical, electrical, or service rooms - or where subject to mechanical damage - shall be installed in raceway at levels below 10 feet.

F. Class 2 wiring shall not be installed in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

G. Do not install wiring in raceway containing tubing.

H. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.

I. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

J. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the Contractor shall provide step-down transformers.

K. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

L. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.

M. Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendation and NEC requirements, except as noted elsewhere.

N. Use coded conductors throughout with different colored conductors.

O. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6" from high-temperature equipment (e.g., flues).

P. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

Q. Adhere to Division 16 requirements where raceway crosses building expansion joints.

R. The Contractor shall terminate all control and/or interlock wiring, and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

S. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end.

T. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (per code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.07 COMMUNICATION WIRING

A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

B. Maximum pulling, tension, and bend radius for cable installation as specified by the cable manufacturer shall not be exceeded during installation.

C. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

D. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer's instructions.

E. All runs of communication wiring shall be unspliced length when that length is commercially available.

F. All communication wiring shall be labeled to indicate origination and destination data.

G. Grounding of coaxial cable shall be in accordance with NEC regulations Article on Communications Circuits, Cable and Protector Grounding.

3.08 INSTALLATION OF SENSORS

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

D. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across duct. Each bend shall be supported with a capillary clip.

E. Low limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 foot of sensing element for each 1 square foot of coil area.

F. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

3.09 FLOW SWITCH INSTALLATION

A. Use correct paddle for pipe diameter.

B. Adjust flow switch in accordance with manufacturer's instructions.

3.10 ACTUATORS

A. Mount and link control damper actuators per manufacturer's instructions.

1. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

2. Provide all mounting hardware and linkages for actuator installation.

B. Electric/Electronic:

1. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degree available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.

2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.11 IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2" of termination with the DDC address or termination number.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 1/2" letters on laminated plastic nameplates.

D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.

E. Identify room sensors relating to terminal box or valves with nameplates.

F. Manufacturers' nameplates and UL or CSA labels to be visible and legible after equipment is installed.

G. Identifiers shall match record documents.

3.12 CONTROL SYSTEM CHECKOUT AND TESTING

A. Startup Testing: All testing listed in this article shall be performed by the Contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Owner's Representative is notified of the system demonstration. Provide written report of checkout and testing results to Owner's Representative. Control System Demonstration and Acceptance will not be scheduled until this written report has been reviewed by the Owner's Representative.

1. The Contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures per manufacturers' recommendations.
4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The Contractor shall check all control valves and automatic dampers to ensure proper action and closure. The Contractor shall make any necessary adjustments to valve stem and damper blade travel.
6. Verify that the system operation adheres to the Sequences of Operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum Start/Stop routines.
7. Alarms and Interlocks:
    a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
    b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
    c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.13 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration:

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the

Contractor has completed the installation, started up the system, and performed its own tests.

2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, startup, and debugging process and as specified in the "Control System Checkout and Testing" Article in Part 3 of this specification. The Owner's Representative will be present to observe and review these tests. The Owner's Representative shall be notified at least 10 days in advance of the start of the testing procedures.

3. The demonstration process shall follow that approved in Part 1: "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.

4. The Contractor shall provide at least two persons equipped with two-way communication, and shall demonstrate actual field operation of each control and sensing point. Any test equipment required to prove the proper operation shall be provided by and operated by the Contractor.

5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

6. Demonstrate compliance with Part 1: "System Performance."

7. Demonstrate compliance with Sequences of Operation through all modes of operation.

8. Demonstrate complete operation of Operator Interface.

9. Demonstrate trend logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status to the Owner's Representative. These logs shall cover three 48-hour periods and have a sample frequency as indicated in the object schedule. The logs shall be provided in both printed and disk formats.

10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance:

1. All tests described in this specification shall have been performed to the satisfaction of the Owner's Representative prior to the acceptance of the control system as meeting the requirements of Completion. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's Representative. Such tests shall then be performed as part of the warranty.

2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

3.14 CENTRAL PLANT OPTIMIZATION SYSTEM (CPO 30) SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Examination

1. Supply all required equipment to installing subcontractor along with instructions and support for that subcontract to install, connect and power all equipment required in this Section.

2. Install software in controller supplied by this Section. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

3. Configure software to achieve system optimization and energy performance specified.

B. Field Quality Control

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

2. Perform the following field tests and inspections and prepare test reports:
   a. Operational Test: After the BAS is commissioned, CPO software provider shall complete functional testing.
   b. Test each system for compliance with optimization and energy performance requirements.
   c. CPO vendor shall provide written commissioning test procedure specification prior to commissioning of the optimization system and provide the completed test report upon successful commissioning.

C. Adjusting

1. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide remote assistance in adjusting system to suit occupied conditions.

D. Demonstration and Training

1. Engage a factory-authorized service representative to remotely train Owner's maintenance personnel to operate, and maintain Central Plant Optimization System provided per this Section.

2. Provide a minimum of 4 total hours of training for CPO system.

3. Provide quarterly performance reports as determined by the Owner that show the energy performance of the facility compared to minimum requirements listed in this Section. Provide explanations and recommended corrective action for any elements that do not meet the minimum energy performance criteria listed in this Section.

E. Service and Technical Support

1. Provide a toll-free number to call for live service support and the ability to dispatch service personnel on a 24/7 basis from the nearest metropolitan area.

2. Provide technical phone support for optimization during regular business hours.

F. Warranty

1. Provide as a part of this contract, service and labor warranty for CPO controller(s) supplied and installed under this agreement. Such warranty period begins at system acceptance.

2. Provide service and labor warranty for all firmware and software provided in the execution of this scope of work. During the warranty period all manufacturer's regular system software and firmware upgrades shall be provided as part of this extended warranty.

3.15 CLEANING

A. The Contractor shall clean up all debris resulting from its activities daily. The Contractor shall remove all cartons, containers, crates, etc., under its control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, the Contractor shall clean all of its work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the

adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.16 TRAINING

A. Provide a minimum of five on-site or classroom training sessions, eight hours each, throughout the contract period for personnel designated by the Owner.

B. Train the designated Day-to-day Operators of the Owner to enable them to:

1. Proficiently operate the system.
2. Understand control system architecture and configuration.
3. Understand DDC system components.
4. Understand system operation, including DDC system control and optimizing routines (algorithms).
5. Adjust and change system set points, time schedules, and holiday schedules.
6. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
7. Understand system drawings, and Operation and Maintenance manual.
8. Understand the job layout and location of control components.
9. Access data from DDC controllers and ASCs.
10. Operate portable operator's terminals.

C. Train the designated Advanced Operators of the Owner to enable them to:

1. Make and change graphics on the workstation.
2. Create, delete, and modify alarms, including annunciation and routing of these.
3. Create, delete, and modify point trend logs, and graph or print these both on an ad-hoc basis and at user-definable time intervals.
4. Create, delete, and modify reports.
5. Add, remove, and modify system's physical points.
6. Create, modify, and delete programming.
7. Create, delete, and modify system displays - both graphical and otherwise.
8. Perform DDC system field checkout procedures.
9. Perform DDC controller unit operation and maintenance procedures.
10. Perform workstation and peripheral operation and maintenance procedures.
11. Perform DDC system diagnostic procedures.
12. Configure hardware including PC boards, switches, communication, and I/O points.
13. Maintain, calibrate, troubleshoot, diagnose, and repair hardware.
14. Adjust, calibrate, and replace system components.

D. Train the designated System Managers/Administrators of the Owner to enable them to:

1. Maintain software and prepare backups.
2. Add new users and understand password security procedures.

E. These objectives will be divided into three logical groupings. Participants may attend one or more of these, depending on level of knowledge required:

1. Day-to-day Operators: Subject matter as listed.
2. Advanced Operators: Training to include subject matter listed for Day-to-day Operators.
3. System Managers/Administrators: Training to include subject matter listed for Day-to-day Operators and Advanced Operators.

F. Provide course outline and materials. The instructor(s) shall provide one copy of training material per student.

G. The instructor(s) shall be factory-trained and experienced in presenting this material.

H. Classroom training shall be done using a network of working controllers representative of the installed hardware.

3.17 OPERATING SEQUENCES

A. Refer to Section 15985.

3.18 POINTS LIST

A. General:

1. BAS card protocol listed in parenthesis when available.
2. Each table of points presented below is required for each piece of equipment.

B. Abbreviations & Descriptions:

1. AI – Analog Input to BAS
2. AO – Analog Output from BAS
3. BI – Binary (Digital) Input to BAS
4. BO – Binary (Digital) Output from BAS
5. AV – Analog Value: Analog setpoint from BAS
6. BV – Binary (Digital) Value: Binary setpoint from BAS
7. Trend: Value that shall be trended in BAS
8. Alarm: BAS shall be configured to generate an alarm when this object exceeds user definable limits.
9. Graphic: BAS shall be configured to illustrate this point on the system graphics.
10. Hardware Points: Physical Input/Output points in the field.
11. Software Points: Points configured in the BAS architecture.

C. Hydronic Pumps (BACnet MS/TP):

	Hardware Points				Software Points				
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Trend**	**Alarm**	**Show On Graphic**
Pump Motor kW	x						x		x
Pump Differential Pressure	x						x		x
Pump VFD Speed		x					x		x

	Hardware Points				Software Points				
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Trend**	**Alarm**	**Show On Graphic**
Pump Status			x				x		x
Pump VFD Fault			x					x	x
Pump Start/Stop				x			x		x
Pump VFD Setpoint					x		x		x
Pump Failure								x	x
Pump Running in Hand								x	
Pump Runtime Exceeded								x	
High Differential Pressure								x	
Low Differential Pressure								x	
Totals	**2**	**1**	**2**	**1**	**1**	**0**	**6**	**6**	**8**

Total Hardware (6) **Total Software (13)**

D. Water Cooled Chillers (BACnet IP):

	Hardware Points				Software Points				
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Trend**	**Alarm**	**Show On Graphic**
Chilled Water Return Temp	x						x		x
Chilled Water Supply Temp	x						x		x
Condenser Water Return Temp	x						x		x
Condenser Water Supply Temp	x						x		x
Total Chiller kW	x						x		x
Chiller Demand Limiting (%FLA)	x						x		x
Evaporator Refrigerant Pressure	x						x		x
Condenser Refrigerant Pressure	x						x		x
Evaporator Refrigerant Temperature	x						x		x
Condenser Refrigerant Temperature	x						x		x
Oil Differential Pressure	x						x		x
Oil Temp	x						x		x
Compressor 1 Motor RPM / VFD Speed	x						x		
Compressor 1 General Fault	x						x		
Compressor 1 IGV Position	x						x		
Compressor 1 kW	x						x		
Compressor 2 Motor RPM /	x						x		

	Hardware Points				Software Points				
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Trend**	**Alarm**	**Show On Graphic**
VFD Speed									
Compressor 2 General Fault	x						x		
Compressor 2 IGV Position	x						x		
Compressor 2 kW	x						x		
Chilled Water Supply Temp Setpoint Reset		x					x		x
Emergency Shutdown			x				x	x	x
Refrigerant Leak Shutdown			x				x	x	x
Chiller Status			x				x		x
Compressor 1 State			x				x		
Compressor 2 State			x				x		
Chilled Water Flow Status			x				x		x
Condenser Water Flow Status			x				x		x
Chiller Enable				x			x		x
Chilled Water Supply Temp Setpoint					x		x		x
Chiller Failure								x	
Chiller Running in Hand								x	
Chiller Runtime Exceeded								x	
High Chilled Water Supply Temp								x	
Low Chilled Water Supply Temp								x	
High Condenser Water Return Temp								x	
Low Condenser Water Return Temp								x	
High Condenser Water Supply Temp								x	
Low Condenser Water Supply Temp								x	
Totals	**17**	**1**	**7**	**1**	**1**	**0**	**27**	**11**	**17**

Total Hardware (26) Total Software (39)

E. Constant Volume Air Handling Unit (BACnet MS/TP):

	Hardware Points				Software Points				
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Trend**	**Alarm**	**Show On Graphic**
Zone Temp	x						x		x
Zone Setpoint Adjust	x								x

	Hardware Points				Software Points				
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Trend**	**Alarm**	**Show On Graphic**
Discharge Air Temp	x						x		x
Cooling Valve Position		x					x		x
Smoke Detector			x				x	x	x
Fan Status			x						x
Fan Start/Stop				x			x		x
Cooling Setpoint							x		x
High Zone Temp								x	
Low Zone Temp								x	
High Discharge Air Temp								x	
Low Discharge Air Temp								x	
Dirty Filter								x	
Fan Failure								x	
Condensate Drain Pan Leak Detection			x					x	
Totals	**3**	**1**	**3**	**1**	**0**	**0**	**6**	**8**	**8**

Total Hardware (8) **Total Software (14)**

F. Shutoff Control Valves - Chilled or Condenser Water:

	Hardware Points				Software Points				
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Trend**	**Alarm**	**Show On Graphic**
Isolation Valve Status - Open			x				x		x
Isolation Valve Status - Closed			x				x		x
Local / Remote Switch			x					x	x
Command Open				x				x	
Command Closed				x				x	
Isolation Valve Failure								x	
Isolation Valve in Hand								x	
Isolation Valve Runtime Exceeded								x	
Totals	**0**	**0**	**3**	**2**	**0**	**0**	**2**	**6**	**3**

Total Hardware (5) **Total Software (8)**

G. Throttling Control Valves - Chilled Water:

	Hardware Points	Software Points

Point Name	AI	AO	BI	BO	AV	BV	Trend	Alarm	Show On Graphic
Throttling Valve Position	x						x		x
Throttling Valve Setpoint		x					x		x
Local / Remote Switch			x					x	x
Throttling Valve Failure								x	
Throttling Valve in Hand								x	
Throttling Valve Runtime Exceeded								x	
Totals	**1**	**1**	**1**	**0**	**0**	**0**	**2**	**4**	**3**

Total Hardware (3) **Total Software (6)**

H. Flow Transmitters (BACnet IP):

	Hardware Points				Software Points				
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Trend**	**Alarm**	**Show On Graphic**
Instant Flow	x						x		x
Totalized Flow	x						x		x
Totals	**2**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**2**

Total Hardware (2) **Total Software (2)**

I. Pressure Transmitters - Hydronic:

	Hardware Points				Software Points				
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Trend**	**Alarm**	**Show On Graphic**
Pressure	x						x		x
High Pressure Alarm								x	
Totals	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**

Total Hardware (1) **Total Software (2)**

J. Temperature Transmitters – Hydronic or Airside:

	Hardware Points				Software Points				
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Trend**	**Alarm**	**Show On Graphic**
Temperature	x						x		x
Totals	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**

Total Hardware (1) **Total Software (1)**

PART 4 -MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15952

SECTION 15985

SEQUENCE OF OPERATION

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment

1.02 RELATED SECTIONS

A. Section 15010 - Basic Mechanical Requirements.

B. Section 15952 – Controls and Instrumentation

C. Section 15980 - Instruments and Control Elements.

D. Section 16142 - Electrical Connections for Equipment: Electrical characteristics and wiring connections.

1.03 SYSTEM DESCRIPTION

A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

1.04 SUBMITTALS FOR REVIEW

A. Shop Drawings: Indicate mechanical system controlled and control system components.

1. Label with settings, adjustable range of control and limits. Include written description of control sequence.
2. Include flow diagrams for each control system, graphically depicting control logic.
3. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

1.05 SUBMITTALS AT PROJECT CLOSEOUT

A. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

1.06 QUALITY ASSURANCE

A. Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State of Colorado.

PART 2 - PRODUCTS - NOT USED

PART 3 - CENTRAL PLANT SYSTEMS

3.01 GENERAL

A. The Central Utility Plant's Building Automation System (BAS) is based upon the following setup:

1. Johnson Controls, Metasys Extended Architecture
2. Protocol: BACnet IP or MS/TP (Application Specific)

B. Local Contacts:

1. Project Manager: Luke McMillan, 303-229-8510, Luke.McMillan@jci.com
2. Preconstruction: Steve Nixon, 303-868-5587, steve.r.nixon@jci.com

3.02 ELECTRICAL ROOM AIR HANDLING UNIT

A. Supply Fan Control:

1. The constant speed supply fan will be started based on occupancy schedule. When the supply fan status indicates the fan started, the control sequence will be enabled. Upon a loss of airflow, the system will automatically restart.

B. Temperature Control:

1. The discharge air temperature setpoint will be reset as the zone temperature deviates from its 90 deg F setpoint (+/-2.5°F)

C. Occupied Mode:

1. The occupancy mode will be controlled via a network input, normally set to "OCCUPIED" due to the electrical room requirements for cooling. The occupancy mode can also be overridden by a network input.

D. Unoccupied Mode:

1. The Unit will remain off during unoccupied periods.

E. Cooling Coil:

1. The cooling coil Delta-P control valve, TCV-126 will modulate to maintain the discharge air temperature setpoint. When the unit is shutdown, the cooling coil will be off. Upon a loss of airflow, the cooling coil will be off.

F. Unit Enable:

1. A network unit enable signal will control the mode of the unit.

G. Power Fail Reset:

1. Upon power restoration, the unit restart shall be delayed.

H. Determine fan status by current sensing devices. If fan fails to start as commanded, signal alarm.

I. Safety Devices:

1. High Temperature Protection: Stop fans if temperature in return air is above 120 degrees F; signal alarm.
2. Smoke Detector: Stop fans, close outside dampers, and close smoke dampers if smoke is detected; signal alarm.

3. Condensate Drain Pan Leak Detection: Stop fan and close chilled water control valve if a leak is detected; signal alarm.

J. Display:

1. System graphic.
2. System on/off indication.
3. Fan discharge air temperature indication.
4. Space/Return air temperature indication.
5. Fan discharge temperature control point adjustment.

3.03 CHILLER PLANT – MECHANICAL COOLING MODE M1

A. Mode M1:

1. Tonnage Range: 1000-2500 TR
2. Available Chillers: Chillers C-4A OR C-4B only
3. Example Chiller for Sequence Below: C-4A

B. Centrifugal Water Cooled Chillers:

1. General Chiller Control:
   a. The chiller shall be controlled via its own internal controls to maintain a chilled water supply temperature of 40F. When a chiller is required, the chiller with the lowest runtime total shall be enabled by the BAS to run.
2. Startup Sequence:
   a. Two (2) cooling tower cells must be confirmed as available.
   b. A minimum of one slide gate (3 or 4) must be confirmed open.
   c. Open and prove the CHW valves TCV-114A and TCV-104A.
   d. Chilled water pumps are enabled (see separate CHW pump sequence).
   e. Once evaporator flow is confirmed, open and prove the CW valves TCV-214A and TCV-204A.
   f. Once vertical turbine CW pressure setpoint and CW pump P-24 flow are both confirmed, sequence will continue. (see separate CW pump sequence)
   g. When the CW temperature is at setpoint, enable chiller start through chiller control panel controls.
   h. Chiller's internal control panel shall modulate compressor VFD and inlet guide vanes to maintain chilled water supply setpoint.
   i. Chilled water control valve TCV-104A is available to prevent exceeding boundary conditions through chiller evaporator bundle:
      1) Note: C-4A and C-4B allowable evaporator flows (EACH):
         a) High: 6000 GPM
         b) Design: 3750 GPM
         c) Low: 1560 GPM
3. Shutdown Sequence:
   a. Disable chiller through chiller panel controls.
   b. After the pumpdown timer has expired (initially 5 minutes), disable chiller condenser water pump P-24 and any active vertical turbine CW pumps.
   c. After the pumpdown timer has expired (initially 5 minutes), disable active chilled water pumps.
   d. Close chilled water control valves (TCV-114A, 104A) and condensing water

control valves (TCV-214A, 204A).

e. Disable any associated cooling tower cells via a fan shutdown.

4. Notes:
   a. Chilled Water and Condenser Water Isolation valves can modulate.
   b. Chiller Failure is defined as a chiller alarm being received from the chiller panel.
   c. Chiller status will be monitored through the Chiller control integration.

C. Chilled Water Pump Control

1. Five (5) pumps are available to operate, a maximum of 4 are allowed to run at any one time. System is sized for N+1.
2. When any chilled water is required, one pump will be started and ramp up to maintain the setpoint defined below. When the system is shut down, the pump(s) will continue to pumpdown for 5 min (adj) to allow the equipment to coast and cool down.
   a. Chilled Water Pump Control Setpoint: Maintain bypass flow rate setpoint in the decoupler (measured by FE213) at -1% of system flow (measured by FE026).
3. If the pump status does not match the command, an alarm will be generated and the pump will be locked out and the next pump will be started.
4. The lowest runtime pump will be the lead pump on startup or staging. Pump rotation is also available for the operators to command or schedule.
5. If the pump speed is over 95% for 10 minutes (regardless of number of chiller operating), an additional pump will be brought on to meet the demand efficiency. All pumps will modulate at the same speed.
6. If the pump speed is below the stagedown setpoint (see table below) for 10 minutes, a pump will be taken offline.
   a. Note: Pumpdown timers (initially 5 minutes) also apply to this pump, therefore pump will not shutoff until 15 minutes after speed is below setpoint.
   b. Table: (Exact numbers TBD)
      1) 4 pumps down to 3 = ~31%
      2) 3 pumps down to 2 = ~31%
      3) 2 pumps down to 1 = ~45%

D. System Condenser Water Pump Control (Vertical Turbine Sump CW Pumps):

1. One pump will be required for every two towers that are enabled from a call for cooling. Pumps P-23 or P-24 will always be the lead pump due to their VFDs. Subsequently higher runtime pumps will be lag or standby pumps. If the pump status does not match the command, an alarm will be generated, the pump locked out until manually reset, and the next pump will be started.
2. TCV-255 and TCV-256 are commanded closed, confirm status.
3. Pumps will be ramped and/or staged to maintain 43 PSI in the first condenser water header.
   a. Two pressure sensors will be located in the header for pump VFD control (east and west). When the header is not separated (TCV-257 open), the two pressure sensors will be averaged together for pump control.
   b. TCV-255 is available for emergency relief if header pressure exceeds 45 PSIG.
4. All slide gates will be open in normal operation (both sumps available).
5. Note: Pump P22 has a higher inlet and should only be ran if the water level in the west sump is above 7’-5”.

E. Chiller Specific Condenser Water Pump Control (Horizontal CW Pumps):

1. When called for (see chiller control above) and after header pressure setpoint has become satisfied (see VT pump sequence), the pump associated with an individual chiller will be started. If the pump status does not match the command, an alarm will be generated and the chiller will be stopped and locked out of service until manually reset. The next chiller will be commanded to run. After the chiller is commanded off, the pump will continue to run for a short time to dissipate the heat.
2. Pump P-24 VFD speed will be modulated to maintain a 10 deg F differential between inlet and out condenser water temperatures for Chiller C-4A.

F. Exceptions:

1. East Side Isolation:
   a. P-21, P-22 and P-23 will not be available.
2. West Side Isolation:
   a. P-24 and P-25 will not be available.
   b. Chillers C-4A and C-4B are only available if TCV-257 is open.

3.04 CHILLER PLANT – MECHANICAL COOLING MODE M2

A. Mode M2:

1. Tonnage Range: 2500-5000 TR
2. Available Chillers: Chillers C-4A AND C-4B only
3. Example Chillers for Sequence Below: C-4A AND C-4B

B. Centrifugal Water Cooled Chillers:

1. General Chiller Control:
   a. The chillers shall be controlled via their own internal controls to maintain a chilled water supply temperature of 40F. Chiller VFDs will be ramped in unison to accommodate load.
2. Startup Sequence:
   a. Three (3) cooling tower cells must be confirmed as available.
   b. A minimum of one slide gate (3 or 4) must be confirmed open.
   c. Open and prove the CHW valves TCV-114A, TCV-104A, TCV-114B and TCV-104B.
   d. Chilled water pumps are enabled (see separate CHW pump sequence).
   e. Once evaporator flow is confirmed, open and prove the CW valves TCV-214A, TCV-204A, TCV-214B and TCV-204B.
   f. Once vertical turbine CW pressure setpoint and CW pump P-24 flow are both confirmed, sequence will continue. (see separate CW pump sequence)
   g. When the CW temperature is at setpoint, enable chiller starts through chiller control panel controls.
   h. Chillers' internal control panel shall modulate compressor VFDs and inlet guide vanes to maintain chilled water supply setpoint.
   i. Chilled water control valve TCV-104A and TCV-104B are available to prevent exceeding boundary conditions through chiller evaporator bundles:
      1) Note: C-4A and C-4B allowable evaporator flows (EACH):
         a) Combined Limit: 7500 GPM
         b) High: 6000 GPM
         c) Design: 3750 GPM
         d) Low: 1560 GPM

3. Shutdown Sequence:
    a. Disable chiller through chiller panel controls.
    b. After the pumpdown timer has expired (initially 5 minutes), disable chiller condenser water pump P-24 and any active vertical turbine CW pumps.
    c. After the pumpdown timer has expired (initially 5 minutes), disable active chilled water pumps.
    d. Close chilled water control valves (TCV-114A/B, 104A/B) and condensing water control valves (TCV-214A/B, 204A/B).
    e. Disable any associated cooling tower cells via a fan shutdown.
4. Notes:
    a. Chilled Water and Condenser Water Isolation valves can modulate.
    b. Chiller Failure is defined as a chiller alarm being received from the chiller panel.
    c. Chiller status will be monitored through the Chiller control panel integration.

C. Chilled Water Pump Control

1. Five (5) pumps are available to operate, a maximum of 4 are allowed to run at any one time. System is sized for N+1.
2. When any chilled water is required, one pump will be started and ramp up to maintain the setpoint defined below. When the system is shut down, the pump(s) will continue to pumpdown for 5 min (adj) to allow the equipment to coast and cool down.
    a. Chilled Water Pump Control Setpoint: Maintain bypass flow rate setpoint in the decoupler (measured by FE213) at -1% of system flow (measured by FE026).
3. If the pump status does not match the command, an alarm will be generated and the pump will be locked out and the next pump will be started.
4. The lowest runtime pump will be the lead pump on startup or staging. Pump rotation is also available for the operators to command or schedule.
5. If the pump speed is over 95% for 10 minutes (regardless of number of chiller operating), an additional pump will be brought on to meet the demand efficiencty. All pumps will modulate at the same speed.
6. If the pump speed is below the stagedown setpoint (see table below) for 10 minutes, a pump will be taken offline.
    a. Note: Pumpdown timers (initially 5 minutes) also apply to this pump, therefore pump will not shutoff until 15 minutes after speed is below setpoint.
    b. Table: (Exact numbers TBD)
        1) 4 pumps down to 3 = ~31%
        2) 3 pumps down to 2 = ~31%
        3) 2 pumps down to 1 = ~45%

D. System Condenser Water Pump Control (Vertical Turbine Sump CW Pumps):

1. One pump will be required for every two towers that are enabled from a call for cooling. Pumps P-23 or P-24 will always be the lead pump due to their VFDs. Subsequently higher runtime pumps will be lag or standby pumps. If the pump status does not match the command, an alarm will be generated, the pump locked out until manually reset, and the next pump will be started.
2. TCV-255 and TCV-256 are commanded closed, confirm status.
3. Pumps will be ramped and/or staged to maintain 43 PSI in the first condenser water header.
    a. Two pressure sensors will be located in the header for pump VFD control (east and west). When the header is not separated (TCV-257 open), the two pressure

sensors will be averaged together for pump control.

b. TCV-255 is available for emergency relief if header pressure exceeds 45 PSIG.

4. All slide gates will be open in normal operation (both sumps available).

5. Note: Pump P22 has a higher inlet and should only be ran if the water level in the west sump is above 7'-5".

E. Chiller Specific Condenser Water Pump Control (Horizontal CW Pumps):

1. When called for (see chiller control above) and after header pressure setpoint has become satisfied (see VT pump sequence), the pump associated with an individual chiller will be started. If the pump status does not match the command, an alarm will be generated and the chiller will be stopped and locked out of service until manually reset. The next chiller will be commanded to run. After the chiller is commanded off, the pump will continue to run for a short time to dissipate the heat.

2. Pump P-24 VFD speed will be modulated to maintain a 10 deg F differential between inlet and out condenser water temperatures for headers serving Chiller C-4A and Chiller C-4B.

F. Exceptions:

1. East Side Isolation:
   a. P-21, P-22 and P-23 will not be available.

2. West Side Isolation:
   a. P-24 and P-25 will not be available.
   b. Chillers C-4A and C-4B are only available if TCV-257 is open.

3.05 CHILLER PLANT – MECHANICAL COOLING MODE M3

A. Mode M3:

1. Tonnage Range: 3200-6650 TR

2. Available Chillers: Chillers C-4A OR C-4B AND C-1 OR C-2 OR C-3 only

3. Example Chillers for Sequence Below: C-4A AND C-1 with C-4B shutting down.

B. Centrifugal Water Cooled Chillers:

1. General Chiller Control:
   a. The chillers shall be controlled via their own internal controls to maintain a chilled water supply temperature of 40F. Chillers will be staged on and off when the percent of full load amps goes over or under setpoint. When a chiller is required, the chiller with the lowest runtime total shall be enabled by the BAS to run.

2. Shutdown Sequence for C-4B for Transition to C-1:
   a. Open TCV-104A/B and TCV-114A/B fully
   b. Temporarily override normal Chilled Water Setpoint control via the decoupler flow setpoint and modulate control to maintain 7500 GPM plant CHW flow (measured by FE026 + FE213).
   c. Chiller C-4B is commanded off.
   d. TCV-101 is commanded open, confirm status and evaporator flow.
   e. TCV-104B and TCV-114B are commanded closed, confirm status.
   f. Resume normal decoupler flow setpoint control outlined below.

3. Startup Sequence:
   a. Four (4) cooling tower cells must be confirmed as available.

b. A minimum of one slide gate (3 or 4) must be confirmed open.

c. Open and prove the CHW valves TCV-114A, TCV-104A and TCV-101.

d. Chilled water pumps are enabled (see separate CHW pump sequence).

e. Once evaporator flow is confirmed, open and prove the CW valves TCV-214A, TCV-204A TCV-221 and TCV-201.

f. Once vertical turbine CW flow and horizontal split case CW flow are both confirmed, sequence will continue. (see separate CW pump sequence)

g. When the CW temperature is at setpoint, enable chiller starts through Chiller control panel controls.

h. Chiller's internal control panel shall modulate compressor VFD (when equipped) and inlet guide vanes to maintain chilled water supply setpoint.

i. Chilled water control valves TCV-104A and TCV-101 are available to prevent exceeding boundary conditions through Chiller C-4A evaporator bundle:
   1) Note: C-4A allowable evaporator flow:
      a) Design: 3750 GPM
      b) Low: 1560 GPM

j. Chilled water control valves TCV-101 and TCV-104A are available to prevent exceeding boundary conditions through Chiller C-1 evaporator bundle and will modulate to maintain approximately 6000-6200 GPM through C-1:
   1) Note: C-1 allowable evaporator flow:
      a) High: 6500 GPM
      b) Design: 6225 GPM
      c) Low: 5500 GPM
      d) Actual chiller min flow: 3110 GPM

4. Shutdown Sequence:
   a. Disable chiller through chiller panel controls.
   b. After the pumpdown timer has expired (initially 5 minutes), disable chiller condenser water pump P-24 and P-31and any active vertical turbine CW pumps.
   c. After the pumpdown timer has expired (initially 5 minutes), disable active chilled water pumps.
   d. Close chilled water control valves (TCV-114A, 104A, and 101) and condensing water control valves (TCV-214A, 204A, 221 and 201).
   e. Disable any associated cooling tower cells via a fan shutdown.

5. Notes:
   a. Chilled Water and Condenser Water Isolation valves can modulate.
   b. Chiller Failure is defined as a chiller alarm being received from the chiller panel.
   c. Chiller status will be monitored through the Chiller control panel integration.

C. Chilled Water Pump Control

1. Five (5) pumps are available to operate, a maximum of 4 are allowed to run at any one time. System is sized for N+1.

2. When any chilled water is required, one pump will be started and ramp up to maintain the setpoint defined below. When the system is shut down, the pump(s) will continue to pumpdown for 5 min (adj) to allow the equipment to coast and cool down.
   a. Chilled Water Pump Control Setpoint: Maintain bypass flow rate setpoint in the decoupler (measured by FE213) at -1% of system flow (measured by FE026).

3. If the pump status does not match the command, an alarm will be generated and the pump will be locked out and the next pump will be started.

4. The lowest runtime pump will be the lead pump on startup or staging. Pump rotation is also available for the operators to command or schedule.

5. If the pump speed is over 95% for 10 minutes (regardless of number of chiller operating), an additional pump will be brought on to meet the demand efficiencty. All pumps will modulate at the same speed.

6. If the pump speed is below the stagedown setpoint (see table below) for 10 minutes, a pump will be taken offline.
   a. Note: Pumpdown timers (initially 5 minutes) also apply to this pump, therefore pump will not shutoff until 15 minutes after speed is below setpoint.
   b. Table: (Exact numbers TBD)
      1) 4 pumps down to 3 = ~31%
      2) 3 pumps down to 2 = ~31%
      3) 2 pumps down to 1 = ~45%

D. System Condenser Water Pump Control (Vertical Turbine Sump CW Pumps):

1. One pump will be required for every two towers that are enabled from a call for cooling. Pumps P-23 or P-24 will always be the lead pump due to their VFDs. Subsequently higher runtime pumps will be lag or standby pumps. If the pump status does not match the command, an alarm will be generated, the pump locked out until manually reset, and the next pump will be started.

2. TCV-255 and TCV-256 are commanded closed, confirm status.

3. Pumps will be ramped and/or staged to maintain 43 PSI in the first condenser water header.
   a. Two pressure sensors will be located in the header for pump VFD control (east and west). When the header is not separated (TCV-257 open), the two pressure sensors will be averaged together for pump control.
   b. TCV-255 is available for emergency relief if header pressure exceeds 45 PSIG.

4. All slide gates will be open in normal operation (both sumps available).

5. Note: Pump P22 has a higher inlet and should only be ran if the water level in the west sump is above 7’-5”.

E. Chiller Specific Condenser Water Pump Control (Horizontal CW Pumps):

1. When called for (see chiller control above) and after header pressure setpoint has become satisfied (see VT pump sequence), the pump associated with an individual chiller will be started. If the pump status does not match the command, an alarm will be generated and the chiller will be stopped and locked out of service until manually reset. The next chiller will be commanded to run. After the chiller is commanded off, the pump will continue to run for a short time to dissipate the heat.

2. Pump P-24 VFD speed will be modulated to maintain a 10 deg F differential between inlet and out condenser water temperatures for Chiller C-4A.

3. Pump P-31 will be started when called upon for Chiller C-1 startup (constant speed).

F. Exceptions:

1. East Side Isolation:
   a. P-21, P-22 and P-23 will not be available.

2. West Side Isolation:
   a. P-24 and P-25 will not be available.
   b. Chillers C-4A and C-4B are only available if TCV-257 is open.

3.06 CHILLER PLANT – ADDITIONAL MECHANICAL COOLING MODES

A. Several additional mechanical cooling modes, which are not detailed here are possible

including, but not limited to, the following:

1. M4 = 2 Trane Chillers + 1 York Chiller
2. M5 = 1 Trane Chiller + 2 York Chillers
3. M6 = 2 Trane Chillers + 2 York Chillers

B. Modes M1 through M3 above describe fundamental plant sequencing and operation. Additional modes shall be coordinated with sequences of operation detailed in Johnson Controls' Central Utility Plant Controls Upgrade Project.

C. Chillers shall be staged according to the following table:

Mode Transition Points - System Load (tons)

CHW System dT (°F)	M1 > M2	M2 > M3	M3 > M4	M4 > M5	M5 > M6	M6 > M5	M5 > M4	M4 > M3	M3 > M2	M2 > M1
8	2000	2650							2550	1900
9	2000	3000							2900	1900
10	2000	3300	5000					4900	3200	1900
11	2000	3600	5000	6400			6300	4900	3500	1900
12	2000	3900	5000	6900	8000	7900	6800	4900	3800	1900
13	2200	4200	5400	7500	8600	8500	7400	5300	4100	2100
14	2200	4600	6000	8100	9200	9100	8000	5900	4500	2100
15	2200	4900	6500	8600	10000	9900	8500	6400	4800	2100
16	2200	5000	6500	9000			8900	6400	4900	2100

3.07 CHILLER PLANT – PLATE AND FRAME HEAT EXCHANGER MODE PF1

A. NO CHANGE FROM PREVIOUS JCI SEQUENCE.

3.08 CHILLER PLANT – TRANSITION FROM MECHANICAL COOLING TO PLATE AND FRAME HEAT EXCHANGER MODE T1

A. Mode T1:

1. Transition: M1 to T1
2. Available Chillers: Chillers C-4A OR C-4B
3. Available Heat Exchangers: EX-1, EX-2, EX-3
4. Examples for Sequence Below: C-4A AND EX-3

B. General:

1. If east or west sump separation was enabled while in the previous mode (Free Cooling Mode), then the system will not attempt to switch to this transition mode, as both sumps must be available.
2. During this mode the sump shall be fully separated into two compartments. The west sump will be the "cold" sump (initially 71 degF, setpoint 37 degF) and be dedicated to free cooling; while the east sump is dedicated to normal mechanical cooling operation.
3. The West sump shall operate with Heat Exchangers EX-1, EX-2 and EX-3 and Cooling Towers CT-2, CT-3, and CT-4. CT-5 will be unavailable during this transition. The East sump shall operate with the chiller and cooling towers CT-6, CT-7, CT-8, and

CT-9.

C. Sequence:

1. Two of the 4 towers (CT-6 thru 9) are to be made available per chiller.
2. Once these are confirmed (with end switches or a timed delay), the towers 2-5 will be commanded off.
3. The condenser water vertical turbine pumps (one or two in operation) should be switched over to P24 & 25. Pump P24 shall be the lead pump due to its VFD.
   a. Once P24 and/or P25 are confirmed running, the pumps 21 thru 23 should be shut off.
   b. Two pressure sensors will be located in the header for pump VFD control (east and west). When the sump is not separated, the two pressure sensors will be averaged together for pump control.
   c. P24's VFD shall ramp to maintain 43 PSI in the header as read by the east header pressure sensor.
4. Once cooling towers 2-5 are confirmed off and vertical turbine pumps confirmed running, the slide gates 1, 2 and 5 are commanded closed. Slide gates 3 and 4 are commanded open.
5. TCV-257, TCV-258, TCV-221, TCV-222, TCV-223 and TCV-251 are commanded closed.
6. Once control valves are proven closed, this has isolated the chiller operation through the east towers, and sump without interruption. The chiller shall continue to modulate its compressor VFD speed to maintain leaving CHW setpoint. The next step is to get the heat exchanger working.
7. Once TCV-251 is proven closed, towers 2-4 are commanded available. (CT-5 remains unavailable). Two of these towers are commanded open, based upon lowest run time, through their bypass valves (TCV-252, 253, 254).
8. TCV-242, TCV-243 and TCV-244 are commanded closed.
9. TCV-233 is commanded open.
10. Once a flow path is available (valves confirmed opened and closed respectively), vertical turbine pumps serving west sump will become available.
11. Vertical turbine pumps P21, P22 and P23 will be available. Pump P21 shall be the lead pump, P22 shall be the standby pump. P23 will be available only if P21 and P22 fail to start.
    a. The full capacity of one of the vertical turbine pumps is required for proper lift from the sump, thru the heat exchangers and to the tower nozzles. P21 and P22 shall be lead pumps since P23's VFD will impose electrical losses from the VFD at full load.
12. Condenser water (West sump) shall be pumped over the towers to achieve 37 deg F sump temperature setpoint. This continues to happen (without heat transfer across EX-3) until the actual sump temperature reaches discharge CHW setpoint minus 4 degrees F. At that point, the following happens.
13. TCV-133 is commanded open.
14. Chillers are commanded off, and their pumpdown sequence is started.
15. At the conclusion of chiller pumpdown, the chillers isolation valves (TCV-114A and TCV-114B) are commanded closed.
16. CT-6 ,7,8,9 are now available for cooling capacity after switching into Free Cooling Mode (PF-1)

17. TCV-251 is commanded open.
18. TCV-241 – 249 will be opened depending on which tower is being called for.
19. Once tower isolation valves are proven open, TCV-252, 253, 254 will be commanded closed.
20. TCV 257 is commanded open. .
21. Vertical turbine pumps P24 and P25 are now available for standby operation.
22. Mode is switched to Plate and Frame Heat Exchanger Mode PF1.

D. Chilled Water Pump Control:

1. Pump operation should continue as other modes and control VFDs via decoupler sequence.

E. Chiller Specific Condenser Water Pump Control (Horizontal CW Pumps):

1. Operate as needed per previous mechanical cooling mode.

F. System Condenser Water Pump Control (Vertical Turbine Sump CW Pumps):

1. The VFD-driven pumps (P23 and P24) will be the leads. Subsequently higher runtimes will be lag or standby pumps. If the pump status does not match the command, an alarm will be generated, the pump locked out until manually reset, and the next pump will be started.
2. Note: Pump P22 has a higher inlet and should only be ran if the water level in the west sump is above 7'-5".

3.09 CHILLER PLANT – TRANSITION FROM PLATE AND FRAME HEAT EXCHANGER TO MECHANICAL COOLING MODE T2

A. Mode T2:

1. Transition: PF1 to M1
2. Available Chillers: Chillers C-4A OR C-4B
3. Available Heat Exchangers: EX-1, EX-2, EX-3
4. Examples for Sequence Below: C-4A AND EX-3

B. General:

1. If east or west sump separation was enabled while in the previous mode (Free Cooling Mode), then the system will not attempt to switch to this transition mode, as both sumps must be available.
2. During this mode the sump shall be fully separated into two compartments. The west sump will be the "cold" sump (initially 37 degrees F, setpoint 71 degrees F) and be dedicated to free cooling; while the east sump is dedicated to normal mechanical cooling operation.
3. The West sump shall operate with Heat Exchangers EX-1, EX-2 and EX-3 and Cooling Towers CT-2, CT-3, and CT-4. CT-5 will be unavailable during this transition. The East sump shall operate with the Chillers and Cooling Towers CT-6, CT-7, CT-8, and CT-9.
4. Maximum of 1 chiller operating in transition mode.

C. Sequence:

1. TCV-221, TCV-222, TCV-223 and TCV-258 are commanded closed (if not already), confirm status.
2. Vertical turbine pumps P21, P22 and P23 will be available. Pump P21 shall be the lead pump, P22 shall be the standby pump. P23 will be available only if P21 and P22 fail to start.
    a. The full capacity of one of the vertical turbine pumps is required for proper lift from the sump, thru the heat exchangers and to the tower nozzles. P21 and P22 shall be lead pumps since P23's VFD will impose electrical losses from the VFD at full load.
3. Slide gates1, & 2 are commanded closed, confirm status.
4. Slide gates 3 & 4 are commanded open, confirm status.
5. Command TCV-257 closed, confirm status.
6. Command TCV-214A and TCV-204A open, confirm status.
    a. Note: Only Chiller C-4A will be commanded to flow water at this point, no matter the load.
7. Enable vertical turbine pump P-24 and control via east header pressure sensor to maintain 43 PSI setpoint. Confirm status.
8. Enable horizontal split case pump P-24 and initially set flow at 7500 GPM via flow meter.
9. Command TCV-114A and TCV-104A open, confirm status.
10. CHW Pumps should already be enabled (see separate sequence).
11. Command slide gate 5 closed, confirm status.
12. Command TCV-252 thru 254 open, confirm status.
13. Command TCV-251 closed, confirm status.
14. Command TCV-242 thru 244 closed, confirm status.
15. Check east sump water temperature:
    a. If less than 60: See Warm Up Sequence below.
    b. If greater than 60, enable at least two cooling tower (CT-6 thru 9)
16. Open and confirm corresponding cooling tower control valves TCV 246 thru 249 and maintain east sump temperature of 65 deg F.
17. Command TCV-259 closed, confirm status.
18. EX-3 shall continue to operate until changeover to Chiller C-4A.
19. Enable Chiller C-4A (if not already enabled from Warm Up Sequence).
20. Once Mechanical Cooling is enabled and the Sump Warm Up Sequence is complete, the heat exchanger side of operation can be disabled. All towers will become available for cooling.
    a. Vertical turbine pumps P21 thru 23 are commanded off and pumped down.
    b. Command TCV-133, 233, 252, 253 and 254 closed, confirm status.
    c. TCV-257 is commanded open.
21. The system is released into mechanical cooling mode M1.

D. East Sump Warm Up Sequence:

1. Command TCV-259 open, confirm status
2. Command TCV-201 thru 203, TCV-242 thru 249 closed, confirm status.

3. Enable Chiller C-4A.
    a. The chiller will recycle water to bring entering CW up to 60 degrees. During this period, most CW flow from the vertical turbine pump P-24 will be discharged through the 24" TCV-259 relief valve.
    b. TCV-104A is available for modulating chilled water flow between C-4A and EX-3.
    c. Note: C-4A and C-4B allowable evaporator flows (EACH):
        a) High: 6000 GPM
        b) Design: 3750 GPM
        c) Low: 1560 GPM
4. Towers 5-9 remain unavailable, and water continues to bypass directly back to the east sump.
5. Upon sump temperature of 65, warm up sequence is completed.

E. Chilled Water Pump Control:

1. Pump operation should continue as other modes and control VFDs via decoupler sequence.

PART 4 -MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15985

SECTION 15990

TESTING, ADJUSTING, AND BALANCING

PART 1 -GENERAL

1.01 GENERAL

A. This section of the Specifications covers testing and balancing of environmental systems, including, but not limited to distribution systems and the connected equipment and apparatus. The testing and balancing of all environmental systems shall be the responsibility of a single Testing, Balancing, and Adjusting (TBA) firm.

B. Related Work Specified Elsewhere: General Requirements of Division One and Section 15010 "Basic Mechanical Requirements," pertain to and are hereby made part of the Work of this section of the Specifications.

1.02 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems (supply, exhaust and ventilation).

B. Testing, adjustment, and balancing of hydronic and refrigerating systems.

C. Sound measurement of equipment under operating conditions.

D. Vibration measurement of equipment under operating conditions.

E. Vibration measuring.

F. Verifying that automatic control devices are functioning properly.

G. Reporting results of activities and procedures specified in this Section.

1.03 RELATED SECTIONS

A. Section 01650 - Starting of Systems.

B. Section 15010 - Basic Mechanical Requirements.

1.04 ALLOWANCES

A. Cash Allowance: Include under provisions of Division 1.

B. Allowance includes testing, adjusting, and balancing of mechanical systems. Work is included in this section and is part of the Contract Sum/Price.

1.05 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. AABC: Associated Air Balance Council.

C. Balance: To proportion flows within the distribution system, including submains, branches,

and terminals, according to indicated quantities.

D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

F. NC: Noise criteria.

G. NEBB: National Environmental Balancing Bureau.

H. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

I. RC: Room criteria.

J. Report Forms: Test data sheets for recording test data in logical order.

K. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.

L. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

M. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.

N. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

O. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

P. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

Q. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

R. TAB: Testing, adjusting, and balancing.

S. TABB: Testing, Adjusting, and Balancing Bureau.

T. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

U. Test: A procedure to determine quantitative performance of systems or equipment.

V. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.06 REFERENCES

A. Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in this section and with the following references as applicable. Refer to Section 15010 for listing of issuing organizations or agencies.

B. Applicable Standards:

1. Associated Air Balance Council (AABC):
   a. National Standards for Total System Balance.
2. Air Diffusion Council (ADC):
   a. Test Code for Grilles, Registers, and Diffusers.
3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
   a. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
4. International Building Code (IBC) with the Denver Amendments
5. International Fire Code (IFC) with the Denver Amendments
6. National Environmental Balancing Bureau (NEBB):
   a. Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
7. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA):
   a. HVAC Systems Testing, Adjusting, and Balancing.

1.07 SUBMITTALS

A. Submit name of adjusting and balancing agency for approval within 30 days after award of Contract to ensure that the TAB firm has met the requirements this section of the Specifications and is on the project from the outset of construction.

B. All TAB submittals shall be electronically submitted in PDF format to the DIA Project Manager and directly to the DIA Mechanical Engineer [Lee Walinchus, lee.walinchus@diadenever.net].

C. Field Reports: Submit under provisions of Section 15010.

D. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

E. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.

F. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for DIA Project Manager and for inclusion in operating and maintenance manuals.

G. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.

H. Test Reports: Indicate data on AABC National Standards for Total System Balance forms, or forms prepared following ASHRAE 111, NEBB or TABB forms. When necessary, supplement with forms containing information indicated in Schedules.

I. Final Report: At least fifteen (15) days prior to Contractor's request for final inspection, submit in letter size, a single PDF file of the final test report on applicable reporting forms for

review. Each individual final reporting form must bear the signature of the person who recorded data and that of the reporting organization. Identify instruments of all types which were used and last date of calibration of each. Report shall include all items listed in PART 3- Execution.

1. A statement outlining all abnormal or notable conditions not covered in above data.
2. Proposed resolutions to equipment that is performing outside of the specified performance ranges.

J. "As Built" Plans shall be 24x36 and provided in the same electronic format and manner as described above.

1.08 PROJECT RECORD DOCUMENTS

A. Record actual locations of balancing valves and rough setting.

1.09 QUALITY ASSURANCE

A. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance, or ASHRAE 111, or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.10 QUALIFICATIONS

A. TAB Contractor Qualifications: Engage a TAB entity with minimum of three years documented experience and certified by AABC or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or TABB or registered Colorado Professional Engineer experienced in performance of this Work.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or TABB as a TAB technician.

1.11 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Notify the DIA Project Manager, DIA Mechanical Inspector and DIA Mechanical Engineer in writing a minimum of 72 hours prior to testing of any equipment and/or systems. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.12 PRE-BALANCING CONFERENCE

A. Convene a conference one week prior to commencing work of this section.

B. Attendance shall include representatives of all systems and equipment Installers having performed, or in the process of performing, project work subject to testing, balancing, and adjustment by the TAB firm.

C. Conference agenda shall include review of status of installation and completion of each system requiring testing balancing and adjusting, for the purpose of confirming that the schedule of work to be performed will be planned so as to ensure readiness of systems.

1.13 SEQUENCING AND SCHEDULING

A. Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

B. Schedule and provide assistance in final adjustment and test of ife safety system with Fire Authority.

1.14 WARRANTY

A. Warranty of all equipment described in this Section shall meet warranty requirements of Section 15010 - Basic Mechanical Requirements.

B. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Duration of Guarantee shall be 120 days. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS - NOT USED.

PART 3 - EXECUTION

3.01 AGENCIES

A. Subject to conformance with specified requirements, the following agencies are acceptable:

1. Able Balance Corp.
2. Griffith Engineering Service.
3. Jedi Balancing, Inc.
4. JPG Engineering, Inc.
5. TAB Services, Inc.
6. Substitutions: Under provisions of Section 15010.

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.

4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire, smoke and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Return air paths are not obstructed (i.e. walls to structure).
13. Hydronic systems are flushed, filled, and vented.
14. Pumps are rotating correctly.
15. Proper strainer baskets are clean and in place.
16. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies noted during performance of services, which prevent system balance.

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to DIA Project Manager to facilitate spot checks during testing.

B. Provide additional balancing devices as required.

3.04 INSTALLATION TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: minus 5 to plus 10%.
2. Air Outlets and Inlets: 0 to plus 10%.
3. Heating-Water Flow Rate: 0 to plus 10%.
4. Cooling-Water Flow Rate: 0 to plus 5%.

B. Supply, return and exhaust air flow rate tolerances shall be identical for each system. (IE: If an AHU is balanced to 97% of design air flow rate, the corresponding exhaust fan should match this 97% tolerance.)

3.05 ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 TEMPERATURE CONTROLS

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

L. VAV Boxes (Fan Powered and Shut off): Verify the following and report any discrepancies to the responsible installer:

1. Velocity pressure sensor is receiving the proper signal and is then sending that signal to the regulator.
2. Primary air damper will allow design flows without going to end point settings.
3. Thermostats are calibrated.
4. Control pressure is compatible with the primary damper motor range, dead band range and heating electric P.E. or valve motor range.
5. Direct acting or reverse acting controls are properly installed.
6. Primary fan static pressure controls are receiving the proper signal in their installed location and transmitting this signal to the fan controller.

M. Include a written certificate (include in balance report) that the above items are functioning properly.

3.07 GENERAL PROCEDURES FOR TESTING AND BALANCING:

A. Perform testing and balancing procedures on each system according to the procedures

contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems“ and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.08 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

K. Check for proper sealing of air duct system.

3.09 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:
    a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

5. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

C. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.10 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5%.

B. Prepare schematic diagrams of systems' "as-constructed" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.

2. Check expansion tank liquid level.

3. Check makeup-water-station pressure gage for adequate pressure for highest vent.

4. Check flow-control valves for specified sequence of operation and set at indicated flow.

5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several

terminal valves are kept open.

6. Set system controls so automatic valves are wide open to heat exchangers.

7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.11 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 5% of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5% greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.

2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.

3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.12 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.13 PROCEDURES FOR TEMPERATURE CONTROL VALVES TCV-104A AND 104B (NEW CHILLER TCVs)

A. Coordinate testing and reporting with Building Automation System (BAS) Contractor.

B. Test and determine all temperature control valve setpoints in order to automatically isolate and balance the flow through each chiller when an existing York OM Chiller (C-1, C-2, C-3) and new chiller(s) (C-4A, C-4B) are operating together. Exact set points shall be provided by TAB contractor and approved by Engineer, BAS Contractor and Owner. Control sequence will involve operating modulating chiller isolation valves (TCV-104A, TCV-104B) at a static position (adjustable at BAS) based on which chillers are operating in order to balance flow for all possible combinations of chiller operation. Furnish completed chart to Owner and BAS Contractor. (Determine XX% valve positions for each chiller combination).

Testing Stage	Chillers in Operation	TCV-101 (or 102 or 103) Position	TCV-104A Position	TCV-104B Position
0	None	0%	0%	0%
1	C-4A	0%	100%	0%
2	C-4B	0%	0%	100%
3	C-4A and C-4B	0%	XX%	XX%
4	C-1 (or C-2 or C-3) and C-4A	100%	XX%	0%
5	C-1 (or C-2 or C-3) and C-4B	100%	0%	XX%
6	C-1 (or C-2 or C-3) and C-4A and C-4B	100%	XX%	XX%

C. Provide a NEBB certified report to the Owner. The test and balance report shall provide field verification of the accuracy of the control algorithm set points described within this scope of work for chiller evaporator isolation valve set points for C-4A and C-4B.

3.14 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.15 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller

installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. If water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatt.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatt.
6. Capacity: Calculate in tons of cooling.
7. If air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.16 PROCEDURES FOR VIBRATION MEASUREMENTS

A. Use a vibration meter meeting the following criteria:
   1. Solid-state circuitry with a piezoelectric accelerometer.
   2. Velocity range of 0.1 to 10 inches per second.
   3. Displacement range of 1 to 100 mils.
   4. Frequency range of at least 0 to 1000 Hz.
   5. Capable of filtering unwanted frequencies.

B. Calibrate the vibration meter before each day of testing.
   1. Use a calibrator provided with the vibration meter.
   2. Follow vibration meter and calibrator manufacturer's calibration procedures.

C. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not influence measurements of equipment being tested.
   1. Turn off equipment in the building that might interfere with testing.
   2. Clear the space of people.

D. Perform vibration measurements after air and water balancing and equipment testing is complete.

E. Clean equipment surfaces in contact with the vibration transducer.

F. Position the vibration transducer according to manufacturer's written instructions and to avoid interference with the operation of the equipment being tested.

G. Measure and record vibration on rotating equipment over 3 hp.

H. Measure and record equipment vibration, bearing vibration, equipment base vibration, and building structure vibration. Record velocity and displacement readings in the horizontal, vertical, and axial planes.
   1. Pumps:
      a. Pump Bearing: Drive end and opposite end.

b. Motor Bearing: Drive end and opposite end.
c. Pump Base: Top and side.
d. Building: Floor.
e. Piping: To and from the pump after flexible connections.

2. Fans and HVAC Equipment with Fans:
a. Fan Bearing: Drive end and opposite end.
b. Motor Bearing: Drive end and opposite end.
c. Equipment Casing: Top and side.
d. Equipment Base: Top and side.
e. Building: Floor.
f. Ductwork: To and from equipment after flexible connections.
g. Piping: To and from equipment after flexible connections.

3. Chillers and HVAC Equipment with Compressors:
a. Compressor Bearing: Drive end and opposite end.
b. Motor Bearing: Drive end and opposite end.
c. Equipment Casing: Top and side.
d. Equipment Base: Top and side.
e. Building: Floor.
f. Piping: To and from equipment after flexible connections.

I. For equipment with vibration isolation, take floor measurements with the vibration isolation blocked solid to the floor and with the vibration isolation floating. Calculate and report the differences.

J. Inspect, measure, and record vibration isolation.

1. Verify that vibration isolation is installed in the required locations.
2. Verify that installation is level and plumb.
3. Verify that isolators are properly anchored.
4. For spring isolators, measure the compressed spring height, the spring OD, and the travel-to-solid distance.
5. Measure the operating clearance between each inertia base and the floor or concrete base below. Verify that there is unobstructed clearance between the bottom of the inertia base and the floor.

3.17 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:

1. HVAC Pumps
2. Centrifugal Water Chillers
3. Fan Coil Units

3.18 MOTOR STARTERS AND THERMAL HEATERS

A. Coordinate the requirement for the exchange of thermal overloads as required for proper motor protection on magnetic and manual starters. Check for correct sizing and notify Installers responsible for supply of proper devices of corrections or replacements needed.

3.19 REPORT OF WORK

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect and Engineer's name and address.
6. Contractor's name and address.
7. Report date.
8. Signature of TAB firm who certifies the report.
9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
10. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Final performance percentage of design performance.
    c. Equipment system or zone service
    d. Notable characteristics of systems.
    e. Description of system operation sequence if it varies from the Contract Documents.
11. Nomenclature sheets for each item of equipment.
12. A set of contract document drawings indicating 'as-built' conditions shall be included in the report with all terminals (VAV boxes, outlets, inlets, coils, unit heaters, etc.) and thermostat locations clearly marked and all equipment designated. Locations of all tests shall be clearly indicated.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values and proposed resolutions for equipment measured outside of the acceptable specified ranges.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outside-, return-, and exhaust-air dampers.

b. Conditions of filters.
c. Cooling coil, wet- and dry-bulb conditions.
d. Face and bypass damper settings at coils.
e. Fan drive settings including settings and percentage of maximum pitch diameter.
f. Inlet vane settings for variable-air-volume systems.
g. Settings for supply-air, static-pressure controller.
h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations, locations, size, velocity and flow.
7. Position of balancing devices.

F. Equipment measurements shall include the following information.

1. Instrument list including instrument, manufacturer, model, serial number, range, calibration date.
2. Data to be submitted for systems having electric motor drives, except as otherwise indicated, shall in all cases include the following to the extent applicable:
   a. Electric Motor data including manufacturer, HP, Voltage, phase, amperage (name plate, actual (in all operating modes), no load), service factor, efficiency, power factor, starter size (brand, model, enclosure type, installed thermal heaters and the rating of the heaters, required thermal heaters and the rating of the heaters if different than installed).
   b. For motors controlled by variable frequency controllers, test data shall include amperage at one-third, two-thirds, and full speed motor RPM.
   c. V-Belt Drive data including identification/location, required driven RPM; driven sheave (diameter and RPM), belt (size and quality), motor sheave (diameter and RPM), center to center distance (maximum, minimum and final).
3. Air Moving Equipment data including location, manufacturer, model, supply air flow (specified and actual), return air flow (specified and actual), outside air flow (specified and actual), total static pressure (specified and actual), inlet pressure, discharge pressure, fan RPM, motor and V-belt drive data. Include Manufacturer's fan curves.
4. Air Terminal Device data including air terminal number, room number/location, terminal type, terminal size, area factor, design velocity, design air flow, test (final) velocity, test (final) air flow, percent of design air flow.
5. Terminal Unit data including manufacturer, type (constant, variable, dual duct, reheat, fan powered parallel, fan powered-series), identification/number, location, model, size, minimum static pressure, minimum air flow (specified and actual), maximum air flow (specified and actual), inlet static pressure, fan air quantity (specified and actual) on fan powered terminal units. Include discharge air temperature for maximum cooling air flow, and for maximum heating air flow for units equipped with heating coils.

6. Duct Traverse data including system zone/branch, duct size, area, design velocity, design air flow, test velocity, test air flow, duct static pressure, air temperature, air correction factor.

7. Total CFM (required and final) for each fan system, including cabinet heaters, fan coils, etc.

8. Pump data including identification/number, manufacturer, size/model, impeller, service, flow rate (specified and actual), pressure drop (specified and actual), discharge pressure, suction pressure, total operating head pressure, shut-off (discharge and suction pressures), shut-off (total head pressure), and motor data. Include manufacturer's pump curves.

9. Chiller data including identification/number, manufacturer, capacity, model, evaporator leaving water temperature (specified and actual), evaporator pressure drop (specified and actual), evaporator water flow rate (specified and actual), condenser entering water temperature (specified and actual), condenser leaving water temperature (specified and actual), condenser pressure drop (specified and actual), condenser water flow rate (specified and actual), motor amperage.

10. Flow Measuring Station and Calibrated Balancing Valve data including identification, location, size, manufacturer, model, flow rate (specified and actual), pressure drop (specified and actual), station or valve calibrated setting.

11. Sound Measurement: Record sound measurements on octave band and dBA test forms and on an NC or RC chart indicating the decibel level measured in each frequency band for both "background" and "HVAC system operating" readings. Record each tested location on a separate NC or RC chart. Record the following on the forms:
    a. Date and time of test. Record each tested location on its own NC curve.
    b. Sound meter manufacturer, model number, and serial number.
    c. Space location within the building including floor level and room number.
    d. Diagram or color photograph of the space showing the measurement location.
    e. Time weighting of measurements, either fast or slow.
    f. Description of the measured sound: steady, transient, or tonal.
    g. Description of predominant sound source.
    h. Record measured octave bands with all area HVAC equipment off and all area HVAC equipment on.
    i. Sound data curves for measured equipment and/or spaces with baseline [NC-35] [NC-40] [NC-45] curves for compliance.

12. Vibration Test: Where vibration limitations are specified or shown on the drawings, work shall include measurement and reporting of as-installed systems performance, including the following data:
    a. Location of points:
        1) Fan bearing, drive end
        2) Fan bearing, opposite end
        3) Motor bearing, center (if applicable)
        4) Motor bearing, drive end
        5) Motor bearing, opposite end
        6) Casing (bottom or top)
        7) Casing (side)
        8) Duct after flexible connection (discharge)
        9) Duct after flexible connection (suction)
    b. Test readings:
        1) Horizontal, velocity and displacement
        2) Vertical, velocity and displacement
        3) Axial, velocity and displacement

c. Normally acceptable readings, velocity and acceleration

d. Unusual conditions at time of test

e. Vibration source (if non-complying)

13. Instrument Calibration Reports:

a. Report Data:

1) Instrument type and make.
2) Serial number.
3) Application.
4) Dates of use.
5) Dates of calibration.

14. Measurements outside of tolerance: If the final measurements differ from the design measurements in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED." TAB firm shall provide recommendations and/or solutions for resolving all FAILED measurements.

3.20 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.

2. Randomly check the following for each system:

a. Measure airflow of at least 100% of air outlets.

b. Measure water flow of at least 5% of terminals.

c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.

d. Measure sound levels at two locations.

e. Verify that balancing devices are marked with final balance position.

f. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by DIA Project Manager, DIA Mechanical Engineer or their designated representative(s).

2. TAB firm test and balance engineer shall conduct the inspection in the presence of DIA Project Manager, DIA Mechanical Engineer or their designated representative(s).

3. DIA Project Manager, DIA Mechanical Engineer or their designated representative(s) shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10% of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10% of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final

report.

7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.21 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15990

SECTION 15995

MECHANICAL SYSTEM COMMISSIONING

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. The requirements of the General Conditions, Supplemental Conditions and Section 15010 apply to all work specified in this section.

B. Refer to Specification Section 15990 for interface requirements with test and balance contractor.

C. Section 15010 - Basic Mechanical Requirements.

1.02 DESCRIPTION OF WORK

A. This specification covers the start-up, operating performance test and commissioning of Division 15 systems. The purpose of this effort is to bring the project mechanical systems to a state of dynamic operation in accordance with the contract documents by verifying the operation of individual components, subsystems and systems.

B. The Owner will retain the services of an independent commissioning agent (CA) separate from the work of this Contract. As herein specified the DIA Project Manager and CA shall develop detailed commissioning procedures, equipment checkout procedures and data forms for recording compliance with contract documents, performance and punch list deficiencies, and will assist in developing schedules for checkout and Owner acceptance, at a future date during the construction phase.

C. The Division 15 Mechanical Contractor and the General Contractor shall include as part of the work of this contract, labor and material to provide manpower, equipment, tools, ladders, instruments, etc. necessary to accomplish the work and labor and material for execution, monitoring and printing data forms necessary to verify and record system observations.

D. The Test and Balance Contractors shall include as part of the work of this contract, labor and material to provide manpower, equipment, tools, ladders, instruments, etc. necessary to execute and accomplish the work.

E. At the completion of the start-up, operations performance test and test and balance, the Contractor shall conduct a 72 hour dynamic mode demonstration of the systems in the presence of the DIA Project Manager and CA.

1.03 COMMISSIONED EQUIPMENT

A. Air Conditioning Units.

1.04 COMMISSIONED SYSTEMS

A. Building Automation System.

PART 2 - PRODUCTS

2.01 MATERIALS, LABOR, INSTRUMENTS, TOOLS, LADDERS AND APPARATUS

A. The Contractor shall provide all materials, labor, instruments, tools, ladders and apparatus necessary to start-up, perform operating performance test and systems conditioning.

B. The Contractor shall be responsible for maintaining the commissioning documentation until final acceptance of the project. The checklists in appendix one are samples for bidding purposes. Final checklists will be produced by the CA and provided prior to beginning commissioning. The commissioning documentation shall be kept current by the Contractor and shall be available for inspection at all times. At the time of acceptance of the project, the Contractor shall surrender 3 completed copies of the commissioning documentation to the DIA Project Manager.

PART 3 - EXECUTION

3.01 START-UP AND OPERATING PERFORMANCE TEST

A. Before request for contract compliance inspection and system commissioning all equipment, components, and systems shall be started-up, adjusted, calibrated; set, test and check all electric disconnect, fuses, circuit breakers, valves, dampers, temperatures and pressures of all systems for proper operation and performance. After completion of the start-up and operating performance test, the Contractor will notify the Owner in writing that the system is ready for commissioning.

B. Information, date, etc. from start-up and operating performance test may be utilized, as appropriate, to execute preliminary commissioning documentation, however, certification of equipment and systems for the preliminary commissioning phase shall be completed in accordance with the following Article of this section of the specifications.

C. Start-up and operating performance test documentation shall include the following:

1. Air Conditioning Unit Systems:
    a. Coil entering and leaving air temperature.
    b. Space temperatures at thermostats or sensors.
    c. Total fan air CFM.
    d. Selected air flow readings at major branch ducts and grilles.
    e. Fan speed.
    f. Fan total static pressure.
    g. Unit automatic reset after failure due to fire alarm or power.
2. Electric Motors:
    a. Full load amperes and voltage.
    b. Starter heater size and rated amperage range for heater installed.
    c. Measure running current, after adjustment of system to deliver rated performance.
3. Controls:
    a. Operational setting of controllers and instruments.
    b. Positioning and function of valves and dampers.
    c. Interlock and operation of systems (HVAC and Fire).
    d. New points appear in history.
    e. Refresh and updating of unit and overall graphics.

3.02 SYSTEM COMMISSIONING

A. All systems, components, equipment, etc. furnished as part of this Contract shall be subjected to system commissioning as hereinafter specified. All systems, components, equipment, etc. commissioned In this section of the Specifications shall be evaluated based on the sequences of control/operation, performance characteristics, and equipment schedules, etc. as specified in other sections of the Specifications and as shown on the contract drawings. Systems, components, equipment, etc. that do not have specified operating sequence, etc. shall be operated and evaluated based on their use and function for this project.

B. Commissioning Documentation: The Contractor shall maintain the commissioning documentation in 3-ring binders. The commissioning documentation shall be organized by system when practicable. All pages shall be numbered and a table of contents page shall be provided. The commissioning documentation shall include, but not be limited to, the following:

1. Design Criteria provided by the A/E.
2. Approved Test and Balance Report for the system or component being commissioned, provided by Test and Balance Contractor.
3. Approved submittals for all equipment to be commissioned, provided by Mechanical Contractor.
4. All approved shop drawings of equipment to be commissioned. Shop drawings shall be full size sheets folded as required to fit in binders. Provided by Mechanical Contractor.
5. All pre-commissioning checklists initialized by indicated personnel organized by system and subsystem.
6. All functional performance test checklist initialized by indicated personnel organized by systems and subsystems.
7. Three copies of the Operation and Maintenance Manuals specified in other sections of these specifications shall be reviewed by the CA for completeness and for applicability. The manuals shall be incorporated in the Commissioning Documentation prior to the commencement of the training required in other sections of the specifications. Preparation of Operation and Maintenance Manuals shall be as specified in other sections of these specifications.

C. Shop Drawings and As-Built Drawings and Specifications shall be assembled by the Contractor after completion of the pre-commissioning phase and turned over to the DIA Project Manager. Changes as a result of subsequent Commissioning procedures will be incorporated (as required) at the conclusion of final Commissioning.

1. Contact Mark Hughes at Mark.Hughes@flydenver.com (Ph: 303.214.5620) to coordinate all BIM submittal requirements.

D. Commissioning Schedule:

1. Phase 1 - Preliminary Commissioning: All shop drawings, including but not limited to, equipment, controls, test and balance reports, and operation and maintenance manuals, shall be submitted and approved by the CA. In addition, all pre-commissioning checklists shall be completed (initialed by all parties).
2. Phase 2 - Functional Performance Testing shall be performed as indicated on the Functional Performance Test Checklists. Functional Performance Testing shall not begin until Phase 1 of the commissioning process is complete. Owner's operation and maintenance personnel shall observe the function performance testing. The Contractor may perform initial system familiarization and training of Owner's operating and maintenance personnel required under other sections of the Specification during the functional performance testing.

3. Functional Performance Test Notification: The Contractor shall notify the CA 2 weeks before functional performance testing is to begin.

4. Phase 3 - System training and operating instructions shall be conducted by the Contractor as indicated in the specifications of each item of equipment. The Contractor shall be responsible for specified training and operating instructions being observed by the CA

E. Pre-Commissioning Checklists:

1. Pre-Commissioning Checklists shall be developed by the CA and shall be executed and certified prior to the commencement of functional performance testing. The indicated initial is required in each location for all items, except where an "X" is shown indicating an initial is not required. See initials legend below for required initials. The pre-commissioning checklist will not be accepted as complete until all items have been initialed signifying this portion of the project is ready for Functional Performance Testing. The Contractor shall provide the CA with the completed Pre-Commissioning Checklists for his review and initials. The CA shall be the last person to initial each checklist item. The Contractor shall submit for approval a list of all contractor and subcontractor representatives responsible for the completion of the pre-commissioning checklist phase of the project. This list of representatives shall be submitted 2 weeks prior to commencement of any pre-commissioning activities of any systems or equipment. Representatives may be replaced only after written approval from the CA.

2. Initials Legend:
   a. Construction Manager.
   b. Mechanical Contractor's representative.
   c. Electrical Contractor' s representative.
   d. Commissioning Agent.
   e. Balancing Contractor's representative.
   f. Controls Contractor's representative.

3. Blank Example Pre-Commissioning Checklists are in Appendix, located at the end of this section of the specifications. A separate Pre-Commissioning checklist shall be provided for each system and piece of HVAC equipment to be Commissioned.

F. Functional Performance Test Checklist:

1. Functional performance testing shall be performed by the Contractor as directed by the CA and observed by an commissioning team consisting of the individuals indicated on the Functional Performance Test Checklists. The Contractor shall submit in writing a list of all contractor and subcontractor representatives responsible for the functional performance testing phase of the project. This list of representatives shall be submitted 2 weeks prior to the commencement of functional performance testing of systems and equipment. All representatives shall remain on the commissioning team throughout functional performance testing. Substitutions will not be permitted. Functional performance test checklists shall be completed in the presence of all commissioning team personnel at the time of the functional performance test.

2. Upon failure of completion of a functional performance test checklist, the Contractor shall provide a written report to the CA listing the deficiencies causing the failure and remedies to correct all deficiencies. After the Contractor has corrected all deficiencies, the entire functional performance test checklist for the item of equipment shall be repeated. If possible, corrections can be accomplished during the functional performance testing of equipment in other non-related systems. In any case, no system will be accepted until all equipment items in the system have complete functional performance test checklists thereby demonstrating satisfactory performance.

3. Failure to complete 2 functional performance test checklists constitutes failure of Phase 2 of the HVAC Commissioning process. The Contractor shall provide a written report to the CA listing the deficiencies causing all failures and remedies to correct all deficiencies. After correction of all deficiencies, Phase 2 of the HVAC Commissioning process shall be repeated in its entirety. The Contractor shall give the CA 2 weeks notice before repeat functional performance testing is scheduled. Should the first or one subsequent functional performance test fail, the Owner reserves the right to obtain compensation from the Contractor for fees and expenses incurred in conjunction with having to perform more than two (2) functional performance tests.

4. Blank examples functional performance test checklists are in the Appendix 2 located at the end of this section of the specifications. A separate Functional Performance Checklist shall be provided for each system and piece of equipment to be Commissioned.

3.03 DEMONSTRATION TEST

A. After completion of system start-up, operating performance test and commissioning, but before Owner acceptance, the Contractor shall conduct a 72 hour dynamic mode demonstration of the systems provided under this Contract. The intent of the 72 hour dynamic test is to verify that the mechanical and electrical equipment will respond as designed to meet the changes that may occur under varying indoor/outdoor conditions including seasonal variations and occupancy loads.

B. A detailed procedure and sequence of events shall be developed by the Contractor and submitted to the Owner and CA for review and approval. Procedures and sequence of events should contain as a minimum the following activities:

1. Hours 1-4: Bring all systems on line for standard operations and parameters.

2. Hours 5-28: Operate all systems under normal parameters and verify proper operation.

3. Hours 29-52: Validation of systems operation through indoor/outdoor changes to include heating, cooling, ventilation, humidity control, domestic and control systems.

4. Hours 69-72: Return of systems to normal operation.

C. Systems and their associated equipment which are to be included in the dynamic test are all systems and components furnished under this Contract and as a minimum will include, but are not limited to the following:

1. Air Handling Systems.

2. Chilled Water Systems.

3. Pumping Systems.

4. Building Management and Control Systems.

D. Contractor shall notify the Owner and CA in writing that the project is completed and ready for the demonstration test. Schedule for test will then be established and documented. Initiation of the 72 hours dynamic test will not occur until all systems are balanced, operational and incorporated into the building management and control system. Should the demonstration test fail for any reason, the problems shall be corrected and another demonstration test conducted. Should the first or one subsequent demonstration test fail, the Owner reserves the right to obtain compensation from the Contractor for fees and expenses incurred in conjunction with having to witness more than two (2) 72 hour demonstration tests.

E. The attendees of each 72 hour demonstration test shall include representative from the following organizations:

1. General Contractor.
2. Mechanical Contractor.
3. Electrical Contractor.
4. Test and Balance Contractor.
5. Building Management and Control System Contractor.
6. DIA Project Manager of Record.
7. Mechanical Engineer.
8. Electrical Engineer.
9. Commissioning Agent.

F. Minor problems are anticipated and the necessary personnel required to correct problems and adjust systems need to be available to insure continuation of the dynamic testing process. If major problems are encountered, at the discretion of the Owner and CA, the testing will be terminated and rescheduled.

G. The Contractor shall notify any external organizations, which would include but not be limited to Fire Department which are not directly involved in the testing, but might b e affected due to interface to insure that alarms do not occur.

H. During the demonstration test all systems shall operate in the "hands-off" automatic mode in accordance with the requirements of the Contract Documents. Changes in operating modes required to simulate load shifting, seasonal changeover, emergency modes, etc. will be accomplished by changing set points and equipment operating status at the BMS central control console as required to observe capacity control and monitoring. Provide a readout of space temperature at each thermostat building relative humidity, building pressurization, chilled water supply and return temperatures and chiller capacity.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15995

APPENDIX A
PRECOMMISSIONING CHECKLISTS

Pre-commissioning Team and Checklists

The Contractor shall designate team members to participate in the pre-commissioning checks specified herein. The team members shall be as follows.

Designation	Function
Q	Contractor's Representative
M	Contractor's Mechanical Representative
E	Contractor's Electrical Representative
O	Owner's Representative
C	Automatic Temperature Controls Representative

Each checklist shall be completed by the pre-commissioning team as applicable. Acceptance by each pre-commissioning team member of each pre-commissioning checklist item shall be indicated by initials and date; unless an "X" is shown indicating that participation by that individual is not required.

Pre-Commissioning Checklist – PIPING
For Chilled Water Piping System

Checklist Item	Q	M	E	O	C
Installation					
a. Piping Complete	___	___	X	___	X
b. As-built shop drawings submitted	___	___	X	___	X
c. Piping flushed and cleaned	___	___	X	___	X
d. Strainers cleaned	___	___	X	___	X
e. Valves installed as required	___	___	X	___	X
f. piping insulation required	___	___	X	___	X
g. thermometers and gauges installed as required	___	___	X	___	X
h. verify operation of valves	___	___	X	___	___
i. air vents installed as specified	___	___	X	___	X
j. flexible connectors installed as specified	___	___	X	___	X
k. verify that piping has been labeled and valves identified as specified	___	___	X	___	X
l. piping properly supported	___	___	X	___	X
m. final HVAC punch list items complete	___	___	X	___	X
Testing Adjusting and Balancing (TAB)					
a. hydrostatic test complete	___	___	X	___	X
b. TAB operation complete	___	___	X	___	___
c. TAB punch list items resolved	___	___	X	___	X

Pre-Commissioning Checklist – DUCTWORK
For Electrical Room Air Handler:

Checklist Item	**Q**	**M**	**E**	**O**	**C**
Installation					
a. Ductwork Complete	___	___	X	___	X
b. As-built shop drawings submitted	___	___	X	___	X
c. ductwork leak test complete	___	___	X	___	X
d. fire dampers, smoke dampers, and access doors installed as required	___	___	X	___	X
e. ductwork installed as required	___	___	X	___	X
f. thermometers and gauges installed as required	___	___	___	___	X
g. verify OPEN/CLOSED status of dampers	___	___	X	___	___
i. flexible connectors installed as specified	___	___	X	___	X
Testing Adjusting and Balancing (TAB)					
a. TAB operation complete	X	___	X	___	X

Pre-Commissioning Checklist – AIR HANDLING UNIT
For Electrical Room Air Handler:

Checklist Item	Q	M	E	O	C
Installation					
a. vibration isolation devices installed	___	X	___	___	X
b. inspection and access doors are operable and sealed	___	X	___	___	X
c. casing undamaged	___	X	___	___	X
d. insulation undamaged	___	X	___	___	X
e. condensate drainage is unobstructed (visually verify pan drains completely by pouring a cup of water into drain pan.)	___	X	___	___	X
f. fan belt adjusted	___	X	___	___	X
g. manufacturer's required maintenance clearance provided	___	X	___	___	X
Electrical					
a. power available to unit disconnect	___	___	X	___	X
b. power available to unit control panel	___	___	X	___	X
c. proper motor rotation verified	___	___	X	___	X
d. verify that power disconnect is located within the sight of the unit controls	___	___	X	___	X
e. phase failure protection provided	___	___	X	___	X
Coils					
a. hydronic piping properly connected	___	X	___	___	X
b. hydronic piping pressure tested	___	X	___	___	X
c. air vents, drains and shut-off valves installed on hydronic coils as specified.	___	X	___	___	X
d. any damage to coils has been repaired	___	X	___	___	X
Controls					
a. control valves/actuators properly installed	___	X	X	___	___
b. control valves/actuators operable	___	X	X	___	___
c. dampers/actuators properly installed	___	X	X	___	___
d. dampers/actuators operable	___	X	X	___	___
e. verify proper location, installation, and calibration of all temperature, pressure and airflow inputs	___	___	X	___	X
f. verify condensate drain pan leak detection is operable	___	___	X	___	___
g. air handler controls system operational. System graphics present and match systems and tags h. verify condensate drain pan leak detection is operable	___	___	X	X	X
Testing, Adjusting and Balancing (TAB					
a. construction filters removed and replaced	___	X	___	___	X
b. TAB report submitted	X	X	___	___	X
c. TAB results within specified tolerances	___	X	___	___	X

Pre-Commissioning Checklist – PUMPS
For PUMP: P-11, Chilled Water Pump

Checklist Item	Q	M	E	O	C
Installation					
a. piping system installed	___	___	X	___	X
b. piping system pressure tested	___	___	X	___	X
c. pump not leaking	___	___	X	___	X
d. field-assembled couplings aligned to meet manufacturer's prescribed tolerances	___	___	X	___	X
e. pressure gauges installed	___	___	X	___	X
Electrical					
a. power available to pump disconnect	___	X	___	___	X
a. pump rotation verified	___	___	___	___	X
c. control system interlocks functional	___	X	___	___	___
d. verify that power disconnect is located within the sight of the unit controls	___	X	___	___	X
Testing, Adjusting and Balancing (TAB					
a. pressure/temperature gauges installed	___	___	X	___	X
b. piping system cleaned	___	___	X	___	X
c. chemical water treatment complete	___	___	X	___	X
d. water balance complete	___	___	X	___	X
e. water balance within specified design tolerances	___	___	X	___	X
f. TAB report submitted	X	___	X	___	X

Pre-Commissioning Checklist – PUMPS
For PUMP: P-24, Condenser Water Pump

Checklist Item	Q	M	E	O	C
Installation					
a. piping system installed	___	___	X	___	X
b. piping system pressure tested	___	___	X	___	X
c. pump not leaking	___	___	X	___	X
d. field-assembled couplings aligned to meet manufacturer's prescribed tolerances	___	___	X	___	X
e. pressure gauges installed	___	___	X	___	X
Electrical					
a. power available to pump disconnect	___	X	___	___	X
a. pump rotation verified	___	___	___	___	X
c. control system interlocks functional	___	X	___	___	___
d. verify that power disconnect is located within the sight of the unit controls	___	X	___	___	X
Testing, Adjusting and Balancing (TAB					
a. pressure/temperature gauges installed	___	___	X	___	X
b. piping system cleaned	___	___	X	___	X
c. chemical water treatment complete	___	___	X	___	X
d. water balance complete	___	___	X	___	X
e. water balance within specified design tolerances	___	___	X	___	X
f. TAB report submitted	X	___	X	___	X

Pre-Commissioning Checklist – HVAC SYSTEM CONTROLS
For HVAC SYSTEM: Centrifugal Chiller C-4A

Checklist Item	Q	M	E	O	C
Installation					
a. as-built shop drawings submitted	X	X	___	___	X
b. layout of control panel matches drawings	___	X	___	___	X
c. framed instructions mounted in control panel	___	X	___	X	X
d. components properly labeled	___	X	___	___	X
e. control components piped and/or wired to each labeled terminal strip	___	X	___	___	X
f. BAS connection made to each unit controller and labeled	___	X	___	___	X
g. control wiring and tubing labeled at all termination, splices, and junctions.	___	X	___	___	X
h. shielded wiring used on electronic sensors	___	X	___	___	X
i. all unit controls system operational. System graphics present and match systems and tags	___	X	___	X	X
j. graphics templates for unique devices have been created	___	X	___	X	X
Electrical					
a. power available to panel as specified.	___	X	___	___	X
b. control panel receptacles do not connect to other systems	___	X	___	___	X

Pre-Commissioning Checklist – HVAC SYSTEM CONTROLS
For HVAC SYSTEM: Centrifugal Chiller C-4B

Checklist Item	Q	M	E	O	C
Installation					
a. as-built shop drawings submitted	X	X	___	___	X
b. layout of control panel matches drawings	___	X	___	___	X
c. framed instructions mounted in control panel	___	X	___	X	X
d. components properly labeled	___	X	___	___	X
e. control components piped and/or wired to each labeled terminal strip	___	X	___	___	X
f. BAS connection made to each unit controller and labeled	___	X	___	___	X
g. control wiring and tubing labeled at all termination, splices, and junctions.	___	X	___	___	X
h. shielded wiring used on electronic sensors	___	X	___	___	X
i. all unit controls system operational. System graphics present and match systems and tags	___	X	___	X	X
j. graphics templates for unique devices have been created	___	X	___	X	X
Electrical					
a. power available to panel as specified.	___	X	___	___	X
b. control panel receptacles do not connect to other systems	___	X	___	___	X

SECTION 15996

COMMISSIONING AGENT REQUIREMENTS

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to section 15995 for commissioning requirements and Division 1 for additional information.

B. Section 15010 - Basic Mechanical Requirements.

1.02 DESCRIPTION OF THE WORK

A. This Section covers the Scope of Work for the Commissioning Agent (CA) who will be hired by the Owner.

B. The Commissioning Agent shall oversee the commissioning of the HVAC systems as described in Section 15995. The CA shall prepare pre-commissioning and functional performance test checklists to be used by the Contractor. Prepare and publish a commissioning plan. Witness startup and operational tests of equipment and systems. Perform observations of the mechanical systems throughout construction and prepare the final commissioning document.

C. The CA shall have authority to direct and schedule testing. The CA shall have no authority to direct changes to the systems.

1.03 COMMISSIONING PLAN

A. The CA shall prepare a plan listing the parties involved with their responsibility, scope, definitions, safety concerns, design criteria, attendance schedules, commissioning schedules, and commissioning manual requirements.

1.04 COMMISSIONING FORMS

A. Review 100%o CD's. Provide written summary of how each commissioned item of equipment should operate; include calculations verifying scheduled capacity.

B. The CA shall develop forms similar to that in Section 15995 for the Contractors use during the commissioning process. The forms shall become part of the final commissioning manual. Forms shall be provided for each piece of commissioned equipment and system. Any deviations from the design shall be noted and approved by the DIA Project Manager prior to acceptance. Each form shall be signed by the Contractor, CA and DIA Project Manager prior to acceptance of a system or piece of equipment.

1.05 COMMISSIONED SYSTEMS

A. All HVAC systems.

1.06 PROJECT OBSERVATIONS

A. The CA shall perform observations of construction progress for the equipment and systems to be commissioned twice a month at a minimum and more as required to keep pace with construction. The CA shall note progress and any deviations of the construction documents shall be brought to attention of the Contractor and DIA Project Manager for resolution. The CA will have no authority to direct changes or corrections to the system. Observation reports shall be published to the DIA Project Manager and Contractor and shall be part of the final commissioning manual.

1.07 OPERATIONAL AND START-UP TESTS

A. The CA shall witness start-up tests and collect documentation of the tests. The CA shall notify the DIA Project Manager and Contractor of any deviations from the contract documents. Any deviations shall be corrected or accepted by the DIA Project Manager prior to acceptance.

B. After the Contractor has submitted in writing that the systems are completed, the CA shall schedule and direct operational tests of the systems. These tests shall be as described in Section 15951 and 15995. The results shall be documented and made part of the commissioning manual. Any deviations from the design shall be brought to the attention of the DIA Project Manager and Contractor. Any deviations shall be corrected or accepted by the DIA Project Manager prior to acceptance.

1.08 COMMISSIONING MANUAL

A. The CA shall prepare the final commissioning manual. The manual shall provide a complete history of the commissioning process and shall include:

1. Design and Energy Codes.
2. Commissioning Plan.
3. Completed Commissioning Forms.
4. Completed Observation Reports.
5. Completed Start-up Reports.
6. System Operational Tests.
7. Final sequence of operation to be achieved.
8. Summary of building operation as commissioned, noting deviations from design.
9. Design Criteria (extended from Design Documents by CA).
10. Written summary of normal startup and operating procedures for each commissioned item of equipment.
11. The manual shall be a three ring binder with tabs for each section. Provide 5 copies.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement will be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 15996

DIVISION 16 – ELECTRICAL

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Certain labor, materials, and equipment may be furnished under other Sections of these specifications, by utility Companies or by the Owner. When this is the case, the extent, source and description of these items will be as indicated on the drawings or as described in the specifications.

B. All electrical/electronic circuits, including audio, video and fire alarm systems, shall be in an approved raceway system. No “wild circuits” will be accepted.

C. Contractor shall not install rigid metal conduit, electrical metallic tubing, flexible steel conduit, liquid-tight flexible steel conduit, non-metallic rigid conduit or innerduct in any horizontal or vertical concrete wall or slab structures or portions thereof, e.g., cast-in-place concrete floor slab on steel decking; cast-in-place concrete slabs integral with concrete structural support systems; prestressed concrete slabs; post-tensioned concrete slabs; precast concrete construction with or without field applied or plant fabricated concrete topping slabs, slabs on grade, foundation walls or in concrete cast-in-place walls, etc.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Basic Electrical Requirements specifically applicable to all Division 16 Sections, in addition to Division 1 - General Requirements, and Division 15.

B. All electrical/electronic circuits and equipment from any other Division shall meet the requirements of Division 16.

C. Description: Work shall consist of furnishing all labor, equipment, supplies, and materials, unless otherwise specified, necessary for the installation of complete electrical systems as required by the specifications and as shown on the drawings, subject to the terms and conditions of the contract. The Work shall also include the completion of those details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems.

D. Temporary Power: See Division 1 for construction power constraints.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

B. Latest editions of the following:

1. ANSI/NFPA 70 - National Electrical Code (as adopted and amended by the Denver Building Code).
2. Uniform Fire Code (as amended by the Denver Fire Department).
3. ANSI/IEEE C2 - National Electrical Safety Code.
4. OSHA - Occupational Safety and Health Administration, as Amended
5. Underwriter's Laboratory (UL)
6. National Fire Protection Association (NFPA)
7. Other references as listed elsewhere in these specifications.
8. IEEE standard 519- recommended practices and requirement for harmonic control in electrical power systems.

1.05 DEFINITIONS

A. "Furnish" or "Provide": To supply, install and connect complete and ready for safe and regular operation of particular work unless specifically otherwise noted.

B. "Install": To erect, mount and connect complete with related accessories.

C. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

D. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

E. "Wiring": Raceway, fittings, wire, boxes and related items.

F. "Concealed": Embedded in masonry, concrete or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.

G. "Or Equal. Or Approved Equal": Refers to products that, in the opinion of the DIA Project Manager, are similar in all respect to products specified by proprietary brand name. (Refer to Section 01630 for procedures for submittal of proposed substitutions.)

H. "Exposed": Not installed underground or "concealed" as defined above.

I. "Indicated," "Shown" or "Noted": As indicated, shown or noted on drawings or specifications.

J. "Similar" or "Equal": Same in materials, weight, size, design, construction, capacity, performance, and efficiency of specified product.

K. "Reviewed," "Satisfactory," "Accepted," or "Directed": As reviewed, satisfactory, accepted, or directed by or to Project Manager.

L. "Related Work" includes all "Work" required for a complete working system.

M. "Equipment": A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as a part of, or in connection with, an electrical installation.

N. "Busbar": A rigid metallic conductor, lug or bar used to make a common connection between more than one circuit. (Includes all termination assemblies.)

O. "Shall": Mandatory requirements of this specification are characterized by the use of the word "shall".

P. Refer to Article 100 of the currently adopted National Electrical Code for other definitions as applicable to this project.

1.06 WORK SEQUENCE

A. Construct Work in sequence under provisions of Division 1 where applicable.

1.07 DRAWINGS AND SPECIFICATIONS

A. The drawings indicate the general arrangement of circuits, outlets, panelboards and other work. Information shown on the drawings is schematic; however, re-circuiting will not be permitted without specific acceptance. In cases of conflict between specifications and drawings, the specification shall have precedence. Data presented on the drawings is as accurate as planning can determine, but accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is required. Review all of the contract documents and adjust all work to conform to all conditions shown therein.

B. Prior to submitting a bid, a site visit is required to ascertain all conditions affecting the proposed installation and to adjust all work accordingly. Costs for providing for these adjustments, including response to site constraints, shall be itemized and listed in the bid proposal.

C. Discrepancies between different plans, between plans and specifications, between specifications, or regulations and codes governing this installation shall be brought to the attention of the Project Manager in writing 72 hours before the date of bid opening. In the event such discrepancies exist, and the Project Manager is not so notified, the adjudication of responsibility shall be solely at the discretion of the Project Manager.

1.08 COORDINATION

A. Prior to fabrication or installation of any electrical work, participate in detailed coordination planning meetings with all other building utilities system trades, under the direction of the General Contractor, so as to completely establish routings, elevations, space requirements, and coordination of access, layout, and suspension requirements in relationship to the building structure and the work of all other trades.

B. Any electrical work penetrating concrete walls or floors require saw cutting and/or core drilling and shall require approval by the Project Manager. The contractor shall submit shop drawings of any saw cutting or core drilling to the Project Manager prior to performing the work. Refer to Section 01410 - Cutting and Patching. Reference 3.02 C for additional information.

C. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the Project Manager two weeks prior to the shutdown.

1.09 COORDINATION DRAWING

A. Where the Contractor modifies the design, through selection of equipment differing from that shown, coordination drawings shall be provided by the Contractor in accordance with Division 1 to a scale of 1/4"=1'0" or larger for equipment rooms, details, congested areas

and sections; other plans at a scale of 1/8"=1'0". These drawings are to detail major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. The Contractor shall indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of raceway systems, equipment, and materials. Include the following:
   a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
   b. Exterior wall and foundation penetrations.
   c. Fire-rated wall and floor penetrations.
   d. Equipment connections and support details.
   e. Sizes and location of required concrete pads and bases.
   f. Support details.
2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Floor plans, elevations, and appropriate details are required to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

1.10 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

A. Submit shop drawings, coordination drawings and product data in accordance with provisions of Division 1. Submit all required information under a given specification section together. Do not split out submittals under the same specification section.

B. Prior to submission, shop drawings, material lists and catalog cut sheets or manufacturer's printed data shall be thoroughly checked for compliance with contract requirements, compatibility with equipment being furnished by the Contractor or Owner, accuracy of dimensions, coordination with work of other trades, and conformance with sound and safe practice as to erection of installation. Each submittal shall bear Contractor's signed statement evidencing such checking.

C. Clearly mark each shop drawing as follows for purposes of identification:
   1. Shop Drawing
   2. Equipment Identification Used on Contract Drawings
   3. Date
   4. Name of Project
   5. Branch of Work
   6. Project Manager's Name
   7. Contractor's Name

D. Clearly mark printed material, catalog cut sheets, pamphlets or specification sheets, and shop drawings with the same designation shown on the contract document schedules.

E. Contractor agrees that submittals processed by the Project Manager are not change orders; that the purpose of submittals is to demonstrate to the Project Manager that the Contractor understands the design concept; and that the Contractor demonstrates this understanding

by indicating which equipment and material he intends to furnish and install and by detailing the installation methods he intends to use.

F. Contractor shall be responsible for dimensions (which he shall confirm and correlate at the job site), fabrication processes and techniques of construction, and coordination of his work with that of other trades. The Contractor shall check and verify all measurements and review shop drawings before submitting them. If any deviations from the specified requirements for any item of material or equipment exist, such deviation shall be expressly stated in writing and incorporated with the submittal.

G. Maintain one copy of accepted shop drawings at the project field office until completion of the project, and make this copy available, upon request, to representatives of the Project Manager and Owner.

H. No equipment or materials shall be installed or stored at the jobsite until submittals for such equipment or materials have been given review action by the Project Manager accepting their use.

I. Shop drawings and manufacturer's published data shall be submitted for all equipment required for this project.

1.11 RECORD DOCUMENTS

A. Maintain a contract set of electrical drawings and specifications at the site. Neatly mark all changes, discoveries and deviations from the original drawings. Use a reproducible color that contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be updated daily as the job progresses and shall be made available for inspection by the Project Manager at all times. Upon completion of the contract, this set of record drawings shall be delivered to the Project Manager. Follow DIA CADD standards, to be furnished to the successful bidder. Record documents to be provided by the Contractor shall clearly and accurately show the following:

1. Provide horizontal and vertical dimensions for all raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.

2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.12 REGULATORY REQUIREMENTS

A. Obtain and pay for all permits, plan review, and inspections from authority having jurisdiction.

B. The drawings and specifications take precedence when they are more stringent than codes, statutes, or ordinances in effect. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent than the drawings and specifications.

1.13 ENVIRONMENTAL CONDITIONS

A. The equipment shall be designed and constructed to operate successfully at the rated values under the following environmental conditions:

1. Location Indoors

2. Altitude 5,500 feet above sea level

3. Temperature range -30ºF to 120ºF

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and Equipment: Acceptable to the authority having jurisdiction as suitable for the use intended, except where more stringent requirements are indicated by the Contract Documents.

B. All equipment and materials installed shall be new, unless otherwise specified.

C. Defective or damaged materials shall be replaced or repaired, prior to final acceptance, in a manner acceptable to the Project Manager or Owner and at no additional cost to the Owner.

D. All electrical "equipment" and assemblies shall be acceptable for installation only if labeled and listed by a nationally recognized testing laboratory, such as UL or an equivalent..

E. All major equipment components shall have the manufacturer's name, address, model number, and serial number permanently attached in a conspicuous location.

2.02 STORAGE AND PROTECTION

A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.

B. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering and provide ventilation to avoid condensation.

C. Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged and are maintained under required conditions.

2.03 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards.

B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not specifically named with supporting documentation.

2.04 PRODUCTS LIST

A. Within 15 days after date of Notice to Proceed, submit complete list of major products required for submittal under these specifications, with name of manufacturer, trade name, and model number of each product.

2.05 SUBSTITUTIONS

A. Refer to DIVISION 1 - GENERAL REQUIREMENTS, Section 01630 Substitutions.

2.06 GUARANTEE

A. The entire electrical system installed under this Contract shall be left in proper working order. Replace, at no additional cost to the Owner, any work, materials, or equipment which evidences defects in design, construction, or workmanship within two years, or any longer period specifically noted elsewhere in these specifications, from date of final acceptance.

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. Only quality workmanship will be accepted. Poor workmanship, improper layout of work and lack of coordination of work, as determined by the Project Manager, is not acceptable and shall be corrected at the contractors cost.

B. Contractor shall include no more than one apprentice per Journeyman Electrician. Apprentices shall be under the direct supervision of a licensed electrician at all times.

C. Any changes or deviations from the drawings and specifications must be accepted in writing by the Project Manager. All errors in installation shall be corrected at the expense of the Contractor. All specialties shall be installed as detailed on the drawings. Where details or specific installation requirements are not provided, manufacturer's recommendations shall be followed.

D. Upon completion of work, all equipment and materials shall be installed complete, thoroughly tested, checked, correctly adjusted, and left ready for intended use or operation. All work shall be thoroughly cleaned and all residues shall be removed from surfaces. Exterior surfaces of all material and equipment shall be left in a perfect, unblemished condition.

E. Contractor shall provide a complete installation, including all required labor, material, cartage, testing, insurance, permits, and taxes.

3.02 CHASES, OPENINGS, CUTTING AND PATCHING

A. Carefully lay out all work in advance so as to eliminate where possible, cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings and roofs. Any damage to the building, structure, piping, ducts, equipment or any defaced finish shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner and to the satisfaction of the DIA Project Manager. Any necessary cutting, channeling, drilling or welding as required for the proper support, concealment, installation or anchoring of raceways, outlets, or other electrical equipment shall be performed in a careful manner, and shall be pre-approved by the Project Manager.

B. All openings made in fire-rated walls, floors, or ceilings shall be sealed and made tight in a manner to conform to the fire rating for the barrier penetrated. Reference specification section 07841 for additional information.

C. All penetrations required through completed concrete construction shall be core drilled at minimum size required. All penetrations in concrete require an x-ray or ground penetrating radar to determine if the location is clear of reinforcing steel and embedded systems. Precautions shall be taken when drilling to prevent damage to structural concrete.

3.03 ELECTRICAL INSTALLATIONS

A. Coordinate electrical systems, equipment, and material installation with other building components. If the Contractor furnishes equipment of a different size, the Contractor shall furnish and install the proper fuses, circuit breaker, disconnect switch, wire and conduit required for the equipment furnished, at no additional cost to the Owner, and as deemed acceptable by the DIA Project Manager.

3.04 PROGRESS OF WORK

A. Order the progress of electrical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the sites will permit. Any cost resulting from defective or ill-timed work performed under this Division shall be borne by the Contractor.

3.05 ELECTRICAL COMPLETION

A. Indoctrination of Operating and Maintenance Personnel: Furnish the services of a qualified representative of the supplier of each item or system itemized below who shall instruct specific personnel, as designated by the Owner, in the operation and maintenance of that item or system.

1. Instruction shall be given when the particular system is complete, shall be of the number of hours indicated, and at the time requested by the Owner. A representative of the Contractor shall be present for all demonstrations.

Systems	Hours Of Instruction
Medium Voltage VFDs	8
Low Voltage VFDs	4

B. Operating and Maintenance Manuals and Parts Lists: Deliver three complete operating & maintenance manuals and parts lists in three ring binders to the Owner at the time of the above required indoctrination. The information shall be provided on the manufacturer’s original data sheets. Fully explain the contents of the manuals as part of required indoctrination and instruct the Owner's personnel in the correct procedure in obtaining service, both during and after the guarantee period.

1. The operating and maintenance manuals and parts lists shall give complete information as to whom the Owner shall contact for service and parts. Include address and phone number. Furnish evidence that an authorized service organization regularly carries a complete stock of repair parts for these items (or systems), and that the organization is available for service. Service shall be furnished within 24 hours after requested.

C. Operating and Acceptance Tests: Provide all labor, instruments, and equipment for the performance of tests as specified below and elsewhere in these specifications for all applicable equipment furnished and installed as part of this contracts. Submit three copies of test reports to the Project Manager for his approval.

D. Clean Up: Remove all materials, scrap, etc., relative to the electrical installation, and leave the premises and all equipment, lamps, fixtures, etc. in a clean, orderly condition. Clean all electrical equipment, such as switchboards, panelboards, luminaries etc. of construction dirt, dust, etc. and touch-up or repaint all scratches, blemishes, rust spots etc. to its original condition. Any costs to the Owner for clean up of the site will be charged against the Contractor.

E. Acceptance Demonstration: Upon completion of the work, at a time to be designated by the Project Manager, the Contractor shall demonstrate for the Owner the operation of the entire installation, including all systems provided or modified under this contract.

F. Final Acceptance by the Owner will not occur until all operating instructions are received and Owner's personnel have been thoroughly indoctrinated in the maintenance and operation of all equipment.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16010

SECTION 16015

ELECTRICAL DEMOLITION

PART 1 – GENERAL

1.01 DESCRIPTION

A. The work specified in this section consists of performing electrical demolition.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 16 - All sections.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein and in Section 16010 except where more stringent requirements are listed herein or otherwise required by the Contract Documents

PART 2 - PRODUCTS

2.01 PRODUCT

A. Provide construction tools, equipment materials and supplies of the type and quantities that will facilitate the timely execution of the work.

PART 3 - EXECUTION

3.01 PROCEDURES

A. Existing electrical systems shall not be abandoned in place except as authorized in writing by the Project Manager or as shown on the drawings.

B. No area; new, remodeled, or existing shall be without a fully operational electrical system, except for scheduled outages.

C. The contractor shall remove, relocate or replace any electrical equipment or systems as required for installation of any structural, mechanical or plumbing equipment,

D. Maintain all existing electrical, control, communication and signaling systems to the extent required by the owner.

E. Methods for maintaining the existing system in operation and for providing temporary systems shall be designed to assure complete safety. Requirements for protection, support and in-service maintenance of these systems shall be the sole responsibility of the contractor

F. Where remodel or demolition interferes with circuits outside of the work area, schedule outages to rework the circuits as required.

G. All items that are removed and not designated by the Project Manager to be used or turned over to the owner shall be removed from the airport.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16015

SECTION 16065

TESTING, ACCEPTANCES AND CERTIFICATION

PART 1 – GENERAL

1.01 REQUIREMENT

A. The contractor shall provide the necessary field-testing and startup services for all electrical and mechanical equipment except as noted otherwise. The field-testing and startup services shall be in accordance with each equipment manufacturer's written recommendations for field-testing proving they meet contract standards.

B. The contractor shall be responsible for furnishing all equipment, power source when needed, coordinating and performing electrical/electronic testing required by the contract documents. Testing requirements may be located on the drawings or other sections of the specifications.

C. The contractor shall provide all necessary assistance and cooperation with any Independent Testing Organization furnishing by the City. The contractor shall correct, repair or replace all equipment found to be defective by the Independent Testing Organization.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced Standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply unless in conflict with the equipment manufacturer's written recommendations:

1. Building Code and DIA Standards.
2. ANSI/IEEE C2 - National Electrical Safety Code.
3. OSHA - Occupational Safety and Health Administration, as Amended
4. NETA - National Electric Testing Association
5. NEMA ICS 1 - General Standards for Industrial Control and Systems.
6. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies.
7. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
8. UL 1008 - Standard for Automatic Transfer Switches.
9. NFPA 72 - National Fire Alarm Code (as adopted and amended by the Denver Building Code and DIA Standards).
10. NFPA 101 - National Electrical Safety Code (as adopted and amended by the Denver Building Code and DIA Standards).
11.

1.03 CONTRACTOR SUBMITTALS

A. Comply with Division 1 submittal requirements.

B. Five copies of complete certified test reports shall be submitted to the Project manager by the contractor. The test reports shall include the following as a minimum:

1. Power cable high potential test reports
   a. Insulation resistance tests.
   b. Continuity tests.
2. Transformer test reports to include where applicable:
   a. Transformer turns ratio
   b. Winding resistance
3. All electrical/electronic equipment and systems functional test report.
4. All other reports required by individual specification sections.
5. Generator load bank test report
6. Transfer Switch test report
7. Load balance report for each panelboard.

PART 2 - MATERIALS

2.01 GENERAL REQUIREMENTS

A. The electrical and mechanical equipment shall be completely tested in the field in the presents of DIA Inspectors in accordance with good engineering practices to assure that:

1. The equipment has not been damaged during manufacturing, shipping or installation.
2. The equipment has been installed according to the requirements contract documents.
3. The equipment meets the requirements of the contract documents.

B. If the contractor finds during the testing that any piece of equipment failed to satisfactorily pass the required field test, the Project manager shall be promptly notified and the contractor shall take the necessary actions for the prompt repair or replacement. A retest to demonstrate the equipment will meet the requirements of the contract documents shall be scheduled with the Project Manager.

2.02 HVAC

A. Test the operation of all heaters and air conditioners

2.03 GROUND RESISTANT TEST

A. Upon completion of installation of electrical grounding system, test ground resistance to earth in accordance with ANSI/IEEE81. Submit test results to the Project Manager

2.04 CONDUCTOR INSULATION TEST

A. Prior to energizing, all building service cables feeders to and/or from transformers, switchboards, panelboards are to be tested with a 1000-volt dc insulation megohm meter to determine insulation resistance levels. Test cables rated for three hundred volt with a 500-volt dc megohm meter or as recommended by the manufacturer. All field test data is to be recorded, corrected to a baseline temperature and furnished to the Project Manager. A test is to include meggering between conductors and between each conductor and ground. Cables are to be meggered after installation with cables disconnected at both ends. Insulation test values shall meet or exceed the values given below.

Conductor Size (AWG or KCMIL)	Resistance (Megohms-1,000ft)
12-8	200
6-2/0	100
3/0-750	50

B. Do not test wires or cables with an ac test set.

PART 3 - EXECUTION

3.01 TESTING

A. The contractor shall allow only certified personnel to perform the testing.

B. The contractor shall perform the testing using all necessary safety precautions and proper test equipment.

C. The contractor shall notify the Project manager three days in advance of the proposed testing dates.

D. Witness of testing by DIA Inspector, Electrical Maintenance and Electrical Inspector.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16065

SECTION 16110

RACEWAYS AND FITTINGS

PART 1 – GENERAL

1.01 SUMMARY

A. Rigid metal conduit and fittings.

B. Intermediate metal conduit - Not Acceptable.

C. Electrical metallic tubing and fittings.

D. Flexible steel conduit and fittings.

E. Liquid-tight flexible steel conduit and fittings.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 – General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 1 – Cutting and Patching.

B. Division 16 – All sections.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1. ANSI C80.1 – Rigid Steel Conduit, Zinc-Coated.
2. ANSI C80.3 – Electrical Metallic Tubing, Zinc-Coated.
3. ANSI/NEMA FB 1 – Fittings and Supports for Conduit and Cable Assemblies.
4. FS WW-C-566 – Specification for Flexible Metal Conduit.
5. All equipment furnished under this section shall carry a listing from an independent testing lab such as UL or an equivalent.

PART 2 - PRODUCTS

2.01 RIGID METAL CONDUIT AND FITTINGS

A. Rigid Steel Conduit

B. Fittings and Conduit Bodies: threaded type, steel or malleable iron

2.02 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

A. EMT: galvanized tubing.

B. Fittings, Conduit Bodies, couplings, and connectors: steel or malleable iron

2.03 FLEXIBLE STEEL CONDUIT AND FITTINGS

A. Conduit: steel.

B. Fittings and Conduit Bodies: steel or malleable iron.

2.04 LIQUID-TIGHT FLEXIBLE CONDUIT AND FITTINGS

A. Conduit: Flexible steel conduit with PVC jacket.

B. Fittings and Conduit Bodies: steel or malleable iron.

2.05 CONDUIT SUPPORTS

A. Conduit Clamps, Straps, and Supports: Steel or malleable iron. In accordance with Section 16190

2.06 PROHIBITED MATERIALS

A. Intermediate conduits

B. Aluminum conduit, Zinc Die Cast boxes and fittings

C. Power poles.

D. Non metallic flexible conduit.

PART 3 - EXECUTION

3.01 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

A. Size conduit for conductor type installed or for Type THHN conductors, whichever is larger; 3/4-inch minimum size. For communication 1 inch is the minimum.

B. Arrange conduit to maintain headroom and present a neat appearance. Refer to Section 16010 for coordination requirements.

C. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers.

D. Maintain a minimum of six inches (6”) between conduit and other piping. Maintain twelve inches (12”) clearance between conduit and a heat source such as heating pipes, exhaust flues and heating appliances.

E. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.

F. Do not support conduit from cable tray or cable tray supports.

G. Support conduit at a maximum of 8 feet on center, within two feet of a box or fitting, and at each change of direction.

H. All vibrating equipment such as motors, transformers, and generators shall be connected with flexible steel conduit or liquid-tight flexible steel conduit , not to exceed six feet in length.

I. Flexible conduit shall not be less than one-half (1/2) inch except when supplied with lighting fixtures.

J. When anchoring to a dual sheet metal pan deck and concrete, anchors of any type when placed from below the deck shall be placed only in the lower pan form. No anchors shall be installed in the upper (high) pan.

K. X-ray or ground penetrating radar studies shall be made of concrete floors, walls or CMU walls to be penetrated.

3.02 CONDUIT INSTALLATION

A. Use only factory cast hubs for fastening conduit to cast boxes, and use steel or malleable iron hubs for fastening conduit to sheet metal boxes or equipment in damp or wet locations.

B. All exposed and concealed conduit runs shall be squared with the building lines. Use conduit bodies to make changes in direction around beams or columns.

C. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

D. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture during construction.

E. Provide a 200 lb. Nylon measuring pull string in all empty conduits.

F. Exposed conduits to be rigid steel to 8'-0" above floor, deck or grating except in electrical, communications and mechanical rooms.

G. Conduit stubbed up shall be two inches above slab or housekeeping pad and the empty conduits shall be capped. Under freestanding equipment conduits with conductors shall be sealed with duct seal.

H. Flexible steel conduit runs shall not exceed 3’ in length when connecting equipment, 6' in length when connecting light fixtures or when fished in hallow spaces with written approval by Project Manager and shall contain a grounding conductor.

I. Raceways shall not be installed in stairways or on the exterior of any building.

J. Electrical installations in hollow spaces, vertical shafts, and ventilation or air-handling ducts shall be so made that the possible spread of fire or products of combustion will not be substantially increased. Openings around electrical penetrations through fire-resistant-rated walls, partitions, floors or ceilings shall be fire stopped using UL approved, classified, listed or labeled material and/or methods to maintain the fire resistant rating.

3.03 CONDUIT INSTALLATION SCHEDULE

A. Installation In Concrete Slab: Not allowed.

B. In Slab Above Grade: Not allowed.

C. Wet Interior Locations: Rigid steel.

D. Concealed Dry Interior Locations: Electrical metallic tubing.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16110

SECTION 16120

WIRES AND CABLES

PART 1 – GENERAL

1.01 SUMMARY

A. Building wire.

B. Cable.

C. Wiring connections and terminations.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 16 - All Sections.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

B. Institute of Electrical and Electronic Engineers (IEEE): Provide components which comply with the following standard.

1. 48 - Test Procedures and Requirements for High Voltage Alternating-Current Cable Terminations.
2. 400 - IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above
3. 404 - Cable Joints for Use with Extruded Dielectric Cable Rated 5,000 through 46,000 Volts, and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500 through 500,000 Volts.
4. 1202 – Standard for Flame Propagation Testing of Wire and Cable.
5. 1210 - Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable.

C. National Electrical Manufacturers Association (NEMA) and Insulated Cable Engineers Association (ICEA): Provide components which comply with the following standards.

1. a. ICEA S-93-639 (NEMA WC74) – 5 to 46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electrical Energy.

D. National Fire Protection Association (NFPA): Comply with the following standards.

1. 70 - National Electrical Code (NEC).

E. Underwriters Laboratories (UL): Provide components which are listed and labeled by UL under the following standards.

1. 44 - Rubber-Insulated Wires and Cables.
2. 83 - Thermoplastic-Insulated Wires and Cables.
3. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
4. 1072 – Medium Voltage Power Cables

1.05 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

A. Submit shop drawings and product data under the provisions of Division 1.

B. Includes, but not limited to, the following:

1. Product Data Sheets for electrical wires, cables, and connectors:
   a. Wire and cable data sheet.
   b. Wire and cable outside diameter, insulation thickness and medium voltage cable dimensioned construction.
   c. Wire and cable weight.
   d. Recommended maximum pulling tension and minimum bending radius of wire and cable.
   e. Recommended wire and cable pulling lubricants.
   f. Recommended medium voltage termination and splicing kits.
   g. Recommended medium voltage cable maximum dc voltage for field high-potential test.
   h. All field test data.

C. Certification of medium voltage cable terminator and splicer.

1.06 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required by field verification.

1.07 COORDINATION

A. Coordinate Work under provisions of Section 16010.

B. Determine required separation between wiring and other work.

C. Determine routing to avoid interference with other work.

PART 2 - PRODUCTS

2.01 BUILDING WIRE

A. All conductors shall be copper.

B. All building wire and cable shall be installed in an approved raceway.

C. Medium voltage cable where indicated.

1. 5kV, shielded, single copper conductor, ethylene propylene rubber (EPR) insulation, jacketed conforming to NEMA WC74.
2. Conductors: Soft annealed copper, class B concentric compacted or compressed stranded.
3. Strand Shielding: Extruded layer of semiconducting ethylene propylene rubber (EPR) thermosetting compound.
4. Insulation: Ethylene propylene rubber (EPR) 115 mils thick. Triple-tandem extruded with the conductor and insulation shield.
5. Insulation Level: 133 percent.
6. Insulation Shield: Semiconducting nonmetallic extrusion applied over the insulation plus 5 mil thick copper helically-wrapped tape with 12.5% overlap minimum.
7. Conductor Jacket: Polyvinyl chloride (PVC) 60 mils thick for no. 6-2/0 and 80 mils thick for no. 3/0-1000kCMIL.
8. Identification: Surface printing shall show manufacturer's name, insulation type, jacket type, conductor size, conductor type and voltage rating.
9. Temperature Rating: 105° C continuous wet or dry locations, 140° C for emergency and 250° C for short circuit.
10. All medium voltage splices and cable terminations shall be made by a certified medium voltage cable splicer.

2.02 REMOTE CONTROL AND SIGNAL CABLE

A. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600 volt insulation, individual conductors twisted together, shielded, and covered with a PVC jacket.

B. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

C. All power, control, data, communication and signal wire or cable shall be installed in an approved raceway.

PART 3 - EXECUTION

3.01 GENERAL WIRING METHODS

A. Minimum wire size shall be based on the over current protection device and as governed by the NEC.

B. Size circuit conductor for 20 ampere, 120- volt and 277-volt branch circuit home runs for a maximum of 3% voltage drop.

C. Place an equal number of conductors for each phase in the same raceway or cable.

D. Neatly train and lace wiring inside boxes, equipment, and panelboards. Make temporary connections to panelboard devices with sufficient slack conductor to facilitate reconnections required for balancing loads between phases.

E. Where harmonic currents exist on circuits, that supply electric discharge lighting, data processing or similar equipment, a full size neutral conductor shall be provided for each single-phase circuit.

F. Verify raceways are open, continuous and clear of debris before installing cables.

G. All medium voltage splices and cable terminations shall be made by a certified medium voltage cable splicer.

3.02 WIRING INSTALLATION IN RACEWAYS

A. Pull all conductors into a raceway at the same time. Use a listed wire pulling lubricant for pulling No. 4 AWG and larger wires.

B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

C. Completely and thoroughly swab raceway system before installing conductors.

3.03 CABLE INSTALLATION

A. Provide protection for exposed cables where subject to damage.

B. Use suitable cable fittings and connectors.

C. Pulling winches and other necessary pulling equipment shall be of adequate capacity to ensure a continuous pull on the cable. Strain gages shall be used to monitor the cable pulling tension.

D. Cable and Wire pulling lubricants that are non-corrosive and harmless to hands and clothes shall be used. Lubricants shall be compatible with cable jackets and insulation.

3.04 WIRING CONNECTION AND TERMINATIONS

A. Splice only in accessible junction and outlet boxes.

B. For No. 8 AWG and smaller, use insulated spring wire connectors with plastic caps.

C. Use irreversible compression for copper wire splices and taps, No. 6 AWG and larger. Tape un-insulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor – protect edges from wear.

D. Thoroughly clean wires before installing lugs and connectors.

E. All control cable and conductor splices shall be made on numbered terminal strips. Wire nuts are not acceptable for control cable and conductor splices.

3.05 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 1.

B. Inspect wire and cable for physical damage and proper connection.

C. Torque conductor connections and terminations to manufacturer's recommended values.

D. Perform continuity test on all feeder and branch circuit conductors. Verify proper phasing connections.

E. Verify cables are colored coded and labeled according to contract documents.

F. Prior to energizing, all building service cables, feeders to and/or from transformers, switchboards and panelboards are to be tested with a 1000-volt dc insulation megohm meter to determine insulation resistance levels. Megger medium voltage cables with 2500Vdc megohm meter before high potential testing between each conductor and ground. All field test data is to be recorded, corrected to a baseline temperature and furnished to the DIA Project Manager. A test is to include meggering for one minute between conductors and between each conductor and ground. Cables are to be meggered after installation with cables disconnected at both ends. Insulation test values shall meet or exceed the values given below.

Conductor Size (AWG or k CMIL)	Resistance (Megohms-1,000 ft)
12-8	200-MOhms
6-2/0	100-MOhms
3/0-750	50-MOhms

G. After the megger test on medium voltage cable is performed, perform a shield continuity test using an ohm meter, record and submit results. Shield continuity readings should be less than 10 ohms per 1000 feet of cable. Notify DIA Project Manager if higher values are measured. After shield continuity test is performed on medium voltage cable, perform a medium voltage cable high-potential tests in accordance with IEEE 400. Direct current high potential test (full test voltage achieved in a minimum of eight steps, one minute per step) for 15 minutes unless against the manufacturer's recommendation. High-potential test at voltage recommended by the manufacturer phase-to-ground on each conductor. Record and submit values. Submit a graph of step voltage vs. leakage current and, while at full test voltage, plot the leakage current vs. time (for 5 minutes).

3.06 WIRE AND CABLE INSTALLATION SCHEDULE

A. Concealed Interior Locations: in approved raceways.

B. Exposed Interior Locations: in approved raceways.

C. Above Accessible Ceilings: in approved raceways.

D. Wet or Damp Interior Locations: in approved raceway.

E. Exterior Locations: in approved raceways.

F. Underground Locations: in approved raceways.

G. Control data, Communication and signal cable (less than 48 volt): raceway and/or cabletray.

H. MC cable, AC cable and Modular wiring are not permitted unless indicated otherwise in the contract documents or as approved by the Project Manager.

3.07 WIRE AND CABLE COLOR CODING

A. Wire No. 6 AWG and smaller shall be factory color-coded. Wire No. 4 AWG and larger shall be color-coded by color taping of 6 inch length of exposed ends.

	120/208 Volts		277/480 Volts
A =	Black	A =	Brown
B =	Red	B =	Orange
C =	Blue	C =	Yellow
Neutral =	White	Neutral =	Gray
Ground =	Green	Ground =	Green

Isolated Ground = Green with a yellow tracer

B. Fire Alarm wire and color coding: Reference Specification Section 16721.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16120

SECTION 16135

ELECTRICAL BOXES AND BOX FITTINGS

PART 1 – GENERAL

1.01 SUMMARY

A. Wall and ceiling outlet boxes.

B. Pull and junction boxes.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 16 - Electrical, All Sections.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents

B. ANSI/NFPA 70 - National Electrical Code.

1.05 PROJECT CONDITIONS

A. Verify field measurements are as shown on Drawings.

B. Verify locations outlets and small pull-boxes prior to rough in.

C. Electrical and pull boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose.

PART 2 - PRODUCTS

2.01 OUTLET BOXES

A. Sheet Metal Outlet Boxes: galvanized steel.

B. Cast Boxes: Provide cover with gasket by box manufacturer. Provide threaded hubs.

2.02 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: galvanized steel.

B. Large Pull Boxes: Boxes larger than 100 cubic inches in volume or 12 inches in any dimension.

1. Interior Dry Locations: Use hinged covered enclosure.
2. Interior damp or wet locations: Use NEMA 3R hinged cover boxes.

C. All boxes shall be NEMA rated for the installed location.

2.03 EQUIPMENT AND TERMINAL BOXES

A. Shall be hinged enclosures.

B. All boxes shall be NEMA rated for the installed location.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install electrical boxes as shown on Drawings, and as required for equipment, terminal strips, splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

B. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed light fixture.

C. Electrical installations in hollow spaces, vertical shafts, and ventilation or air-handling ducts shall be so made that the possible spread of fire or products of combustion will not be substantially increased. Openings around electrical penetrations through fire-resistant-rated walls, partitions, floors or ceilings shall be firestopped using UL approved, classified, listed or labeled material and/or methods to maintain the fire resistant rating.

D. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.

E. Do not install flush mounting boxes back-to-back in walls; provide minimum 8 inch separation.

F. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

G. Use adjustable steel channel fasteners or all thread for hanging ceiling outlet box, support box from structure.

H. Support boxes in the ceiling with ¼“ threaded rod as a minimum.

I. Use appropriate gang box where more than one device is mounted together.

J. Use 4 inch square box with plaster ring for single device outlets.

K. Use malleable iron outlet box when surface mounted: on exterior of building, in wet location or damp location.

L. Minimum junction and pull box size 4-11/16" x 4-11/16" x 2-1/8”.

M. Minimum outlet box size 4" x 4" x 2-1/8” including feed through outlet boxes.

N. Minimum junction box size for fire alarm pull stations, control module, monitor module, 4" x 4" x 2-1/8". Provide plaster ring at all pull station locations.

O. Use flush mounting outlet boxes in finished areas.

P. Install knockout closure in unused box openings.

3.02 INTERFACE WITH OTHER PRODUCTS

A. Coordinate installation of outlet or equipment boxes for systems or products furnished under other sections.

B. Coordinate mounting heights and locations of boxes or outlets so as not to be interfered with by grounding systems, electrical panels, or any other building accessory.

3.03 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16135

SECTION 16142

ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 – GENERAL

1.01 SUMMARY

A. Electrical connections to equipment specified under other Sections or furnish by the Owner

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 – General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 1 - General Requirements.

B. Division 15 – Mechanical Equipment.

C. Division 16 – All Sections.

1.04 REFERENCED STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1.05 WORK INCLUDED

A. Applications of electrical power, control and monitoring connections specified in this section include the following:

1. From electrical source to motor starters
2. From motor starters to motors
3. To lighting fixtures and wiring devices
4. To converters, rectifiers, transformers, inverters, switchgear, switchboards, panelboards, generators and similar equipment
5. To grounds including ground electrode connections.
6. Equipment furnished in other Divisions (unless indicated otherwise).
7. Electrical connections for equipment, that are not furnished as integral part of equipment, are specified in Division 15 and other Division 16 sections, and are criteria of this section.
8. Refer to Division 15 sections for motor starters and controllers furnished integrally with equipment; not criteria of this section.
9. Refer to Division 15 sections for control system wiring, not criteria of this section.
10. Junction boxes and disconnect switches required for connecting motors and other electrical units of equipment are specified in applicable Division 16 sections, and are criteria of this section.

1.06 QUALITY ASSURANCE

A. Products, materials, equipment and systems shall comply with the following Codes and Standards:

1. NFPA Compliance: NFPA 70, "National Electrical Code (NEC)" as adopted and amended by the Denver Building Code and as applicable to products used and the installation of electrical power connections (terminals and splices), junction boxes, motor starters and disconnect switches.

2. IEEE Compliance: Std. 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to connections and terminations.

3. ANSI Compliance: Applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.

4. UL Compliance: UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Electrical connection products and materials are to be UL-listed and labeled.

1.07 SUBMITTALS

A. The following data shall be submitted in accordance with Sections 01300 – Approved Submittals required prior to starting installation:

1. Product Data: Manufacturer's data on electrical connections for equipment products and materials.

2. Complete wiring diagrams and/or shop drawings for installation purposes shall be furnished under the Mechanical or other Divisions, as applicable to DIA Project Manager prior to installation.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

A. Products shall be as specified in other Sections of this Division.

B. General: Each electrical connection shall be a complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, stress cones, splice kits, termination kits, solder less wire nuts, and other items and accessories as needed to complete splices and terminations as required.

1. Connectors and Terminals: Electrical connectors and terminals shall mate and match, including sizes and ratings, with equipment terminals that are recommended by equipment manufacturer for intended applications.

2. Electrical Connection Accessories: Electrical insulating tape, heat-shrinkable insulating tubing and boots, stress cones, splice kits, termination kits, wirenuts and cable ties as recommended for use by accessories manufacturers for type of services required.

2.02 MECHANICAL AND ELECTRICAL COORDINATION

A. Responsibility: It is the contractor's responsibility to complete the EXHIBIT A SCHEDULE included at the end of this specification section. The Contractor shall include all costs and work associated with these items in his bid.

B. Verify location, size and characteristics of all mechanical equipment before installation of electric service. In all cases of the installation of heating, ventilating, air conditioning, plumbing and other mechanical equipment, the contractor is responsible for all revisions, changes and modifications necessary to properly supply electric services to the equipment.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that equipment is ready for electrical connection, wiring and energization.

3.02 PREPARATION

A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

3.03 INSTALLATION

A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.

B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit in damp or wet locations. Length shall be six feet (6') maximum.

C. Install pre-finished cord set where connection with attachment plug is indicated or specified, use attachment plug with suitable strain-relief clamps.

D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.

E. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring as required for a complete operating system.

F. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as required for a complete operating system. Connect with conduit and wiring as required for a complete operating system.

3.04 EQUIPMENT CONNECTION SCHEDULE

A. Furnish, set in place, and wire, except as may be otherwise indicated, all heating, ventilating, air conditioning, plumbing, fire protection, and other motors and controls in accordance with the electrical/mechanical coordination schedule. The contractor shall carefully coordinate with work performed under the Mechanical and other Divisions if these specifications.

B. All line and low voltage wiring shall be installed utilizing materials and methods as specified in the Electrical Division of the specifications.

C. Provide NEMA-rated motors and equipment suitable for operation on the voltage systems as designated below, with tolerances for the allowable voltage variations above and below the nominal:

1. Rated Motor Voltage

Service Voltage and Phase	1/3 HP and smaller Smaller 1-Phase	½ HP and Larger 3-Phase
120/208V, 3Ø	115V	208V (only when 480v is not available)
277/480V, 3Ø		460V

3.05 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Electrical connections shall be installed in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

1. As a minimum: Each feeder circuit to panelboards, switchboards, motor control centers, transformers, and 480-volt (and higher) motor circuits shall have an insulated equipment ground conductor.

2. All medium voltage splices and terminations are to be made by a certified cable splicer/terminator.

3. Electrical service and feeders are to be maintained to occupied areas and operational facilities when temporary service is required during interruptions to existing facilities. Momentary outages for replacing existing wiring systems with new wiring systems shall be scheduled. When the "cutting-over" has been successfully accomplished, temporary wiring is to be removed.

4. Splices shall be covered with electrical insulating material equivalent to, or of greater insulation rating, than electrical insulation rating of those conductors being spliced.

5. Cables and wires shall be trimmed as long as practicable and routing shall be arranged to facilitate inspection, testing and maintenance.

6. Connectors and terminals, including screws and bolts, shall be tightened in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings shall be used to comply with torquing values contained in UL 496A or the manufacturer's literature.

7. Identification markers are to be fastened to each electrical power supply wire/cable conductor in accordance with Section 16195 "Electrical Identification."

   a. Markers are to be affixed on each terminal conductor, as close as possible to the point of connection.

3.06 FIELD QUALITY CONTROL

A. The correct direction of rotation of each motor is to be verified.

B. Provide measured torquing value checklist with witness signature to DIA Project Manager.

PART 4 - MEASUREMENT

4.01 MEASUREMENT

A. No separate measurement will be made for the work specified in this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work specified in this Section, but shall be included in the Contract Lump Sum Bid Price for Division 16 - Electrical, which price shall include all necessary and incidental material and work thereto.

SEE NEXT PAGE FOR EXHIBIT A

EXHIBIT A

It is the contractor's responsibility to complete the following schedule and include all costs associated with these items in his bid.

ITEM	FURNISHED BY *	SET/ INSTALLED BY *	POWER WIRING BY*	CONTROL WIRING BY* AND **
EQUIPMENT MOTORS AND THERMAL OVERLOADS.				
MOTOR CONTROL CENTERS, MOTOR CONTROLLERS, MAGNETIC STARTERS, VERIABLE FREQUENCY DRIVES AND OVERLOAD RELAYS.				
DISCONNECT SWITCHES (FUSED OR UNFUSED), THERMAL OVERLOAD SWITCHES AND FUSES, TIMER SWITCHES.				
PUSHBUTTON STATIONS, PILOT LIGHTS, MULTI-SPEED SWITCHES, FLOAT AND PRESSURE SWITCHES, THERMOSTATS, CONTROL TRANSFORMERS, CONTROL AND MONITOR PANELS, MOTOR OPERATED VALVES, DAMPER MOTORS OR SOLENOIDS, SOLENOID VALVES, EP AND PE SWITCHES AND INTERLOCKES.				
CONTRACTORS AND CONTROL CIRCUITS FOR CONTOL PANELS.				
AUTOMATIC AND/OR MANUAL CONTROL STATIONS, PANELS OR SYSTEMS.				
ALL WIRING INCLUDING POWER AND CONTROL RELATED TO DIRECT DIGITAL CONTROL SYSTEM.				
POWER AND CONTROL EQUIPMENT FURNISHED AS PART OF FACTORY WIRED EQUIPMENT.				
SPECIALTY MECHANICAL AND ELECTRICAL ITEMS OR SYSTEMS.				
ALARM AND MONITORING STATIONS AND PANELS.				
FIRE PROTECTION MONITORING AND CONTROL FUNCTIONS.				
FIRE AND SMOKE DUCT MOUNTED DETECTORS				
A. SAMPLE TUBE MODULE				
B. MONITOR MODULE				
FIRE AND SMOKE DETECTORS, RELAYS FOR FAN START/STOP FUNCTIONS, AS IT RELATES TO SMOKE CONTROL.				
ADDITIONAL ITEMS:				

MC = MECHANICAL CONTRACTOR
EC = ELECTRICAL CONTRACTOR
MFR = EQUIPMENT MANUFACTURER
CC = CONTROL CONTRACTOR
FA = FIRE ALARM CONTRACTOR
FP = FIRE PROTECTION CONTRACTOR
TC = TEMPERATURE CONTROL CONTRACTOR
N/A = NOT APPLICABLE

** ANY CONTROL WIRING ABOVE ONE (1) VOLT.

END OF SECTION 16142

SECTION 16143

WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Wall switches.

B. Receptacles.

C. Device plates and box covers.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 16 - Electrical: All Sections

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1.05 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

A. Submit product data under provisions of Division 1.

B. Provide product data showing grade, configurations, finishes, and dimensions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - WALL SWITCHES

A. Hubbell

B. Leviton

C. Pass & Seymour

D. Lutron

E. General Electric

2.02 WALL SWITCHES

A. Wall Switches for Lighting Circuits: heavy-duty.

B. Device Body: Plastic with toggle handle.

C. Voltage Rating: 120-277 volts, AC.

D. 120/277 volt wall switches shall be specification grade, rated 20 ampere and totally enclosed case.

E. Switch color to be gray, unless otherwise specified.

2.03 ACCEPTABLE MANUFACTURERS - RECEPTACLES

A. Hubbell

B. Leviton

C. Pass & Seymour

D. General Electric

2.04 RECEPTACLES

A. Specification Grade grounding type Duplex Receptacles: Type 5, 20R, gray, unless otherwise specified.

B. GFCI Receptacles: 20 Amp duplex convenience receptacle with integral ground fault current interrupter.

C. Tamper Resistant NEMA 5-20R, UL Listed Hospital Grade.

2.05 ACCEPTABLE MANUFACTURERS - WALL PLATES

A. Hubbell

B. Leviton

C. Pass & Seymour

D. Arrow & Hart

E. General Electric

2.06 WALL PLATES

A. Decorative Cover Plate: Stainless steel SS#4 unless noted otherwise.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install wall switches 48 inches to bottom above finished floor, or as shown on drawings.

B. Install convenience receptacles 18 inches to the top of box above finished floor with grounding pole on bottom.

C. Install decorative plates on switch, receptacle, and blank outlets in finished areas

D. Install devices and wall plates flush and level.

E. All devices to be grounded to box with ground jumper except isolated ground receptacles.

F. Install blank covers on all unused openings.

G. Device plates shall be marked on the inside with adhesive label (Brady) or a fine point permanent marker indicating panel and circuit number that the device is connected to.

END OF SECTION 16143

SECTION 16160

CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.01 SUMMARY

A. Hinged cover enclosures.

B. Cabinets.

C. Terminal blocks and accessories.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section

1.03 RELATED SECTIONS

A. Division 16 - All Sections.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1.05 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

A. Submit product data under provisions of Division 1.

PART 2 - PRODUCTS

2.01 HINGED COVER ENCLOSURES

A. Construction: Type 1,type 3R or type 4X as applicable.

B. Finish: Manufacturer's standard enamel finish.

C. Covers: Continuous hinge. .

D. Panel for Mounting Terminal Blocks or Electrical Components: 14 gage steel, 12 gage if floor mounted, white enamel finish.

2.02 CABINETS

A. Cabinet Boxes: Equipped with removable end walls, as indicated. Provide 3/4-inch thick fire retardant plywood backboard or galvanized steel back plate painted matte white, for mounting terminal blocks.

B. Cabinet Fronts: Steel, flush or surface type as indicated, with concealed trim clamps, concealed hinge and flush lock keyed to match branch circuit panelboard; finish in gray baked enamel.

2.03 TERMINAL BLOCKS AND ACCESSORIES

A. All terminal Blocks: ANSI/NEMA ICS 4; UL listed.

B. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw terminals, rated 600 volts.

C. Signal and Control Terminals: Modular construction type, channel mounted; tubular pressure screw terminals, rated 300 volts.

D. Power and signal/control wiring will use separate terminal blocks.

2.04 FABRICATION

A. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.

B. Provide knockouts on enclosures.

C. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum.

B. All floor-mounted equipment shall be on a 4" nominal concrete housekeeping pad.

C. No cabinet shall be supported on slab or grade.

D. Provide accessory feet for freestanding equipment enclosures.

E. Install trim plumb.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16160

SECTION 16170

CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.01 SUMMARY

A. Disconnect switches.

B. Enclosures.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 16 - All Sections

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1.05 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

A. Submit product data under provisions of Section 16010.

B. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, horsepower, and short circuit.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - DISCONNECT SWITCHES

A. Cutler Hammer.

B. General Electric.

C. Square D.

D. Allen Bradley

E. Substitutions: Under provisions of Section 16010.

2.02 DISCONNECT SWITCHES

A. Fusible Switch Assemblies:

1. Heavy Duty; UL listed, Horsepower rated, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

B. Non-Fusible Switch Assemblies:

1. Heavy Duty; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

C. Enclosures: NEMA rating as applicable.

D. Switches shall have switchblade fully visible in the “OFF” position when door is open.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install disconnect switches where specified, indicated on drawings or as required by code.

B. Install fuses in fusible disconnect switches.

C. Provide one set of spare fuses for each size of fuse used on the project.

3.02 FIELD QUALITY CONTROL

A. Testing: All contacts shall be inspected and cleaned. Each switch enclosure shall be opened for inspection of interior, mechanical linkage, electrical connections, fuse installation (if required), verification of power on load side of fuse, fuse type and rating of fuses installed.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16170

SECTION 16190

SUPPORTING DEVICES AND SEALS

PART 1 - GENERAL

1.01 SUMMARY

A. Raceway, cable tray and equipment supports.

B. Fastening hardware.

C. Wall and floor seals.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Refer to Section 16010 for coordination requirements.

B. Division 16 - All Sections.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

B. NFPA - 70: National Electrical Code.

1.05 QUALITY CONTROL

A. Support systems shall be safe and adequate for weight of equipment and conduit, including wiring, that they carry.

PART 2 - PRODUCTS

2.01 MATERIAL

A. Support Channel: Hot dipped galvanized for all locations.

B. Hardware: Corrosion-resistant steel

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using precast insert system, expansion anchors, preset inserts, or beam clamps, and caddy type fasteners.

B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

C. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit.

D. Do not drill structural steel members.

E. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

F. Install all freestanding electrical equipment on a 4" nominal concrete housekeeping pad.

G. Install surface-mounted cabinets and panelboards with minimum of four anchors.

H. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

I. Where conduit penetrates fire-rated walls, concrete and/or masonry walls and floors, seal opening around conduit with a product listed for the purpose.

J. Where conduit penetrates waterproofed floors or exterior walls subject to entry of moisture, seal annular space around conduit with a product UL listed for the purpose.

K. Route conduit through roof openings provided for piping and ductwork where possible; otherwise, route through roof jack with sealant approved by the roofing manufacturer.

L. Suspended conduit or box supports shall not be less than 1/4" diameter steel rod. Rod used as pedestal support is not acceptable. The contractor shall not use tie wire or wire of any type to support conduits, junction boxes or pull boxes.

M. No more than five (5) 1/2" conduits, three (3) 3/4" conduits or two (2) 1" conduits shall be supported on a single 1/4" diameter steel rod.

N. All conduits shall be supported by approved hangers. Supports installed and used by other trades such as duct hangers, pipe hangers, ceiling hangers, etc. shall not be used for conduit support. No conduit shall be hung from air handling duct of any type.

O. Cable tray and cable tray supports shall not be used to support conduits or other equipment. Cable tray and cable tray supports “shall stand alone.”

P. All light fixtures shall be independently supported at opposite corners from structure, or from trapeze supported from structure by the electrical contractor.

Q. Wall-mounted fixtures shall be supported from building structure with backing support as approved by the Project Manager to prevent any damage to the wall.

R. Use vibration isolation pads for vibrating equipment such as transformers.

S. Plastic or fiber anchors are prohibited.

T. Anchoring deeper than 1-1/2” in overhead cast in place, pre-tensioned or post-tensioned concrete is prohibited unless x-ray or ground penetrating radar study are performed and approved by the DIA Project Manager.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16190

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

A. Electrical power, control, signal, security, data, fiber optic, and communication conductors and raceways.

B. Operational instructions and warnings.

C. Danger signs.

D. Equipment/system identification signs.

E. Equipment Arc Flash Labels.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 16 - All Sections

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1.05 QUALITY ASSURANCE

A. Comply with "OSHA" sign standards for danger, caution, warning, etc.

1.06 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

A. Submit product data under provisions of Division 1.

B. Include schedule for all specified applications of electrical identification.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION MATERIALS

General: The manufacturer's standard products of categories and types required are to be used for each application.

A. Wire and Cable Marker:

1. For wire/cables smaller than No. 2/0 use manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic

coated type, or write-on type with clear plastic self-adhesive cover flap are to be used and numbered to show circuit identification.

2. For cables No. 4 AWG and larger heat shrink sleeving is to be used for phase color coding.

B. Plasticized Tags:

1. Manufacturer's standard preprinted or partially preprinted accident-prevention and operational tags, on plasticized card stock with matte finish suitable for writing, approximately 3-1/4-inch x 5-5/8-inch, with brass grommets and wire fasteners, and with appropriate preprinted wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.

C. Baked Enamel Danger Signs:

1. Manufacturer's standard "DANGER" signs of baked enamel finish on 20-gauge steel; of standard red, black and white graphics; 14-inch x 10-inch size except where 10-inch x 7-inch is the largest size which can be applied where needed; with recognized standard explanation wording, e.g., XXXX VOLTS, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH, etc.

D. Engraved Plastic-Nameplates:

1. All electrical equipment shall be identified unless stated otherwise. Nameplate shall be laminated phenolic black letters on a white background. Nameplates shall be attached with a minimum of two stainless steel machine screws. Embossed plastic adhesive (dymo) tape will not be accepted for nameplates.

2. Thickness: 1/16”, for units up to 20 square inches or 8 inches in length, 1/8 inch for larger units.

3. Provide phenolic nameplates with a minimum letter height as indicated below. Examples are given below for the size of letters to use for a given application and this not a list of the equipment to be identified. All equipment is required to be identified.
   a. For equipment designation: switchboards and motor control centers: 1/2 inch, panelboards: 1/4 inch. For voltage, bus ampacity, feeder source, and circuit number: 1/8 inch.
   b. Individual circuit breakers and or motor starters in motor control centers: For equipment designation and section number: 1/4 inch, for load served and location of load: 1/8 inch. Inside the door, a typed label shall provide complete motor data including nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
   c. Individual breakers in switchgears and switchboards: for breaker number (address number) and equipment designation; 1/4 inch, for breaker frame size and trip setting; 1/8 inch
   d. Individual circuit breaker and spaces in panelboards: for numbers (section number) 1/4 inch.
   e. Individual circuit breakers in distribution panelboards: 1/4 inch for panel being fed and 1/8 inch for its location.
   f. Transformers: 1/4 inch for equipment designation and size; 1/8 inch for primary and secondary voltages, primary source and circuit number, secondary load and its location.
   g. Individual remote indicating lights, meters, instruments and control switches: 1/8 inch, indicate unit, equipment, or fire detector being monitored and condition indicated by illumination.
   h. Individual switches and pilots: 1/8 inch, identify mechanical unit being served.

i. Disconnects, relay panels, lighting contactors: 1/4 inch for 1/8 inch for voltage and source circuit number.

4. All branch circuit panelboards shall have a typed panel schedule indicating the type of equipment served and its location. Contractors name and date.

E. Lettering and Graphics:

1. Numbers, lettering and wording as required or as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment shall be used. Gothic letters shall be provided.

F. Equipment Arc Flash Labels:

1. General: Self-adhesive or pressure-sensitive, preprinted, flexible vinyl signs for arc flash warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, as required by NEC.

a. Equipment Labels: As required by NEC for switchboards, panelboards, industrial control panels, meter socket enclosures and motor control centers and are likely to require examination, adjustment, serving or maintenance while energized shall be field marked to warn persons of potential electric arc flash hazards.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements:

1. Laminated plastic nameplates shall be fastened with two machine screws.

B. System Color Coding Schedule:

1. Where electrical emergency power is exposed, conduit shall be painted with “RED” stripes on each section every 5 feet of electrical conduit (visible from the floor or above a suspended ceiling) and within 3 feet of all equipment.). All junction or pull boxes shall have the cover painted red.

2. Paging system conduits shall have “GREEN” bands painted, 5’ on centers for the entire length of conduit run. All junction or pull boxes shall have the cover painted green with the associated zone number written neatly on the box cover with permanent marker.

3. Temperature control conduits shall have “BROWN” bands painted, 5’ on centers for the entire length. All junction or pull boxes shall have the cover painted brown.

4. Fire Alarm conduit shall be a continuous red factory finish

C. Cable/Conductor Identification:

1. The application of cable/conductor identification, with circuit number, on each wire / cable in each box/enclosure/cabinet is required. The identification shall match the marking system used in panelboards, shop drawings, and contract documents.

D. Junction Box and Pull Box Identification:

1. On the cover of each junction box or pull box: the panel name and circuit number(s) of the enclosed conductors are to be legibly written with a black permanent ink broad tip marking pen. The system shall be identified for: FO (fiber optics), CCTV (closed circuit television), PA (paging system), RF (radio frequency), FA (fire alarm) , EM (emergency work) TC (temperature control).

2. Covers for emergency system junction boxes and pull boxes shall be painted red.

3. Covers for the Fire Alarm System junction boxes and pull boxes shall be painted red.

E. Operational Identification and Warnings:

1. Wherever required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures shall be provided. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

F. Danger Signs:

1. Critical Switches/Controls: Danger signs shall be provided on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation could result in danger to persons, or damage to equipment, or damage to or loss of property.

G. Caution Signs:

1. The following red caution sign is to be provided for all circuit breakers and switchboards where turning off a circuit will automatically start an emergency operation:
   a. "Caution Turning Off this Circuit will Automatically Start Emergency Operation”

2. The following red caution sign is to be provided for all automatic transfer switches, switches, circuit breakers, equipment, and emergency panels that are energized by the emergency power system:
   a. "Caution Automatically Energized by Emergency Power Supply System"

H. Equipment/System Identification:

1. An engraved plastic-laminated sign is to be provided on each unit of electrical equipment furnished; including central or master unit of each electrical system including communication/control/signal/alarm systems. Provide single line of text, letter height as specified, black lettering on white field for normal. Provide text matching terminology and numbering of the contract documents and shop drawings. The sign shall include unit designation, source circuit number, circuit voltage, and other data specifically indicated. Also, the sign shall indicate normal source circuit number ("Fed from . . ."). Include signs for each unit of the following categories of electrical work: List is not inclusive.
   a. Switchboards, panelboards (include main bus ampacity on sign), electrical cabinets and enclosures.
   b. Access panel/doors to electrical facilities.
   c. Disconnect switches.
   d. Push buttons, selector switches, indicating lights. (Circuit number and voltage not required on sign).
   e. Relays
   f. Individual distribution circuit breakers

2. The installation of signs are required at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. The sign shall be secured to the substrate

with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.

3. All panelboards shall have a typed panel schedule indicating the date, contractor, type of equipment served and its location.

I. Equipment Designation (See Next Page)

J. Equipment Arc Flash Labels:

K. Install Arc Flash Warning Labels as required by NEC for switchboards, panelboards, industrial control panels, meter socket enclosures and motor control centers and are likely to require examination, adjustment, serving or maintenance while energized shall be field marked to warn persons of potential electric arc flash hazards.

3.02 ELECTRICAL PANEL NAMING CONVENTIONS

Naming Disconnects and Transformers

Disconnects shall have the same as the equipment they serve.

Transformers shall have the same name as the low-voltage panel they supply power to with the extension of **-X**

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16195

SECTION 16270

MEDIUM VOLTAGE VARIABLE FREQUENCY DRIVE (MVVFD)

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the complete labor, materials, equipment and accessories required to place into operation an integrated medium voltage variable frequency drive (MVVFD) system.

B. Every MVVFD system shall consist of all system components required to meet the performance, protection, safety, testing, and certification criteria of this specification. These components may include input harmonic filter, power factor correction, input isolation transformer, converter/DC-link/inverter, and output filter.

C. The MVVFD system shall be completely factory pre-wired, assembled and then tested as a complete package by the MVVFD manufacturer, to assure a properly coordinated, fully integrated drive system.

D. The MVVFD manufacturer shall be able to demonstrate at least ten (10) years of experience in manufacturing MVVFD's at medium voltage, to demonstrate their capability to provide parts and service support. A user's list of similar design equipment, complete with contact names and telephone numbers, shall be furnished upon request.

1. It is the intention of this specification to purchase dependable and reliable equipment offering the best performance available from currently proven technology. All equipment furnished under this contract must, therefore, have documentation showing proof of actual operation for a minimum of three (3) years in similar service. New components or design topologies that have less than three years of actual operating experience will not be acceptable.

E. Related Work Specified Elsewhere:

1. Wires and Cables: SECTION 16120.
2. Electrical Connections for Equipment: SECTION 16142.
3. Electrical Identification: SECTION 16195.
4. Grounding: SECTION 16452.

1.02 REFERENCES:

A. Applicable Standards:

1. American National Standards Institute (ANSI):
   a. C37.20.3 – Metal Clad and Station-Type Cubicle Switchgear
   b. C57.12.01 - General Requirements for Dry-Type Distribution and Power Transformers.
   c. C57.12.51 - Requirements for Ventilated Dry-Type Power Transformers, 500 kVA and larger, Three-Phase with High-Voltage 601-34,500 Volts, Low Voltage

208Y/120 to 4,160 Volts.

d. C57.12.91 - Test Code for Dry-Type Distribution and Power Transformers.

e. C57.16 – Test Code for Current-Limiting Reactors

f. C57.18.10 – Semiconductor Power Rectifier Transformers.

g. C57.110 – Establishing Transformer Capacity When Supplying Nonsinusoidal Load Currents.

h. C62.11 – Metal-Oxide Surge Arresters for AC Power Circuits.

2. Federal Communications Commission (FCC):
   a. FCC Part 18 – Industrial, Scientific and Medical Equipment.
3. Institute of Electrical and Electronic Engineers (IEEE):
   a. 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters Pertaining to Motor Controllers.
4. National Electrical Manufacturer's Association (NEMA):
   a. ICS 1 – Industrial Control and Systems: General Requirements.
   b. ICS 2 – Industrial Control and Systems: Controllers, Contactors and Overload Relays Rated not more than 2000 volts AC or 750 volts DC.
   c. ICS 3 - Industrial Control and Systems: Medium Voltage Controllers rated 2001 to 7200 volts AC.
   d. TR1 – Transformers, Regulators and Reactors.
5. National Fire Protection Association (NFPA):
   a. 70 – National Electrical Code.
6. Underwriter's Laboratories (UL):
   a. 347 – High Voltage Industrial Control Equipment.
   b. 1561 – Large General Purpose Transformers.

1.03 SUBMITTALS:

A. Refer to DIVISION 1 and SECTION 16010 – BASIC ELECTRICAL REQUIREMENTS for administrative and procedural requirements for submittals.

B. Includes but limited to the following:

1. Product Data and Shop Drawings: Submit manufacturer's data on MVVFD.
   a. Equipment dimensions, including stub-up locations, shipping splits and shipping weights.
   b. Block diagram showing the basic control and protection systems specifying the protection, control, trip and alarm functions at the different locations, the reference signals and commands and the auxiliary supplies.
   c. Electrical single line diagram showing main and auxiliary circuitry, including main power input, transformer, MVVFD, system grounding and auxiliary supplies - showing all CT's, PT's, relays, meters, for the control, protection and operation of the drive system with electrical data (i.e. voltage, current, time ratings, impedances, tolerances).
   d. Catalog data indicating input power, system efficiency, power factor, voltage and current harmonic distortion at 25%, 50%, 75% and 100% load.
   e. Control schematics clearly indicating factory and field wiring for all power, control and instrumentation systems.

f. Recommended spare parts list.
g. Certifications.
h. Warranty.
i. Operations and maintenance manuals.
j. All factory and field test data.

1.04 QUALITY ASSURANCE:

A. MVVFD shall be manufactured, assembled, tested and provided with a UL label.

B. All inspection and testing procedures shall be developed and controlled under the guidelines of the Supplier's quality system. This system must be registered to ISO 9001 and regularly reviewed and audited by a third party registrar.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Handle MVVFD equipment carefully to prevent damage, breaking, and scoring. Do not install damaged sections or components; replace with new.

B. Store MVVFD equipment in a clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with manufacturer's rigging and moving instructions for unloading MVVFD and transporting them to final location for installation.

1.06 SEQUENCING AND SCHEDULING:

A. Sequence equipment installation work with other work to minimize possibility of damage and soiling during remainder of construction period.

1.07 WARRANTY:

A. All equipment furnished under this section shall be warranted by the contractor and the equipment manufacturer(s) for a minimum period of one (1) year after substantial completion.

1.08 COORDINATION:

A. Coordinate the size and location of concrete equipment pads. Concrete, reinforcement, and formwork are specified in DIVISION 3.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allen Bradley – PowerFlex 7000.
2. Robicon – Perfect Harmony Series.
3. No substitutions.

2.02 GENERAL:

A. The MVVFD shall produce a variable voltage variable frequency output to provide continuous operation over the application range of a standard AC squirrel cage induction motor. The MVVFD shall be capable of operating with the output short circuited at full current or with the output open circuited at rated voltage.

B. The MVVFD shall be capable of producing a variable AC voltage/frequency output to provide continuos operations over the normal system 30-100% speed range. The MVVFD must be capable of sustained operation at 1/10 speed to facilitate checkout and maintenance of the driven equipment. As a commissioning and troubleshooting feature, the MVVFD power circuit shall be capable of operating without a motor connected to the MVVFD output.

C. Unless specified otherwise, for constant torque loads (extruders, mixers, reciprocating compressors & pumps, conveyors), the MVVFD shall be capable of a momentary overload of 150% of rated motor current for one minute out of any ten minutes.

D. The MVVFD shall be able to produce full rated torque at any speed in the operating range (constant torque capability).

E. System Efficiency:

1. Guaranteed minimum total MVVFD system efficiency (ηsys) shall be a minimum 95% at 100% speed & 100% load and minimum 95% at 80% speed & 50% load. Efficiency evaluation shall include input transformer, harmonic filter and power factor correction (if applicable), MVVFD converter, and output filter, as indicated below. Auxiliary controls, such as internal MVVFD control boards, cooling fans or pumps, shall be included in all loss calculations. The MVVFD system efficiency is as follows: $\eta_{sys} = \eta_{VFD} \times \eta_{xfmr} \times \eta_{pfc} \times \eta_{harm} \times \eta_{filter}$
   a. Converter/Inverter efficiency (ηVFD)
   b. Input transformer efficiency (ηxfmr)
   c. Power factor correction efficiency (ηpfc)
   d. Input harmonic filter efficiency (ηharm)
   e. Output filter efficiency (η_{filter})
2. A factory test shall be performed at the MVVFD manufacturer's facility certifying that efficiencies have been met.

F. System Power Factor:

1. MVVFD system shall maintain a 0.95 lagging minimum true power factor from 30% to 100% of rated speed. MVVFD system including power factor correction and/or harmonic filter shall never have a leading power factor under utility or generator operation. MVVFD manufacturer is to supply a power factor correction system, if required, to meet this requirement. Power factor correction unit shall include a separate input isolating contactor with fuses, power factor correction grade capacitors (voltage class shall be consistent with the MVVFD system input voltage), and series harmonic de-coupling reactors, all integrated into MVVFD system and mounted within the MVVFD enclosure.

G. Maintenance Features:

1. The system shall be designed for front access only. All power components for the converter shall be modular in design to minimize repair time and provide ease of maintenance.

2. All low voltage components, circuits and wiring shall be physically separated from medium voltage circuits.

3. A backlit LCD display operator interface shall be provided to aid in troubleshooting the system to identify failed components.

2.03 MOTOR COMPATIBILITY:

A. The MVVFD shall provide near sinusoidal voltage and current waveforms to the motor at all speeds and loads. Output current total harmonic distortion (THD) shall be less than 5 percent (%) operating from 10% to 100% speed regardless of load. Standard induction motors shall not require de-rating or upgraded turn-to-turn insulation and shall not require additional service factor. The motor insulation system shall not be compromised thermally or due to dv/dt stress. The dv/dt at the motor terminals (line-to-line) shall be limited to 10 volts per microsecond. If dv/dt at the motor terminals (line-to-line) exceeds 10 volts per microsecond, the manufacturer must state the actual value and include steps taken to guarantee the long term life of the motor insulation system.

B. The motor insulation system shall not be compromised due to excessive peak voltage of the output waveform. Motor peak line-to-line output voltage shall be limited to 5,883 volts peak for a 4,160 volt system. If the motor peak line-to-line output voltages exceed this value the manufacturer shall clearly state the actual value with the product submittal.

C. The MVVFD shall provide stable operation of the motor without compromising the motor insulation system, regardless of motor cable distance. The manufacturer shall clearly state the limitations in motor cable distance with the proposal. If an output filter is required to mitigate reflected waves, or to meet any special requirements of the application, it must be integral to the MVVFD controller.

D. If output filters are used in the MVVFD, a selective harmonic elimination (SHE) switching technique must be available to eliminate a potential harmonic resonance in the operating speed range.

E. MVVFD induced torque pulsations to the output shaft of the mechanical system shall be less than 1% to minimize the possibility of exciting a resonance.

2.04 POWER QUALITY:

A. Input harmonics shall comply with IEEE 519 for total harmonic distortion (THD) for voltage and current waveforms. For the purpose of the specification the point of common coupling is the input terminals to the MVVFD.

B. Input Voltage Harmonics: Individual or simultaneous operation of the MVVFD's shall not add more than 3% total harmonic voltage distortion while operating from 10% to 100% speed regardless of load from the utility source.

C. Input Current Harmonics: Maximum allowable total harmonic current distortion limits for each MVVFD shall not exceed 5% operating from 10% to 100% speed regardless of load as measured at the point of common coupling.

D. The MVVFD converter section shall be designed to eliminate the need for harmonic filters. Provide a pulse width modulating (PWM) active or 18-pulse (minimum) rectifier front end with isolation transformer shall be used to comply with harmonic limitations. Harmonic filters are undesirable due to the necessity to modify the filters to avoid resonance problems and correct tuning whenever other inductive/capacitive loads are placed on the system or when the power system changes.

E. Compliance shall be verified by the MVVFD manufacturer with field measurements of harmonic distortion differences at point of common coupling with and without MVVFD's operating.

F. Power quality metering shall be provided in the MVVFD enclosure. The metering system shall continuously monitor and display the input and output variables.

1. Provide three-phase multi-function, digital meter, with true RMS metering accurate to 31st harmonic and 1% accuracy class. Meter shall have six-digit LED display and touch-pad that selects meter function, phase (A, B, C, Neutral), plus minimum, maximum and alarm mode of each meter function. Meter rated for 120V inputs and 5-ampere current inputs. Meter functions shall consist of the following:
   a. Ammeter.
   b. Phase-Phase Voltmeter.
   c. Phase - Neutral Voltmeter.
   d. Input Wattmeter.
   e. Input Varmeter.
   f. Power Factor Meter.
   g. Frequency Meter.
   h. Demand Ammeter.
   i. Demand Wattmeter.
   j. Demand Volt-Ampere Meter.
   k. Watthour Meter.
   l. Varhour Meter.
   m. Current Waveform Total Harmonic Distortion Percent Meter.
   n. Voltage Waveform Total Harmonic Distortion Percent Meter.
   o. K-factor Meter.
   p. Motor voltage.
   q. Motor current.
   r. Motor kW.
2. Potential Transformers (PT): Current limiting fused, mounted on disconnecting primary type carriages with grounding devices, cast epoxy resin or butyl molded insulated or equal, 4200- 120-volt, 400-VA thermal rating in 55 degrees C ambient, with accuracy classification of 0.3 W, X, Y, Z, ZZ, and M. Wire to set of terminal blocks for easy external connection.
3. Current Transformers (CT): Dry type, toroidal bushing or wound type, with ratio as indicated, or as required for application. "C" or "T" accuracy classification in conformance with ANSI C37.20.2, Table 5, except that for phase current transformers, accuracy classification shall be not less than C20 or T20. Current transformers for differential circuits shall not be less than C400. Series connections of low ratio current transformers are acceptable to maintain accuracy specification.

2.05 SYSTEM COMPONENT REQUIREMENTS:

A. Input and Output Power Terminations:

1. Input and output power terminations shall be made to isolated supported bus. Cable terminations shall be the type as specified in SECTION 16142.

B. Short Circuit and Overcurrent Protective Devices:

1. The system input power is provided by existing medium voltage motor starters indicated on one-line diagrams. The MVVFD manufacturer shall provide coordination settings for the input power protective devices.

2. The system shall include power fuses on the input to the converter rectifier devices to protect the secondary of the transformer from any fault currents.

C. Main Power Bus and Wiring:

1. Main power bus shall comply with NEMA ICS 3 and UL 347 for insulated tin-plated copper for chemical and corrosion resistance and low losses. Bus shall be appropriately sized for the MVVFD continuous current rating and braced to withstand the mechanical forces caused by a momentary short circuit current of 50 kA expected at the bus. All connections shall be bolted or continuously welded.

2. Ground Bus: A continuous copper ground bus shall be provided along the entire length of the MVVFD.

3. All control wiring shall be physically separated from the power wiring. Low and high voltage cables shall be physically isolated from each other. The MVVFD system shall be pre-wired within the enclosure. No soldering shall be used in connection with any wiring. Wiring shall be adequately supported to avoid tension on conductors and terminations. All wiring shall be run in wire-ways. Any section of wiring outside of wire-way shall be securely tied with cable ties at intervals not exceeding six inches. No cables shall be tied off to or in any way supported from power busses. Wherever wiring passes metal edges or through holes, suitable guards or grommets shall be provided to prevent cutting or chafing of the insulation.

4. All wiring shall be tagged with permanent labels at each termination, junction box, and device. Labels shall correspond to the schematic and wiring diagrams.

D. Input Isolation Transformer:

1. The MVVFD system is to be supplied with a drive isolation transformer that complies with the applicable parts of ANSI C57.12.51, C57.12.19, C 57.18.10 and UL 1561 to provide common mode voltage protection and phase shifting as required. MVVFD systems utilizing input three phase AC line reactors which require motors equipped with special higher voltage rated insulation systems are not acceptable and will not be allowed as an alternate bid.

2. Transformer design to be a rectifier grade isolation type with a K-Factor of 12 for variable torque loads or a K-Factor of 20 for constant torque loads when applied to a SCR converter, in accordance with current ANSI Standard C57.110. A K-Factor of 6 is required for diode rectifier converters. Transformers shall have a basic impulse level (BIL) rating of 30kV for 4,160-volt primary in accordance with the requirements of ANSI/IEEE Standard C57.12.01.

3. Dry type transformers with maximum 115°C rise and minimum 220°C insulation with over-temperature protection.

E. MVVFD Features:

1. Active PWM front end or 18-pulse (minimum) inverter to meet harmonic voltage and current distortion limits.

2. Power Interrupt Ride-Through: The system shall be capable of continuous operation in the event of a power loss of 5 cycles or less.

3. Power Sag Ride-Through: The system shall be capable of continuous operations with a 30 percent voltage sag on the input power source.

4. Auto Restart: The system must be capable of automatically restarting in the event of a process or drive trip. The system shall provide the Owner with the choice of automatically restarting or not. The user shall be able to selectively apply this feature to some (but not necessarily all) conditions as determined by the Owner to be appropriate for the specific application.

5. Ground Fault Withstand: In the event of a ground fault, the system shall be capable of annunciating the ground fault condition, safely operating and, by Owner selection, either trip or continue operation. As a result of a ground fault trip, the system shall be capable of being reset and operating normally. There shall be no risk of fire or electric shock as a result of the ground fault.

6. Drive Protection: The system shall have the following minimum protection features:
   a. Under voltage (adjustable)
   b. Over voltage (adjustable)
   c. Instantaneous over current (adjustable)
   d. Ground fault (adjustable)
   e. Overload (adjustable)
   f. Short circuit protection (instantaneous over current)
   g. Over voltage (adjustable)
   h. Motor over speed (adjustable)
   i. Gate driver power supply under voltage
   j. Control power over / under voltage and signals
   k. Over temperature protection

7. Motor Protection Features:
   a. Electronic motor overload protection shall be supplied as standard.
   b. A motor stall protective function will be supplied on all units. The amount of time the drive will be allowed to run at current limit under minimum speed shall be adjustable.

F. DC Link Inductors:

1. DC link inductors shall be air core to prevent saturation. Separate inductors (split dual winding type) shall be provided in the positive and negative leg of the DC link to minimize stray magnetic fields. Maximum temperature rise shall not exceed 115°C with minimum 220°C insulation and over-temperature protection. To minimize cabling costs the inductors shall be integral to the MVVFD system lineup. Inductors shall meet the requirements of ANSI C57.16 and shall be designed to prevent saturation under maximum fault current conditions.

G. DC Link Capacitors:

1. Capacitors used in the converter DC link shall be integral to the MVVFD system lineup to minimize cabling costs.

2. Capacitors used in the converter DC link shall contain discharge resistors and capable of reducing the residual charge to 50 volts or less within five minutes after the capacitor is disconnected from the source of supply.

H. Control Power and Interlocks:

1. To power the cooling system and low voltage control circuits, an auxiliary power supply of 480-volt, three phase shall be manufacturer provided. The system shall provide for control power distribution and transformation if required internal to the system enclosure.

2. All MVVFD control circuits shall be 120 VAC single phase. Manufacturer shall provide an internal control power transformer suitably rated to provide all MVVFD required control power.

3. Mechanical key interlocks shall be provided on all doors. Interlocking shall be fully coordinated to prevent access to all high voltage compartments, including transformer, filters when line power is applied to the system. Interlocks must be mechanical to provide positive lock-out prevention and safety. Electrical interlock switches alone are not acceptable, due to the possibility of inadvertent shutdown and the ease with which such switches could be bypassed.

I. Enclosure:

1. All MVVFD system components including transformer shall be mounted and wired by the MVVFD system manufacturer in a grounded enclosure. Enclosures shall comply with applicable parts of NEMA ICS 1, 2, 3.

2. Input filters, transformer, power conversion, output filters and auxiliary equipment enclosure sections shall be NEMA 1 gasketed. Air-cooled units shall be NEMA 1 gasketed and ventilated doors. Air-cooled units shall have clean-able filter media covering all air inlets. Inlet air filters shall be 100% washable, with a progressively structured, corrosion-free media. Filters shall be front replaceable (for cleaning) while the MVVFD is in operation without exposing maintenance personnel to any of the power components. Cabinet color shall be ANSI 61 Gray. Paint procedures and materials shall be manufacturer's system designed and proven for resistance to chemical attack in industrial environments.

3. Microprocessor and control logic boards and their power supplies shall be housed in a sealed, non-ventilated NEMA 1 gasketed section, safely accessible without exposure to high voltages and without drive shutdown. All low voltage wiring shall be fully isolated from medium voltage compartments by metal barriers.

4. Cabinets and doors shall be fabricated using heavy gauge steel (12-gauge minimum) for sturdy construction and dimensional integrity to assure long-term fit and function. All doors shall be gasketed to provide environmental protection and secure fits.

5. Enclosures must be designed to avoid harmonic and inductive heating effects. When specified, the enclosure must be designed to shield any outside equipment from interference, enclosing and shielding the complete to eliminate any radio frequency interference in compliance with FCC Part 18 requirements.

J. Air-Cooling System:

1. The MVVFD system shall be air-cooled.

2. Air-cooled MVVFDs shall be provided with a mixed flow cooling fan, mounted integral to the MVVFD enclosure. The MVVFD shall include air-flow pressure switches or monitor fan motor current and temperature detectors to monitor proper operation of the air cooling system. If a fan fails, the system must generate alarm indication of the fan failure. Vane type air-flow switches are not acceptable.

K. Environmental:

1. MVVFD system shall be capable of continuous operation in an average ambient temperature between 0°C and 40°C at an elevation up to 5,500 feet above mean sea level without derating. The MVVFD system shall also be simultaneously suitable for continuous operation in a maximum humidity between 0 and 95% non-condensing.

2. Maximum allowable audible noise from the MVVFD system will be 85dB(A) at a distance of one 3.3 ft at any speed or load condition.

L. Operator Interface:

1. A door-mounted keypad with integral digital LCD display shall be furnished, capable of controlling the MVVFD and setting drive parameters. The display must present all diagnostic message, on-line help system and parameter values in standard engineering units when accessed, without the use of codes. The keypad shall allow the operator to enter exact numerical settings in standard engineering units. A plain English language user menu (rather than codes) shall be provided in software as a guide to parameter setting.

2. Drive parameters shall be factory set in non-volatile EEPROM registers and re-settable in the field through the keypad. A minimum of four (4) levels of password security shall be available to protect drive parameters from unauthorized personnel. The EEPROM stored drive variables must be able to be transferred for programming of new or spare boards.

3. The keypad module shall contain a “self-test” software program that can be activated to verify proper keypad operations.

4. The MVVFD system shall have the user selectable option of programming up to three speed avoidance bands. This gives the user the ability to block out and prevent operation at any undesirable speed, such as one that may be coincident with a mechanical resonance condition.

M. System Inputs and Outputs:

1. Sixteen (16) isolated digital inputs and sixteen (16) isolated digital outputs shall be available as standard on the drive, rated from 12V to 260V AC or DC. Hardwired I/O will be for future use.

2. Isolated analog signal interfaces shall be configurable for:
   a. Speed reference input (4-20 mA input signal).
   b. Speed output (4-20 mA output signal).
   c. Voltage output (4-20 mA output signal).
   d. Current output (4-20 mA output signal).
   e. Load (kW) output (4-20 mA output signal).
   f. Torque output (4-20 mA output signal).

3. The MVVFD shall be controlled locally via start/stop push buttons, emergency stop push button, local/remote selector switch, and speed reference potentiometer.

4. Digital inputs (DI) and outputs (DO) shall be provided to interface with the plant control system as follows:
   a. Start/Stop (DO)
   b. Motor running (DI)
   c. In remote (DI)
   d. Minor fault (DI)
   e. Failed (DI)

5. Drive shall communicate over BACnet MS/TP Drive will communicate on a BACnet network.

N. Spare Parts: The following spare parts shall be furnished:

1. Three (3) of each type of power and control fuses.
2. Four (4) of each type of power semiconductor.
3. Five (5) of each type of indicator lamps.
4. One (1) of each type of control and gate firing printed circuit board.
5. One (1) quart of touchup paint.

PART 3 - EXECUTION

3.01 INSPECTION:

A. Examine areas and conditions under which MVVFD are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF MVVFD:

A. Install a concrete equipment pad for each MVVFD as indicated.

B. Install MVVFD as indicated, in accordance with equipment manufacturer's written instructions, with recognized industry practices, complying with applicable requirements of ANSI, IEEE, NEC, NEMA, and UL.

C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors.

D. Adjusting and Cleaning: Adjust operating mechanisms for free mechanical movement. Touch-up scratched or marred surfaces to match original finishes.

E. Grounding: Provide equipment grounding connections for motor control centers as indicated. Grounding shall conform to SECTION 16452.

F. Manufacturer to provide coordination settings for all protective devices to the contractor prior to startup.

3.03 FIELD QUALITY CONTROL:

A. Field Quality Control:

1. Provide the on-site services of the manufacturer's service representative for the direct supervision of inspection, start-up, final adjustments, operational tests functional tests and owner training of all MVVFDs. Provide 8 hours of on-site training of the Owner's personnel on the start-up, operation, troubleshooting, servicing, and preventative maintenance of the variable frequency drives. Submit all meter readings and field test results.
2. Verification of MVVFD input harmonic voltage and current distortion limits specified shall be verified at rated speed and power as part of the final startup and acceptance. Record and submit test results.
3. Prior to energization of MVVFDs, check with insulation resistance tester for proper values of phase-to-phase and phase-to-ground insulation resistances. Record data and submit.
4. Check all equipment grounds for continuity.
5. Remove all blocking material used for shipment.
6. Check motor overload relays for proper current range in accordance with motor nameplate full load amperes. Adjust relays for manual reset.
7. Check control relay coils for proper operating voltage.
8. Clean all contacts and magnetic surfaces.
9. Check all auxiliary contacts for correct arrangement (N.O. or N.C.).
10. Check all fuses, circuit breakers and motor circuit protectors for proper rating.
11. Check connectors for tightness.
12. With motor disconnected, energize control circuits and test for correct operation.
13. Adjust timing cycle of all time delay relays.
14. Prior to energization of circuitry, check MVVFD equipment ground continuity, and electrical circuits for continuity. Check for short circuits.
15. Adjust all overcurrent and short circuit protective device settings to values provided by the manufacturer.
16. Ensure that direction of rotation of each motor fulfills requirements. Correct if necessary.
17. Run the MVVFD motor system through the operational speed range and tune the drive to avoid damaging mechanical harmonic frequencies.

B. Provide identification in accordance with SECTION 16195.

PART 4 - - MEASUREMENT

1.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - - PAYMENT

1.02 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16270

SECTION 16354

MEDIUM VOLTAGE MOTOR CONTROLS AND CENTERS

PART 1 - GENERAL

1.01 SUMMARY

A. The contractor shall furnish and install all medium voltage motor controls and centers, mounting hardware, etc., as required for complete installation as indicated on the drawings.

B. New motor starter sections shall matchup to and attach to existing motor control center G.E, Limitamp 5kV gear. Reference drawing E5.02. New MCC bus shall matchup and bolt directly to existing MCC bus.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements, Section 16010, and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 16 - Electrical: All Sections

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

B. Medium-voltage starters shall be designed, manufactured, assembled, and tested in accordance with the following standards:

1. ANSI/NEMA ICS-3-Part 2.
2. UL 347, High Voltage Industrial Control Equipment.

1.05 CODES, REGULATIONS, AND STANDARDS

A. All work shall be in strict accordance with all applicable codes including Building Code for the City and County of Denver, National Electrical Code (NEC), National Fire Protection Association (NFPA), and Life Safety Code (NFPA 101).

1.06 MATERIAL STANDARDS

A. All material supplied shall be new and shall be equal to or exceed minimum requirements set by American National Standards Institute (ANSI), Underwriter's Laboratories (UL), and National Electrical Manufacturer's Association (NEMA).

B. All equipment supplied under this section shall be produced by a single Manufacturer and be of similar construction and appearance.

1.07 CONSTRUCTION DRAWINGS

A. The drawings are diagrammatic and indicate the general arrangement of electrical work. Locations are approximate and shall be subject to minor modifications as dictated by field conditions and as directed by DIA Project Manager.

1.08 SUBMITTALS

A. Product data: Including manufacturer's name and product number, electrical ratings, dimensions, mounting position, mounting method, materials, descriptive bulletins and product sheets apply to this Section.

B. Shop Drawings: Detail fabrication and installation of medium voltage assemblies including plans, elevations, sections, component details, and attachments to other construction elements. In addition the following information is required:

1. Master Drawing Index.
2. Front view elevation.
   a. Mimic bus layout.
3. Floor plan.
4. Top view.
5. Complete one-line diagram.
6. Complete three-line diagram.
7. Relaying and control schematic diagram.
8. Wiring diagrams shall reflect the physical location of components. Destination labeling shall be used.
9. Nameplate schedule.
10. Component list.
11. Conduit entry/exit locations.
12. Assembly ratings including:
    a. Short-circuit rating.
    b. Voltage.
    c. Continuous current.
    d. Basic impulse level for equipment over 600 volts.
13. Major component ratings including:
    a. Voltage.
    b. Continuous current.
    c. Interrupting ratings.
14. Cable terminal sizes.
15. Where applicable, the following additional information shall be submitted to the DIA Project Manager:
    a. Busway connections.
    b. Connection details between close-coupled assemblies.
    c. Composite floor plan of close-coupled assemblies.
    d. Interlock scheme drawing and sequence of operations.

C. Manufacturer’s System Start-Up Plan

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

F. Quality Assurance Submittals:

1. Design Data, Test Reports, Certificates, Manufacturers' Instructions, Manufacturers' Field Reports, Qualification Statements.

G. Closeout Submittals:

1. The following information shall be submitted for record purposes:
   a. Final as-built drawings in hard copy and electronic format (AutoCAD 2010).
   b. Certified production test reports.
   c. Installation information including equipment anchorage provisions.
   d. Seismic certification.
2. Operation and maintenance manuals shall include the following information and comply with Section 01300 Submittals – Operation and Maintenance Data and Manuals:
   a. Instruction books and/or leaflets.
   b. Recommended renewal parts list.

1.09 QUALITY ASSURANCE

A. Qualifications

1. The Manufacturer of this equipment shall have been pre-qualified by OWNER.
2. When requested by the ENGINEER, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Source Limitations: Obtain enclosed bus-assembly components through one source from a single manufacturer.

C. Comply with NFPA 70 for components and installation.

1.10 WARRANTY

A. The entire electrical system installed under this contract shall be guaranteed per General Conditions. Extended warranties shall be per Section 01700-Contract Closeout.

1.11 SEQUENCING AND SCHEDULING

A. The enclosed medium voltage motor controls equipment installation is to be sequenced and scheduled with other work to reduce possibility of damage and soiling of equipment during the remainder of construction period.

1.12 MAINTENANCE

A. Furnish extra materials including 10 percent of installed components, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver materials as directed by DIA Project Manager.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading

1. Equipment shall be handled and stored in accordance with Manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

B. Storage and Protection

1. Equipment being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition. If stored outdoors indoor gear shall be covered and heated, and outdoor gear shall be heated.

1.14 PROJECT CONDITIONS

A. Field Measurements: Verify existing dimensions by field measurements. Verify clearances and locate obstructions within manufacturing and installation tolerances of enclosed bus assemblies.

B. Project Environmental Requirements

1. Altitude: 5500 ft.
2. Temperature: 0 to 104°F.

1.15 OWNER'S INSTRUCTIONS

A. Manufacturer, without prior written approval from DIA Project Manager, shall not assign or subcontract any portion of this contract unless expressly stated in the proposal. Any such assignments or subcontracts, whether in the original proposal or agreed upon subsequent to the issuance of the purchase order, shall neither change the obligations nor relieve the Manufacturer of any liability under this contract.

B. OWNER has the right to reject any or all proposals under this specification. OWNER, at its sole discretion, has the right to accept the proposal which OWNER and its ENGINEER deem to be in OWNER's best interest. Bidder agrees to this stipulation upon submitting a proposal.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. The Manufacturer shall furnish a new lineup of 5kV, indoor, medium voltage motor starters complete with all wiring and equipment in order to provide a complete and operable lineup. The equipment shall be as specified herein and shall be in conformance with the standards listed. The Manufacturer shall send a representative to the site to take measurements to ensure a compatible system. New sections must be mated up to existing G.E. Limitamp MCC.

1. General Electric Company (G.E.).
2. Pedersen Power Products.
3. Powell Electric.
4. Central Electric Company.

2.02 EQUIPMENT

A. The starters shall be designed to accommodate motors of the size and type as shown on the drawings.

B. The starters shall be non-reversing to accommodate the following motor types, as indicated on drawings:

1. Induction Motor Full-Voltage Start.
    a. Starters will be utilized as feeders for remote mounted, medium voltage, variable frequency drives.

C. In addition to components shown on the drawings, the following equipment shall be provided for the starter type indicated in paragraph 2.02 B

1. Each induction motor full voltage starter shall include as a minimum:
    a. Medium-Voltage Section:
        1) Three – Isolated vertical line connectors.
        2) One – Three-pole isolating switch.
        3) Three – Current limiting power fuses.
        4) One – Draw out three-pole main vacuum contactor assembly.
        5) One – Control circuit transformer 2 kVA.
        6) Two – Control circuit primary current limiting fuses.
        7) One – Control circuit secondary fuse.
        8) One – Run-test circuit.
        9) Four – Electrical interlocks.
        10) Three – Current transformers.
        11) Three – Load terminals.
        12) One – Zero sequence ground fault current transformer where indicated.
    b. Low-Voltage Removable Panel:
        1) One – Motor Protection Relay (G.E. Multilin 369).
            a) RTD monitoring.
            b) Over/Under voltage protection.
            c) Loss of phase protection.
            d) Out of step protection.
            e) Starting overload protection.
            f) V, W, VAR, VA, and PF metering.
            g) Event recording
            h) Short circuit protection.
            i) Ground fault protection.
            j) Power factor protection.
        2) One – Interposing control relay.
        3) One – Set of control circuit terminal blocks.

2. Each two-starter motor control center shall include:
    a. Two metering potential transformers.
    b. Three current limiting primary fuses.
    c. Two current limiting secondary fuses.

D. Starters shall have an integrated interrupting rating with current limiting fuses of 350 MVA minimum.

E. When starters are grouped together in a lineup, the entire assembly shall be suitable for application on a power system having a short-circuit capacity of 50kA or as shown on the drawings, whichever is greater.

F. Enclosures.

1. Provide NEMA 1A gasketed enclosures for indoor applications where shown on the contract drawings. Control power shall be obtained from an internal control power transformer.
2. Enclosures for the medium-voltage starters shall meet NEMA ICS-6 standards. Enclosure shall be NEMA 1, unless otherwise noted, completely front accessible, allowing for free-standing, against a wall, or back-to-back mounting.
3. New sections must be mated up to existing G.E. Limitamp MCC..
4. Structures shall be welded steel frame, formed steel doors and side sheets, flat steel top and rear covers.
5. Standard hardware shall be grade 5, plated zinc-dichromate or stainless steel.

G. Line and load cable terminations shall be completely accessible from the front.

H. A built-in test circuit shall be included to permit checking of the starter control and pilot circuit, with the high-voltage de-energized and isolated, and the contactor in its normal position or in the draw-out position. The control circuit shall be capable of being energized through a polarized plug connector from an external 120-volt supply while in the test mode.

I. The low-voltage control compartment shall be isolated and barriered from the high-voltage area and mounted on a panel with a separate low-voltage access door.

2.03 COMPONENTS

A. Bus

1. When starters are grouped together in a line-up, the insulated horizontal main bus shall be located in its own separate enclosure and isolated from the starters. To allow for ease of maintenance or extension of line-ups without disassembling starters, the main bus shall be front, top and side accessible.
2. Starters shall be connected by an insulated vertical bus.
3. The bus shall be tin-plated copper and have fluidized bed or powder coat epoxy flame-retardant and track-resistant insulation.
4. The bus supports between units shall be either porcelain or flame-retardant, track-resistant, glass polyester.
5. The motor control center shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the interrupting ratings of the starter/fuse combinations.
6. 1200-ampere insulated copper main bus shall be provided and have provisions for future extension.
7. All bus joints shall be tin-plated, bolted and insulated with easily installed boots.
8. Provide a 1/4 x 2-inch ground bus.

B. Isolating Switch.

1. The isolating switch shall be an externally operated manual three-pole type that, in the open position, completely isolates the starter from the line connectors with a mechanically driven isolating shutter leaving no exposed high-voltage components. Integral mechanical interlocks shall prevent entry into the high-voltage areas while the starter is energized and shall block accidental opening or closing of the isolating switch when the door is open or the contactor is closed. The isolating switch handle shall have provisions for three (3) padlocks in the off position.

C. Current Limiting Fuses.

1. Current limiting power fuses shall be of the self-protecting type with visible fuse condition indicators. The fuses shall incorporate special time/current characteristics for motor service allowing proper coordination with the contactor and overload relay for maximum motor protection. This coordination shall be such that under a low-fault condition the interrupting rating and drop-out time of the contactor shall be properly coordinated with all possible fuse sizes to eliminate contactor racing. The power fuses shall be vertically mounted permitting easy inspection and replacement without starter disassembly. A fuse puller shall be provided with each starter.

D. Vacuum Contactor

1. The vacuum contactor shall be of the draw out and magnetically-held design, ampacity rating as shown on drawings with single-break high-pressure type main contacts with weld-resistant alloy contact faces. The vacuum contactor contact wear shall be easily checked with the use of a "go/no-go" feeler gauge, included with each contactor.

2. Contactor shall be closed electrically from a local or remote CLOSE pushbutton, and tripped by a mechanical linkage to an externally operated manual trip device.

3. An electrically-operated solenoid shall be supplied to trip the contactor as indicated on the contract drawings.

4. The vacuum contactor shall have the following minimum ratings:

		400A	800A
a.	Max. Interrupting Current:	7600	13200
b.	Rated Current Enclosed:	360	720
c.	Rated Current Open:	400	800
d.	Chop Current (Average):	0.3	0.5
e.	Short Time Current:		
	1) 30 Second	2160	4320
	2) 1 Second	5400	10800
	3) 0.5 Cycle	55k (peak)	86k (peak)
f.	Mechanical Life:	2.5M	1.0M
g.	Electrical Life @ rated current:	250,000	250,000
h.	BIL:	75kV	75kV
i.	Closing Time:	65ms	65ms

E. Wiring/Terminations.

1. All control wiring shall be tinned, stranded copper, SIS control cable.
   a. Control wiring shall not be smaller than No.14 AWG.
   b. Current circuit wiring shall not be smaller than No.12 AWG.
   c. All control wiring shall be terminated using insulated compression barrel, ring tongue type connectors.
   d. Each conductor shall be clearly identified using a machine printed, heat-shrink type cable marker with destination type labeling.
   e. Wiring associated with each shipping split shall be terminated on one side with a terminal block and the wiring on the other side shall be provided with the proper terminations and markers, neatly tied off with sufficient conductor length for

terminating.

f. All wiring shall be properly and adequately protected from abnormal tension, strain or fatigue - especially at areas such as across hinged doors, through metal partitions or near bolts and other structural parts.

g. All wiring shall be neatly tied or neatly placed in wire trays. Plastic trays of the type manufactured by Panduit are acceptable. If required, screw applied tie mounts are acceptable. Self-adhesive or epoxy applied tie mounts are unacceptable.

h. Sufficient space shall be maintained for all necessary field wiring.

i. Solid state relays shall be provided with dedicated case ground wires as required by the Manufacturer.

2. Terminal blocks.

a. All terminal blocks shall be heavy duty, protected, washer-screw type equal to the General electric type EB-25. Marker strips shall be provided which are machine printed with moisture resistant ink.

b. All current transformer secondary leads shall be terminated in short-circuiting, washer-screw type terminal blocks equal to the General Electric type EB-27.

c. Terminal block wiring shall be properly grouped so that AC and DC circuits are located on separate terminal blocks.

d. All spare contacts shall be wired to terminal blocks.

e. All spare protective relay auxiliary contacts shall be wired to terminal blocks.

f. Two spare twelve (12) point terminal blocks or 20% spare points on existing terminal blocks, whichever is greater, shall be provided in each cubicle.

3. Feeder cable lugs of the type and size indicated elsewhere shall be furnished.

F. Protective Relays.

1. The Manufacturer shall furnish and install the quantity, type and rating of protection relays as indicated on the drawings and described hereafter in this specification.

2. The relays and their components (current transformers, potential transformers, etc.) shall be installed to provide the protection schemes illustrated on the drawings and described in the Specifications.

3. Acceptable manufacturer's of particular protective relays are:

a. General Electric/Multilin: 369.

G. Current, Potential, and Control Power Transformers.

1. Ring type current transformers shall be furnished as indicated on the contract drawings.

a. The current transformers shall be 600/5, 5 lead, multi-ratio, 1.33 continuous current rating at 30 degree Celsius ambient unless otherwise stated on the drawings.

b. The thermal and mechanical ratings of the current transformers shall be 80 times rated current and 180 times rated current, respectively.

c. Their accuracy rating shall be equal to or higher than ANSI C200 unless otherwise stated on the drawings.

d. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.

2. Control power transformers up to 15 kV, 15 kVA, single-phase connected line-to-line shall be mounted internally.

3. Current and voltage transformers shall be wired to test blocks. Test blocks shall be General Electric, four-pole, type PK-2.

H. Control Switches

1. All control switches shall be specifically designed for the power industry and heavy duty industrial applications.
   a. Electro-Switch Series 24.

I. System Control and Monitoring Devices.

1. Test Switches.
   a. Test switches shall be provided as indicated on drawings. Approved Manufacturers are:
      1) General Electric type PK, 4-pole.
2. Indicating Lamps:
   a. General Electric type ET-16 Light Emitting Diode (LED's) Long Life Indicating Lamps.
   b. Indicating Lamps shall be furnished for the appropriate control voltage with appropriate color lamp and lens.

2.04 ACCESSORIES

A. Nameplates

1. Shall be provided per Section 16195-Electrical Identification.
2. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on Manufacturer's wiring diagrams.

B. The Manufacturer shall furnish accessories for test, inspection, maintenance, and operation, including:

1. Portable lifting device for transporting contactor outside its compartment.

C. The Manufacturer shall furnish the following spare parts in addition to the Recommended Spare Parts List in section 1.05:

1. Control fuses (10 of each type).
2. Power fuses (1 of each type).
3. Indicating lamps (2 of each type and color of bulb).

2.05 FABRICATION

A. Each cubicle shall be reasonably tight to minimize entry of dust and debris and to preclude ionized gas from passing from one compartment to another.

B. Bolted 11 gauge aluminum removable plates shall be provided at each power cable and control cable entrance on the equipment. These plates will be field drilled for conduits.

C. All cable terminations for power cables shall be drilled with four, 9/16 inch, NEMA spaced holes. The bus bars shall be tin plated at the locations of the connectors.

D. Power cable supports shall be provided and installed in each cable compartment. The power cables will be terminated using stress cones.

E. Shop Assembly

1. Full length doors shall be provided on the rear of all cubicles, shall be hinged on the right side (back view) and shall have provisions for padlocking. A sign shall be installed on all rear doors stating “DANGER - HIGH VOLTAGE”.
2. Relays, if possible, shall not be placed more than 72 inches off the floor.
3. Control switches shall be placed at not more than 72 inches off the floor.
4. When available as an option, all panel-mounted devices shall be drawout type.
5. No blanks or cut-out covers are acceptable.

2.06 FINISHES

A. Shop Priming, Finishing

1. All steel shall be chemically cleaned and treated. After cleaning, all metal surfaces shall be inspected for rust and scale, and, if necessary, further cleaned to remove all rust and scale. The finish shall consist of a coat of gray (ANSI-61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal and external parts. The coating shall have corrosion resistance of 200 hours to 5% salt spray and resist fading from H2S.

2.07 SOURCE QUALITY CONTROL

A. Inspection

1. DIA Project Manager or its ENGINEER has the right to enter the Manufacturer’s facilities at any reasonable time and with reasonable notice for the purpose of inspecting the equipment under the purchase order and to assure that reasonable progress is made to assure on time shipping.
2. DIA Project Manager or its ENGINEER shall have the right to inspect the equipment prior to shipping for compliance with the specifications. Such inspection shall in no way change or relieve Manufacturer from its obligations or liability to meet the minimum requirements of this specification or terms of the purchase order.

B. Factory Testing

1. Outlined below shall be witnessed by DIA Project Manager.
   a. Manufacturer shall notify DIA Project Manager two (2) weeks prior to the date the tests are to be performed.

C. Tests

1. The following standard factory tests shall be performed on the contactor element provided under this section. All tests shall be in accordance with the latest version of ANSI standards.
   a. Alignment test with master cell to verify all interfaces and interchangeability.
   b. Contactors operated over the range of minimum to maximum control voltage.
   c. Factory setting of contact gap.
   d. One-minute dielectric test per ANSI standards.
   e. Final inspections and quality checks.
2. The following production test shall be performed on each contactor housing:
   a. Alignment test with actual equipment to verify interfaces.
   b. One-minute dielectric test per ANSI standards on primary and secondary circuits.

c. Operation of wiring, relays and other devices verified by an operational sequence test.

d. Final inspection and quality check.

3. The Manufacturer shall provide three (3) certified copies of factory test reports to DIA Project Manager.

D. Verification of Performance

1. DIA Project Manager shall be the responsible party in determining if the equipment is satisfactory to be shipped to the site.

PART 3 - EXECUTION

3.01 INSTALLERS

A. Installers shall specialize in installation of medium voltage equipment with a minimum of 5 years of experience.

3.02 EXAMINATION

A. Site Verification of Conditions

1. CONTRACTOR shall make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in local codes and standards.

2. Examine installation area to assure there is enough clearance to install equipment.

3. Check concrete pads for uniformity and level surface.

4. Verify that medium voltage equipment is ready to install.

5. Verify that required utilities are available, in proper location and ready for use.

6. Beginning of installation means installer accepts conditions.

3.03 INSTALLATION

A. CONTRACTOR shall install all equipment per the Manufacturer's recommendations and contract drawings.

B. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus assembly manufacturer. Tighten joints again after bus assemblies have been energized for 30 days.

C. Connect bus assemblies and components to wiring system and to ground as indicated and instructed by manufacturer.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.04 FIELD QUALITY CONTROL

A. Switchgear Manufacturer shall provide testing and commissioning services as specified in Section 16065 – Testing, Acceptances and Certification. CONTRACTOR shall assist Manufacturer.

B. Testing: Engage a qualified testing agency to perform the following field quality-control testing.

C. Testing: Perform the following field quality-control testing:

1. After installing enclosed bus assemblies and after electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.4. Investigate any insulation-resistance reading less than 100 megohms divided by bus-assembly length in feet (30 megohms divided by bus-assembly length in meters). Certify compliance with test parameters.

D. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

E. Training shall be provided by Manufacturer – Starting of Systems.

1. 2 Hours Classroom, 2 Hours Field

3.05 ADJUSTING

A. Adjust all switches, access doors, and operating handles for proper operation.

B. Adjust relay settings as provided by ENGINEER.

3.06 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris. Repair damaged finish to match original finish.

3.07 PROTECTION

A. Provide final protection to ensure that moisture does not enter bus assembly.

3.08 COMMISSINING

A. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of bus assembly including joints and plug-in units.

1. Use an infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

2. Perform two follow-up infrared scans of bus assembly, one at four months and the other at 11 months after Substantial Completion.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owners maintenance personnel to adjust, operate, and maintain systems.

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining equipment and schedules.

2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."

3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16354

SECTION 16452

GROUNDING

PART 1 - GENERAL

1.01 SUMMARY

A. Power system grounding.

B. Communication system grounding.

C. Electrical equipment and raceway grounding and bonding.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

B. NFPA Compliance: NFPA 70 "National Electrical Code (NEC)," as adopted and amended by the Denver Building Code, Chapter 10.

C. UL Compliance: Applicable requirements of UL Standards Nos. 467 "Electrical Grounding and Bonding Equipment," and 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits and equipment. In addition, require compliance with UL Std 486A, "Wire Connectors." Grounding and bonding products shall be UL-listed and labeled for the use.

D. IEEE Compliance: Applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.

1.04 SYSTEM DESCRIPTION

A. External (underground) metal pipes, water, gas, fuel, drain/sewer etc., are not available for electrical grounding. This is due to extensive cathodic protection and isolation joints of all underground metal pipes at DIA. These systems shall be bonded to the grounding system on the building side only.

B. Ground each separately derived system neutral to nearest referenced ground plate in the electrical room.

C. Provide a minimum of three inch by twelve inch by one-quarter inch (3” x 12” x ¼”) copper ground bar in the electrical room for connecting the grounding systems.

D. An insulated equipment ground conductor shall be installed continuous from the main switchgear or service entrance to all branch panelboards, motor control centers, transformers and all motors. This conductor shall be bonded to the conduit and metal enclosures that it passes through utilizing bonding bushings and terminal devices.

1.05 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

A. Submit shop drawings under provisions of Section 16010.

B. Indicate layout of ground ring, location of system grounding electrode connections, and routing of grounding electrode conductors.

C. Submit all field test reports.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Grounding Connection Accessories:

1. Electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type of service required.

B. Exothermic welded connections are required where grounding conductors connect to underground grounding conductors and to underground grounding electrodes, and for bonding to steel. All underground connections shall be exothermic welded.

C. All ground wires shall be copper, sized according to the NEC or as shown on the drawings which ever is larger.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide a separate, insulated, equipment-grounding conductor in all branch circuit conduits.

B. Provide isolated and insulated ground conductors for all microprocessor and data processing equipment.

C. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, connections are to be tightened to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

D. Provide code-sized ground cable bonding jumpers, installed with ground clamps, across all conduit expansion couplings and fittings, including flexible steel conduit used as expansion fittings.

E. Provide a corrosion-resistant finish to field connections, buried metallic bonding products, and where factory applied protective coatings have been destroyed.

F. Provide an equipment-grounding conductor in all conduits.

G. All receptacles and switches shall be provided with ground jumper from outlet box to ground terminal of the device. Exception isolated ground receptacles.

H. Provide parallel equipment bonding jumper for parallel conduit feeders.

I. Provide bonding jumpers around all concentric or eccentric knockouts.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding system, test ground resistance to earth in accordance with ANSI / IEEE 81 Submit test results to the DIA Project Manager.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16452

SECTION 16470

PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Distribution panelboards.

B. Lighting and appliance branch circuit panelboards.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 16 - Electrical: All Sections.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

B. NEMA AB 1 - Molded Case Circuit Breakers.

C. NEMA PB 1 - Panelboards.

D. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

E. NFPA 70, National Electrical Code as amended by the Denver Building Code.

1.05 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

A. Submit shop drawings and product data for equipment and component devices under provisions of Section 16010.

B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.

1.06 SPARE PARTS

A. Keys: Furnish a spare set of each to the Owner.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Cutler Hammer.

B. General Electric.

C. Square-D.

2.02 GENERAL

A. Reference to Cutler Hammer Electric Corporation in this Section of the specifications is for the purpose of establishing a level of quality and features. Other manufacturers as listed or accepted by substitution provisions of Division 1, Section 01630 are acceptable provided that they comply with the criteria.

B. Panelboards shall be bolt-on circuit breaker type conforming to NEMA PB1. Panelboards identified for use as service entrance equipment shall be labeled as service equipment. Panelboards shall be dead front, safety type with circuit breakers of the quantities, ratings, and types indicated on the drawings and specified herein.

C. Enclosures shall be at least 20 inches wide made from galvanized sheet steel in the sizes and NEMA types indicated, code gauge, minimum 16 gauge thickness. Provide minimum gutter space in accordance with the National Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided. Boxes shall be provided with removable blank ends. The same manufacturer as the panelboard shall fabricate enclosures.

D. Interiors shall be completely factory assembled with bolt-on circuit breaker type devices. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.

E. Full size insulated, copper, neutral busbars shall be provided. The neutral busbar shall be twice the size of the phase busbars on all non-linear load Panelboards with a corresponding increase in the size of the grounded conductor back to the supply. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

F. All phase, neutral and ground busbars shall be plated copper and sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 50^{o}C above an ambient of 40^{o}C maximum (Includes all termination assemblies). Busbar taps for panels with single pole breakers shall be arranged for sequence phasing of the branch circuit devices. Any material substituted for copper will not be accepted.

G. A copper ground busbar shall be included in all panels, switchboards and motor control centers.

H. All panelboard and switchboard cabinets shall be provided with a steel door over all circuit breaker handles. Trims shall be of code thickness, complete with concealed butt hinges, and latch and lock assembly made of steel in the edge of the door trim. Each circuit section shall be provided with a permanently fixed engraved number. Panelboards shall have a typed written directory mounted within a metal frame with transparent protective covering inside of cabinet door. All panelboard enclosures shall be keyed alike. Doors over 48 inches in height shall have auxiliary fasteners.

I. Surfaces of the trim assembly shall be properly cleaned, and a finish coat of gray ANSI 61 paint applied. Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 of an inch on all sides.

J. In all instances where a contractor installs or disconnects a circuit in any panel, a newly typed dated panel schedule with the contractors name shall be furnished. Circuit breakers or disconnect switches in distribution panelboards and switchboards shall have nameplates permanently attached with machine screws indicating the load being fed.

K. In all cases where the conductor to be connected to the busbar is 1/0 or larger cable, the connection shall be made with a 2-hole compression lug. Torque all lug, wire and bus terminations to the manufacturers recommendation using a micrometer type wrench.

L. Short circuit ratings shall be as shown on the drawings.

M. All panelboards shall have National lock assembly, keyed to a number “WEM-2” key, and the latch and lock assembly shall be made of steel.

2.03 DISTRIBUTION PANELBOARDS

A. Distribution panelboards and the devices contained therein shall be fully rated, or series / integrated rated as required to meet existing conditions.

B. Bolt-on, molded-case, main and branch circuit breaker of the types specified herein, shall be provided for each circuit with toggle handles that indicate when the breaker has tripped. Where multiple-pole breakers are required, a factory installed common trip is required so an overload on one pole will trip all poles simultaneously.

C. Circuit breakers shall provide complete circuit overcurrent protection by having inverse time and instantaneous tripping characteristics, and where applicable, be current limiting. Circuit breaker interrupting capacities shall be as indicated on the drawings or as specified hereinafter. Where applicable, circuit breakers shall be listed for series application.

D. Breakers 600 ampere frame and below shall be thermal-magnetic trip with inverse time current characteristics and shall be Cutler Hammer Series C.

E. Trip units shall have adjustable short time setting with a fixed instantaneous override for circuit protection. Main breakers shall be provided with additional short delay trip time adjustment for increased system coordination.

F. Breakers shall have built-in test points for testing long delay, and instantaneous functions of the breaker by means of a 120 volt operated test kit.

2.04 BRANCH CIRCUIT PANELBOARDS

A. Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers, of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.

B. Circuit breakers shall be thermal magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100-ampere frame and up through 100-ampere trip sizes shall take up the same pole spacing. Circuit breakers shall be UL listed as Type SWD for lighting circuits.

1. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, and emergency lights.

2. Main circuit breaker, when shown, shall be vertical mounted top or bottom as required. Chassis mounted reverse fed main circuit breaker is not acceptable.

C. Circuit breakers shall have a minimum interrupting rating of 10,000 amperes symmetrical at 240 volts and 14,000 amperes symmetrical at 480 volts.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards plumb and flush with wall finishes, in conformance with NEMA PB 1.1.

B. All new panelboards shall maintain a height of 6'-6" to the top unless matching height of existing equipment or approved otherwise. All electrical equipment shall be installed as close together as possible.

C. Provide filler plates for unused spaces in panelboards.

D. Provide a typed circuit directory frame and card with clear plastic cover for each panelboard clearly identifying the load on each circuit, equipment serviced and location. Revise directory to reflect circuiting changes required to balance phase loads. In all instances where a contractor installs or disconnects a circuit in any panel, a newly typed panel schedule shall be furnished. The new or revised panel schedule shall have the date and Contractor's name typed at the top right hand corner.

3.02 FIELD QUALITY CONTROL

A. Measure steady state load currents at each panelboard feeder. Should the difference between phases at any panelboard exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing and color code for all branch circuits. Correct panel schedule, as – built drawings, re-label all conductors and all "J" boxes containing circuits rearranged.

B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

C. Submit torque values for all connections with a torque schedule and witness signature.

3.03 PANELBOARD SCHEDULE

A. Panelboards shall be furnished and equipped as follows, except as otherwise specified:

Manufacturer	120/208V*	277/480V*	15-1200A**
Cutler Hammer	PRL-1	PRL-2	PRL-3 or 4
Square-D	NQOB	NEHB	Line
GE	NLAB	NHB	CCB

B. Panelboards may contain not more than one subfeed breaker with ratings in excess of 100A, but less than 225A.

C. Distribution panelboard shall be scheduled where more than one subfeed breaker rated in excess of 100A is required, and for any panelboard containing breakers with ratings of 225A or more.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16470

SECTION 16477

FUSES

PART 1 - GENERAL

1.01 SUMMARY

A. Fuses.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

B. ANSI/UL 198C - High-Intensity Capacity Fuses; Current Limiting Types.

C. ANSI/UL 198E - Class R Fuses.

1.04 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

A. Submit product data under provisions of Section 16010.

B. Manufacturer's product data, including specifications, electrical characteristics, installation instructions, furnished specialties and accessories. In addition, include voltages and current ratings, interrupting ratings, current limitation ratings, minimum melting time-current characteristic curves, total clearing time-current characteristic curves, peak-let-through curves and mounting requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - FUSES

A. Bussman.

1. General Electric.
2. Gould.
3. Reliance.

2.02 FUSES

A. Fuses 600 Amperes and Less: ANSI/UL 198E, Class RK1; dual element, current limiting, time delay, one-time fuse, 250 or 600 volt as required.

B. Interrupting Rating: 200,000 rms amperes.

2.03 SPARE FUSES

A. Maintenance Stock Fuses: For types and ratings required, provide one set of each type and rating used at each site for this project.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install fuses in fusible disconnect switches and all equipment or control assemblies requiring fuses.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16477

SECTION 16480

MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

A. Manual motor starters.

B. Magnetic motor starters.

C. Combination magnetic motor starters.

D. Variable frequency drive controller.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division - General Requirements and other applicable technical specifications apply to work of this section.

1.03 RELATED SECTIONS

A. Division 16 - Electrical: All Sections.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
2. NEMA AB 1 - Molded Case Circuit Breakers.
3. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

1.05 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

A. Submit under provisions of Section 16010.

B. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and overcurrent protective devices.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 16010.

B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 1.

B. Store and protect products under provisions of Section 16010.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - MOTOR STARTERS

A. Allen-Bradley.

1. General Electric.
2. Square D.
3. Cutler Hammer.
4. Danfoss.

2.02 MANUAL MOTOR STARTERS

A. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with overload relay for each phase, low-voltage protection, red pilot light, field-convertible auxiliary contact, and toggle operator.

B. Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and key or toggle operator as indicated.

C. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated pole, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, red pilot light, field convertible auxiliary contact, and toggle operator.

D. Enclosure: ANSI/NEMA ICS 6; Type 1 for indoor and type 3R for outdoor.

2.03 MAGNETIC MOTOR STARTERS

A. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

B. Full Voltage Starting: Reversing or non-reversing type as indicated.

C. .

D. Coil Operating Voltage: 24 volts, 60 hertz.

E. Size: NEMA ICS 2; size as shown on Drawings.

F. Overload Relay: NEMA ICS 2; bimetal.

G. Enclosure: NEMA ICS 6; Type 1 for indoor and type 3R for outdoor.

H. Combination Motor Starters: Combine motor starters with motor circuit protector disconnect in common enclosure. Disconnecting means shall be equipped with provisions enabling locking in the “OFF" position.

I. Auxiliary Contacts: NEMA ICS 2; two field-convertible contacts in addition to seal-in contact.

J. Push buttons: NEMA ICS 2; START/STOP in front cover.

K. Indicating Lights: NEMA ICS 2; RUN: green in front cover with press-to-test lamp testing feature.

L. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, locking type, in front cover.

M. Relays: NEMA ICS 2; as required.

N. An individually fused 480-24 volt control transformer shall be furnished with each combination starter. The control transformer shall be sized by the manufacturer to have a minimum of 20 percent capacity in excess of the continuous voltampere requirements of the holding coil, indicating lights and any externally located devices such as a solenoid valves, external relays, etc. The control transformer shall be capable of operation with an inrush current twenty (20) percent greater than required by the holding coil, indicating lights and external-device, if any.

2.04 VARIABLE FREQUENCY DRIVES (VFD) MOTORS MUST MEET "NEMA-MG1, PARTS 30 AND 31 INVERTER - FED MOTORS"

A. General:

1. Where specified, solid-state variable-speed controllers shall be provided for equipment. Drive shall convert 60 Hz AC line to a variable frequency, variable voltage AC output suitable for control of a standard NEMA Design B induction motor over a 10:1 speed range. (Current source drives may be used when in compliance with all other requirements of this specification.)
2. The VFD shall consist of a 3-phase converter section to rectify the incoming AC source, a filtered DC bus section, PWM type inverter section, as specified below. Power switching devices shall be rated 1200 PIV minimum in the converter section, and 1000 PIV minimum in the inverter section.
3. The VFD and options shall be tested to ANSI/UL Standard 508 and listed by either UL or ETL.
4. The controller shall have input line filtering in compliance with IEEE 519, Guide for Harmonic Control and Reactive Compensation of Static Power Converters, and shall not generate harmonics of a magnitude greater than 5 percent THD voltage and 10 percent THD current at the point of common coupling which is the motor control center bus supplying power to the drive. Provide input line reactors and/or filters to meet the minimum current and voltage distortion limits.
5. The VFD shall not emit either conducted or radiated RFI in excess of the limitations set forth in FCC Rules and Regulations.
6. The VFD torque characteristic shall match the driven load.
7. Controller Input: 460 volt, 3-phase, 60 Hz. Voltage Tolerance: -5% to +10%; Frequency Tolerance: +/-2%.
8. Controller Output 46-460 volts, 3-phase, 6-60 Hz.
9. Ambient Operating Conditions: Temperature, 0-40^{o}C; Relative Humidity, 0-95%, non-condensing; Altitude, 5,500 feet above sea level.
10. Enclosure: NEMA 1 Indoor and 3R for Outdoor
11. The completed assembled VFD shall be functionally tested under motor load before shipment to ensure proper operation. The manufacturer shall provide certification that these tests have been completed.
12. Displaced power factor: 0.95 lagging over rated speed range.

13. Features and controls may be provided by a key touch pad and LCD readout in lieu of separate individual devices.

B. Basic Features:

1. Control power transformer with fused primary and 24V fused secondary.
2. AC input motor circuit protector or circuit breaker, interlocked with door.
3. AC line input current-limiting fuses rated 65,000 AIC minimum.
4. HAND/OFF/AUTO Selector Switch to start and stop the motor. In AUTO position, drive starts and stops motor from remote contact closure. In HAND position, motor is started and stopped from start/stop push buttons.
5. AUTO/MANUAL Selector Switch: In AUTO position, motor speed is proportional to follower signal. In MANUAL position, motor speed is set with the manual speed potentiometer.
6. Manual speed potentiometer.
7. Start and stop push buttons.
8. Meters and Indicating Lights:
   a. Amp meter.
   b. Speed meter.
   c. Power On pilot light.
   d. Fault pilot light.
9. Auxiliary Form C dry contacts to indicate the following:
   a. VFD in run mode.
   b. VFD in zero speed.
   c. VFD fault.
10. Terminals for field-installed external safeties.
11. Field-selectable Auto Restart on power source failure.
12. Adjustable voltage boost for starting high torque loads.
13. Drive shall be capable of starting into a spinning motor by matching frequency and phase angle to the motor back EMF.
14. Signal Follower: In Auto Speed mode, motor speed shall be proportional to external 4-20 ma speed control signal.
15. The VFD shall be capable of supplying 110% of rated full load current for one minute at maximum ambient temperature.
16. Operate in by pass mode
17. Thermal overload relay to protect motor in bypass mode.
18. **Drive shall communicate over BACnet MS/TP Drive will communicate on a BACnet network.**

C. VFD Controllers:

1. PWM type designs shall utilize an adjustable frequency carrier to tune out audible noise generated in the motor. The carrier frequency shall be adjustable over a minimum 10:1 range. The drive output shall be sine-weighted from a minimum of 11 pulses per half cycle at 20% speed to a minimum of 3 pulses per half cycle at full speed.

D. Adjustments:

1. Maximum Frequency: 55 to 66 Hz.
2. Minimum Frequency: 6 to 35 Hz.
3. Acceleration Time: 2 to 20 second minimum range.
4. Deceleration Time: 2 to 20 second minimum range.
5. Volts/Hz Ratio: +/-15% from 7.67 V/Hz.
6. Voltage Boost: Low frequency V/Hz.
7. Critical Speed Lockout: Two critical speeds with adjustable bandwidth.
8. Current Limit: 50 to 110% sine wave current rating.
9. Noise level of PWM drive and motor shall not be greater than 4 db above the noise level of a 6-step drive and motor of the same horsepower.

E. Protective Features:

1. Power source over-voltage, under-voltage, and phase loss protection.
2. DC bus over-voltage protection.
3. Instantaneous shutdown when load current exceeds 150%.
4. Inverse time characteristic overcurrent overload protection for the motor. Provide integral main thermal magnetic circuit breaker or main motor circuit protector. Manufacturer shall size and coordinate the main protective device with the characteristics of the controller, motor and load furnished to provide proper protection by the main protective device, without nuisance tripping.
5. The VFD shall be capable of withstanding randomly applied short circuit current applied across the output terminals without damage.
6. Internal protection of VFD for any external disconnects between the drive and the motor.
7. DC bus discharge circuit for protection of service personnel.

F. Trouble-Shooting Diagnostic Features:

1. Indicator lights on inverter power module to indicate correct operation (or failure) of individual power switching devices.
2. Indicator lights to show drive fault/ready states, and reason for fault shutdown, including: Instantaneous overload, motor overload, output or DC bus over-voltage, or source over-voltage, under-voltage, or phase loss.

G. Input Transient Protection:

1. AC line reactors to minimize noise and notching in the incoming line without the requirement for an input isolation transformer.
2. Metal oxide varistors and RC snubbers to limit high voltage spikes.

H. Acceptable Manufacturers:

1. All VFDs shall be of a single manufacturer.
2. Approved VFD Manufacturers:
   a. Honeywell
   b. Graham.

c. Reliance.
d. Robicon.
e. Cutler Hammer.
f. Eaton
g. Square D

2.05 CONSTANT SPEED BYPASS

A. Provide pre-assembled add-on enclosure or separate compartment containing bypass-only functions for pumps. Enclosure or separate compartment shall include:

1. A circuit breaker disconnect with door interlock handle (in addition to the VFD compartment disconnect). This disconnect shall provide positive shutdown of all power to both the bypass circuitry and the VFD.
2. A VFD output contactor and constant speed contactor.
3. A 3-pole motor overload relay with heaters connected to shut down the motor in both the VFD and bypass modes.
4. Operator's Controls and Indicator Lights as specified hereinafter.
5. Provision for motor winding over-temperature switch (if provided).
6. Control power transformer with fused primary and 24 volt fused secondary.
7. Interlock to allow a controlled VFD deceleration ramp to stop.
8. Panel arranged to allow power-off maintenance of the VFD while motor is operating on bypass. Bypass circuitry in the same compartment as the VFD will not be allowed.

B. Operating Controls: Provide the following operating controls in the bypass enclosure:

1. VFD/OFF/BYPASS selector switch.
2. POWER ON light.
3. MOTOR ON VFD light.
4. MOTOR ON-LINE light.
5. MOTOR FAULT light.
6. A control relay and bypass mode HAND/OFF/AUTO switch to allow remote 2-wire start/stop control of the motor in both VFD (AUTO) and BYPASS (AUTO) modes.
7. Control relays and terminal strip to allow external dry contract type safety devices to shut down the motor in both VFD and BYPASS modes, or independently in VFD or BYPASS mode only.

2.06 CONTROLLER OVERCURRENT PROTECTION AND DISCONNECTING MEANS

A. Motor Circuit Protector: NEMA AB 1; circuit breakers with integral instantaneous magnetic trip in each pole. Handle lockable in OFF position.

B.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install motor control equipment in accordance with manufacturer's instructions.

B. Select and install heater elements in motor starters to match installed motor characteristics.

C. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

D. Floor mounted equipment shall be on a 4" concrete housekeeping pad.

E. Operate VFDs through the speed range of the equipment. Tune the VFD to exclude mechanical damaging frequencies from the operating range. Coordinate with each equipment manufacturer to obtain operational speed range.

F. Name plates per Section 16195.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16480

SECTION 16486

ELECTRIC MOTORS

PART 1 - GENERAL

1.01 SUMMARY

A. Single-phase electric motors.

B. Three-phase electric motors, NEMA frame.

C. Medium Voltage Motors

D. Magnetic motor starters. See Sections 16480 & 16481.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to Work of this Section.

1.03 RELATED SECTIONS

A. Section 16142 - Electrical Connections for Equipment.

B. Section 16480 - Motor Controllers. Magnetic Motor Starters.

C. Section 16481 - Motor Control Centers. Magnetic Motor Starters.

D. Section 16485 - Contractors

E. Section 16354 – Medium Voltage Motor Controls and Centers

F. Division 16 – Electrical: All Sections.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the latest issue of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
3. IEEE 43 - Testing Insulation Resistance of Rotating Machinery.
4. ANSI/IEEE 112 – Standard Test Procedure for Polyphase Induction Motors and Generators.
5. IEEE 429 - Recommended Practice for Thermal Evaluation of Sealed Insulation Systems for AC Electric Machinery Employing Form Wound, Pre-Insulated Stator Coils for Machines 6900V and below
6. ANSI/NEMA MG 1 - Motors and Generators including parts 30 and 31 if applicable.

7. NEMA MG 2 - Safety Standard for Construction, and Guide for Selection, Installation, and Use of Electric Motors and Generators.

8. UL 1004-1 - Rotating Electrical Machines - General Requirements

1.05 SUBMITTALS (REFER TO SECTIONS 01300 AND 01340)

A. Submit product data under provisions of Section 16010.

B. Submit test results verifying nominal efficiency and power factor for three-phase motors larger than 20 horsepower.

C. Submit electric load summary for all motors.

D. 4000V Motor Submittals
1. Outline drawing for each group of identical motors.

2. Nameplate data for each motor including the following data:

a. Manufacturer's name and serial number.
b. Manufacturer's type and frame designation.
c. Horsepower output.
d. Time rating.
e. Maximum ambient temperature.
f. Insulation class.
g. Temperature rise and method of measurement.
h. Rpm at rated load.
i. Frequency.
j. Number of phases.
k. Voltage.
l. Rated load amperes.
m. Code letter.
n. Service factor.
o. Efficiency.
p. Acceleration time with connected load.
q. Allowable locked rotor time.
r. Starting capabilities.
s. Weight.
t. Thermal limit curve superimposed on time-current curves during acceleration of the driven equipment at rated voltage and at minimum specified starting voltage.

3. For each motor, certified factory test report.
4. If requested by Engineer, data to permit the driven equipment manufacturer to perform a torsional analysis of each motor-driven equipment match.

B. 4000V Motor - The manufacturer shall provide an Operations and Maintenance manual that will include shop drawings; wiring diagrams; parts description, identification and quantity; recommended maintenance schedule; lubrication type and schedule; factory and field tests as specified in this section.

C. Perform the following factory tests on each 4000V motor in conformance with IEEE 112:
1. Measurement of winding resistance.

2. No-load readings of current, power, and nominal speed at rated voltage and frequency.

3. Mechanical vibration.

4. Direction of rotation versus phase sequence.

5. Insulation resistance.

6. High-potential test.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 16010. Include assembly drawings, bearing data including replacement sizes and lubrication instructions.

1.07 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 70. (NEC)

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 1.

B. Store and protect products under provisions of Section 16010.

C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.09 ENVIRONMENTAL CONDITIONS

A. The equipment shall be designed and constructed to operate successfully at the rated values under the following environmental conditions:

1. Location: indoors
2. Altitude: 5,500 feet above sea level
3. Ambient Temperature Range: -30° F to 120° F

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. 460V Motors:

1. Magnetek E plus 3 and inverter grade
2. Baldor
3. General Electric.
4. Reliance.
5. Westinghouse.
6. Toshiba
7. US Motor

B. 4000V Motors:

1. ABB.

2. General Electric Company.
3. Siemens Energy and Automation, Inc.
4. Teco-Westinghouse Motor Company.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS – 460V

A. Coordination: Refer to Section 16142 Electrical Connections for Equipment.

B. Motors: Motors shall be utility or industrial grade. Design for continuous operation in 40ºC environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type. All motors shall be NEMA Premium™, except where more stringent requirements are listed herein or otherwise required by Approved Contract Documents

C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency.

D. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame. All motor lead terminal boxes shall have, as a minimum, the inside dimensions shown in the following table or shall be the manufacturer's nearest standard size:

MOTOR HORSEPOWER	HEIGHT INCHES	WIDTH INCHES	DEPTH INCHES
0 thru 3		Manufacturer's Standard	
5 thru 25	8	6	6
30 thru 50	9	7	7
60 thru 75	12	8	8
100 thru 125	12	10	10
150 thru 200	14	12	12

E. Motors used with adjustable voltage or adjustable frequency controls shall meet NEMA MG1, Part 30 and 31.

F. Application: (Except medium voltage motors)

1. Motors shall be designed for across-the-line voltage. Motor torque characteristics shall be selected to ensure acceleration of the driven equipment within a time limit acceptable to the motor manufacturer. Motors shall be capable of starting the driven equipment while operating at 90 percent rated terminal voltage.
2. Motors shall be NEMA Design B, unless otherwise noted or required.
3. The supplying contractor shall be responsible for all additional electrical and other costs involved to accommodate any motors which exceed the scheduled horsepower sizes as called for in Contract Documents.
4. Insulation for motors 1-1/2 HP and larger shall be NEMA Class B or F. Insulation on smaller motors and single-phase motors shall be NEMA Class A or B.
5. Motors rated 1/2 to 200 HP shall be 460/3/60.
6. Motors rated less than 1/2 HP shall be 115/1/60.
7. All motor wiring and windings shall be copper.

8. Motor safe locked rotor time at rated locked rotor current shall be equal to or greater than, the maximum accelerating time at minimum specified starting voltage.

9. Motors shall be capable of withstanding a full voltage bus transfer from one source to another within a transfer time of 6 cycles. The 6 cycle dead time is the difference between the instant that the arc in the normal source circuit breaker is completely extinguished and the time that the standby source circuit breaker is completely closed.

10. The continuous nameplate rating shall be greater than or equal to the maximum brake horsepower required by the driven equipment when that equipment is operated at any point within the operating range specified in the specifications or drawings. Service factor shall not be used to meet this requirement. Motors shall have service factors in accordance with NEMA Standard MG1.

11. All terminal boxes shall have a bolt type copper ground connector brazed, welded or bolted inside the box.

12. All totally enclosed motors shall be furnished with drain-breather elements, Crouse-Hinds Type ECD "Universal" or approved equal.

13. All motors shall be provided with suitable lifting devices or attachments for motor installation and removal.

14. Aluminum frame motors are not acceptable.

2.03 SINGLE-PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one-fourth of full-load torque.

B. Starting Current: Up to six times full-load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50EC temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

2.04 SINGLE-PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full-load torque.

B. Starting Current: Less than five times full-load current.

C. Pull-up Torque: Up to 350 percent of full-load torque.

D. Breakdown Torque: Approximately 250 percent of full-load torque.

E. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-Proof Enclosure: Class A (50ºC temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve or ball bearings.

G. Enclosed Motors: Class A (50ºC temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

2.05 THREE-PHASE POWER - SQUIRREL CAGE MOTORS – 460V

A. Starting Torque: Between one and 1-1/2 times full-load torque.

B. Starting Current: limited by maximum allowable by the latest issue of NEC and NEMA-MG1.

C. Motors shall be designed for inverter duty and operation with variable frequency drive (VFD)..

D. Motors shall be supplied with shaft grounding rings for VFD installation.

E. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B characteristics.

F. Design, Construction, Testing, and Performance: Conform to ANSI/NEMA MG 1 for Design B motors.

G. Insulation System: NEMA Class B or better. Motors with weatherproof enclosures or motors for outdoor application shall have sealed or encapsulated insulation systems produced by a vacuum impregnated MICA - EPOXY process.

H. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication, rated for minimum AFBMA 9, L-10 life of 25,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate. All vertical motors shall be furnished with antifriction thrust bearings which meet ANSI 83.15 OR 16, minimum L-10 Life of 35,000 hours.

J. Sound Power Levels: To ANSI/NEMA MG 1.

K. Multi-Speed Motors: All two-speed motors with 2:1 speed ratio shall be of single-winding type. Provide two-winding type motors for all other multi-speed applications.

L. Power Factor: Motors shall have a labeled power factor, at nameplate rating and rated voltage, of not less than 95 percent. If a motor draws less than 1000 watts labeled rating, it is excluded from the 95% PF requirement. If, through motor or design (i.e., rpm less than 1200), a 95% PF is not available, the supplier shall furnish power factor correction components capable of correcting to 95 percent or better. Provide power factor correction for single speed motors only. Variable speed motors shall have a minimum power factor of 85% at rated RPM.

M. Product Scope and Nominal Efficiency Levels: The NEMA Premium™ efficiency electric motor program scope is single-speed, polyphase, 1-500 horsepower, 2, 4, and 6 pole, squirrel cage induction motors, NEMA Design A or B, continuous rated. Products must meet or exceed the nominal energy efficiency levels specified in NEMA Standards Publication MG 1- 2003 (or its most recent revision), in Tables 12-12 and 12-13, respectively.

N. Derating: Temperature rise for motors shall not exceed that specified in NEMA MG1-20.40 for the class of insulation used. Motors shall be fully derated for the effects of high ambient temperatures and altitude of 5500 feet above sea level.

O. Motors shall be capable of withstanding the number of starts imposed by the drive equipment without appreciable loss of service life.

2.06 MOTORS RATED 250 HORSEPOWER AND LARGER:

A. Motors shall be continuous-duty suitable for a central pant environment where dusts and high humidity are present.

B. Motors shall be self-ventilated.

C. Motors shall be designed for inverter duty and operation with variable frequency drive (VFD), where required.

D. Motors shall be supplied with shaft grounding rings for VFD installation.

E. Motors shall be suitable for operation at an altitude of 5,500 feet above mean sea level.

F. Indoor motors shall be suitable for continuous operation at an ambient temperature of 40^{o}C.

G. All motors shall have squirrel-cage rotors.

H. The nameplate horsepower rating of each motor at 1.0 service factor shall equal or exceed the horsepower required to drive the connected equipment under the design conditions specified and within normal operating ranges. For each motor furnished, the nameplate horsepower rating multiplied by the service factor shall equal or exceed the horsepower required to drive the connected equipment under any operating condition.

I. Rated 4000 volts, 3 phase, 60 hertz.

J. Service factor of 1.15.

K. The torque characteristics of each motor at all voltages from 85% to 110% rated voltage shall be as required to accelerate the motor and driven equipment to full speed without damage to the motor or the driven equipment.

L. Insulation shall be Class F, with Class B 80°C temperature rise at rated horsepower in accordance with NEMA MG1.

M. Sealed type insulation systems shall be furnished on all motors, and shall include bonding with vacuum pressure impregnated epoxy (VPI) resin or other solventless resins.

N. The insulation system on open type motors shall be abrasion resistant.

O. Rotor and stator core shall be constructed from an assembly of high-grade, fully processed grain oriented, C-5 sheet steel laminations.

P. Rotor bars and end rings shall be copper or copper alloy.

Q. Rotor bars shall be swaged to ensure a tight fit into slot and shall be induction brazed to the end rings with a silver brazing alloy.

R. The acceleration time for each motor at all voltages within the starting voltage range specified, when connected to the driven equipment, shall not exceed the allowable locked-rotor times at those voltages.

S. In addition to the starting capabilities specified in NEMA MG-1, following one start with the motor initially at a temperature equal to the rated-load operating temperature, each motor shall be capable of making additional starts with a cooling period at standstill between starts not greater than 45 minutes.

T. Motor enclosure shall be weather protected WPI. Enclosures shall be fabricated of cast iron or fabricated steel, and shall be furnished with corrosion-resistant hardware.

U. Horizontal motors for direct coupled service shall be furnished with sleeve split, spherically seated, self-aligning bearings on motors over 449T frame. Oil seals shall be floating labyrinth type. Bearings shall be lubricated with two-piece, easily replaceable brass oil rings.

V. Sleeve Bearing Horizontal Motor Lubrication:

1. For all motors, furnish oil rings; oil reservoirs; sight glasses located to be readily observable, and marked with the proper oil level when running and at standstill; and drain and fill piping to a location where each bearing and reservoir can be conveniently flushed, drained, and refilled.

2. Where forced lubrication is required, and compatible oil is available from the driven equipment lubrication system, the bearings shall be furnished with connections to the driven equipment lubrication system.

3. Where forced lubrication is required, and compatible oil is not available from the driven equipment lubrication system, each motor shall be furnished with an integral forced lubrication system. The forced lubrication system shall include a shaft driven oil pump, an oil-to-air heat exchanger, and the other equipment as required.

W. Antifriction Bearing Horizontal Motor Lubrication: Grease lubricated, regreaseable, with fittings for relubrication from the outside of the motor.

X. Bearings shall be insulated when required to prevent bearing or shaft damage due to stray shaft currents.

Y. Each horizontal motor shall be mounted on a common baseplate with the driven equipment, or shall be furnished with separate sole plates and subsole plates to permit removal of the motor without disturbing the alignment of the driven equipment.

Z. Furnish two vibration transducer mounting pads on the inboard and outboard bearing housing of each motor connected to equipment specified with a bearing vibration system. Pads shall be placed 90° apart.

AA. Each box shall be adequately sized to enclose connections to the Owner's synthetic-insulated shielded power cables, including preformed stress cones. Heat shrinkable insulating boots or tape shall be furnished for all factory and field connections in each box. Furnish threaded conduit entrance holes in each box as marked by the Engineer on returned outline drawings.

BB. Where combined motor and driven equipment sound levels are specified for items of equipment, systems, or areas, motor sound levels shall be coordinated with driven equipment sound levels to meet the overall sound levels specified. The motor "A" weighted sound pressure level shall not in any event exceed 90 dB when measured at a reference distance of 10 feet.

CC. Motor nameplates shall be stainless steel with permanently stamped letters not less than 1/8-inch high. Information on nameplates shall in accordance with NEMA MG-1. Nameplates shall also be provide for number of starts per hour, bearing identification, recommended lubricate, direction of rotation, electric phase rotation and motor wiring diagram.

PART 3 - EXECUTION

3.01 APPLICATION

A. Motors drawing less than 250 watts and intended for intermittent service may be germane to equipment manufacturer and need not conform to these Specifications.

B. Motors shall be open drip-proof type, except where specifically noted otherwise.

3.02 NEMA OPEN MOTOR SERVICE FACTORS

HP	SERVICE FACTOR
1/6-1/3	1.35
1/2	1.15
3/4	1.15
1	1.15
1.5-150	1.15

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16486

SECTION 16515

INTERIOR LIGHTING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. The contractor shall furnish and install all lighting equipment, lighting fixtures, brackets, hangers lamps, raceway, and cable as shown in fixture schedule, drawings and as required for all outlets indicated on the drawings.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements, Section 16010, and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 16 - Electrical: All Sections.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. All equipment furnished under this section shall carry a UL Listing.

1.05 MATERIAL STANDARDS

A. All material supplied shall be new and shall be equal to or exceed minimum requirements set by American National Standards Institute (ANSI), Certified Ballast Manufacturers (CBM), Illuminating Engineering Society (IES), Reflector and Lamp Manufacturer's (RLM) Standards Institute, Underwriter's Laboratories (UL), and National Electric Manufacturer's Association (NEMA).

1.06 CONSTRUCTION DRAWINGS

A. The drawings are diagrammatic and indicate the general arrangement of electrical work. Locations are approximate and shall be subject to minor modifications as dictated by field conditions and as directed by DIA Project Manager.

1.07 SUBSTITUTIONS

A. Substitutions: Under provisions of Section 16010.

1. One sample of each proposed light fixture substitution unless the project manager waives requirement.
2. Printed physical, electrical and photometric data clearly highlighted to show the differences between the proposed substitutions and the specified light fixture.
3. Photometric information in IES standard format on a compact disk (CD) and printed on 8½” x 11” pages.
4. Point to point lighting calculation for all typical spaces.

1.08 SUBMITTALS

A. Contract documents shall require submittal of the following prior to starting installation:

1. Product Data: Manufacturer's product data and installation instructions on each type of interior building lighting fixture and component.

2. Shop Drawings: Light fixture shop drawings shall be in booklet form with a separate sheet for each fixture, assembled in "luminaire type" alphabetical or numerical order, with proposed fixture, lamp type, and accessories clearly indicated on each sheet. Details indicating compatibility with ceiling grid system are required.

3. Wiring Diagrams: Wiring diagrams for interior lighting fixtures showing connections. Diagrams are to clearly differentiate between portions of wiring which are manufacturer factory-installed and portions, which are field-installed.

4. Samples: One complete operating unit for each type of interior light fixture when it is deemed appropriate.

5. Illumination Data: Light fixture efficiency, table of zonal cavity coefficients of utilization, recommended maximum spacing-to-mounting ratio and candlepower distribution curves drawn to scale such that candlepower can be scaled at different angles (or provide candlepower data in tabular form at 10 degree increments).

6. Maintenance Data: Maintenance data and parts lists for each interior lighting fixture and accessory; including "trouble-shooting" maintenance guide. That data, product data and shop drawings shall be included in a maintenance manual.

1.09 SEQUENCING AND SCHEDULING

A. The interior lighting installation is to be sequenced and scheduled with other work to minimize possibility of interference with pipes, ductwork and conduit. Lighting fixtures shall be protected from damage and soiling during the remainder of construction period.

1.10 MAINTENANCE

A. Extra Stock: Spare replacement lamps are required, amounting to a total of 15 percent, but not less than four lamps of each type and size lamp used on the project.

PART 2 - PRODUCTS

2.01 FIXTURES

A. General: Lighting fixtures are to be of the sizes, types and ratings required complete with, but not limited to, housings, high power factor ballasts, energy-efficient lamps, lamp holders, reflectors, energy-efficient ballasts, starters, and wiring. Fixtures are to be factory-assembled, with those components required for complete installation. Fixtures with concealed hinges and catches are to have metal parts grounded as a common unit and be constructed to dampen ballast generated noise. Equipment and materials shall bear the UL label.

B. Electromagnetic Fluorescent Lamp Ballasts: Energy-efficient fluorescent lamp ballasts are to be capable of operating lamp types required; with high power factor, rapid-start, and low-noise features; Type 1; UL Class P; Sound-rated A; comply with CBM Ballast Efficacy Factors (BEF); CBM labeled.

1. Fluorescent lamps shall be standard wattage with a correlated color temperature of 4,250 degrees Kelvin, types as required. 3,500 degrees Kelvin lamps shall be used in selected areas as indicated on drawings.

C. Interior Lighting Fixtures

1. Design and construction of fixtures utilizing ballasts shall be such that the ballast case temperature will not exceed the UL 90 degree C limit in a 25 degree C ambient. Fixtures to be installed in a damp or wet location shall be constructed with proper gasketing and corrosion resistant materials and/or coatings. Construct steel fixture channels, end caps, interior barriers, reflectors, etc. of adequate gauge.

2. Provide all ferrous metal surfaces with a protective finish having rust inhibiting properties. Painted finishes shall be a minimum of 1.5 mils thick and shall have a balance between hardness and bending properties suitable for the application. White finishes shall have 87% minimum reflectance. Application and cleaning shall be performed so as to prevent saponification.

3. All fixture wire shall conform to the latest requirements of Underwriter's Laboratories and be concealed within fixture construction.

4. All plastics used for light transmission shall be 100% virgin acrylic materials and 0.125" minimum thickness. Minimum unpenetrated thickness shall be 0.35". Polystyrene plastic shall not be permitted. All plastics shall be ETL certified as light stabilized, non-yellowing.

5. Ballasts furnished shall meet Underwriter's Laboratories specifications for Class P listing and application of ANSI Standards. Provide CBM-ETL certified, high power factor ballasts, which will operate on a nominal applied system voltage variation, and which conform with current applicable UL designated Class P requirements. All ballasts shall have automatic resetting type thermal protectors (for the coil) and a non-resetting protector (for the power capacitor).

6. All furnished fluorescent lighting fixtures shall be "ambient rated" by the fixture manufacturer or its authorized representative. Such "ambient rating" shall be submitted in writing and shall consist of the maximum ambient temperature, in degrees Fahrenheit, in which the fixture will function continuously without interruption of the protector employed in the Class P ballast.

7. Exit fixtures shall conform to local code requirements.

8. Lamps shall bear labels of General Electric, or Sylvania and be per General Electric lamp designations shown on the Fixture Schedule. Install all fluorescent lamps aligned for proper lamp contact

9. All incandescent lamps shall be as shown on drawings. See Specification Section 16535 for specific requirements.

PART 3 - EXECUTION

3.01 INSTALLATION OF INTERIOR LIGHTING FIXTURES

A. Set luminaries true, free of light leaks, warps, dents, or other irregularities. Provide the length of stems as required for the luminaries to be level and in the same horizontal plane. Verify the type of all ceilings before bidding, and provide fixtures and mounting to suit. Mount all outlets at position and height to clear equipment, ductwork, piping, etc., in mechanical equipment rooms, storage rooms, etc. Securely fasten all recessed fixtures in suspended ceiling to the ceiling's framing member, as described below.

B. Surface mounting fixtures containing ballasts shall be mounted with a minimum 1-1/2" spacer where mounted on a combustible material unless specifically approved for the application.

C. Protect wiring with tape or tubing at all points where abrasion is likely to occur. Provide chase nipples where field wiring is through knockouts. Wiring in fluorescent fixtures shall be suitable for temperature conditions and in no case less than 90 degree C (194 degree F) rating.

D. Fixtures are to be securely fastened to structural supports. Supports shall be designed for Seismic Zone 1. Individually mounted pendant fixtures longer than 2 feet shall have twin stem hangers. All stem hangers shall have ball hangers and provisions for minimum 1-inch vertical adjustment. Continuous rows of fixtures shall have one additional stem hanger greater than the number of fixtures in the row.

E. Connectors and terminals, including screws and bolts, are to be tightened in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, connectors and terminals are to comply with tightening torques specified in UL Std 486A and the National Electrical Code. Submit a report of all torquing values to the DIA Project Manager.

F. Surface mounted fixtures greater than 2 feet in length shall be supported at a point in addition to the outlet box fixture stud.

G. Each single phase circuit feeding light fixtures with ballasts shall have a dedicated neutral.

H. Lay-in lighting system shall be hard-piped to J-box. J-box shall not be attached to light fixture. Installed 6’ flexible steel conduit between J-box and fixture. Modular wiring is not permitted. (flex ran from fixture to fixture is not acceptable)

I. Light fixtures in storage areas and fixtures mounted below 8’ shall have a guard to protect the lamps.

3.02 ADJUSTING AND CLEANING

A. Interior lighting fixtures are to be cleaned of dust, dirt, fingerprints, smudges, and construction debris upon completion of the installation.

B. Installed fixtures are to be protected from damage during the remainder of the construction period.

3.03 GROUNDING

A. Equipment grounding connections are required for interior lighting fixtures. Connections are to comply with tightening torque values specified in UL Std 486A to assure permanent and effective grounds. Submit a report of all torquing values to DIA Project Manager.

3.04 DEMONSTRATION

A. Upon completion of the installation of interior lighting fixtures, and after building circuitry has been energized, the interior lighting system shall be operated to demonstrate capability and compliance with requirements.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16515

SECTION 16535

EMERGENCY LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. The emergency lighting for the means of egress and exit areas shall be accomplished by the following system:

1. Self-contained, unitized rechargeable battery-powered fixtures shall be connected to existing emergency power supply.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements, Section 16010, and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Division 16 - Electrical: All Sections.

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

B. All work shall be in strict accordance with latest edition of all applicable codes including Building Code for the City and County of Denver (DBC), National Electrical Code (NEC), National Fire Protection Association (NFPA), and Life Safety Code (NFPA 101).

1.05 MATERIAL STANDARDS

A. All material supplied shall be new and shall be equal to or exceed minimum requirements set by American National Standards Institute (ANSI), Certified Ballast Manufacturers (CBM), Illuminating Engineering Society (IES), Reflector and Lamp Manufacturer's (RLM) Standards Institute, Underwriter's Laboratories (UL), and National Electric Manufacturer's Association (NEMA).

1.06 CONSTRUCTION DRAWINGS

A. The drawings are diagrammatic and indicate the general arrangement of electrical work. Locations are approximate and shall be subject to minor modifications as dictated by field conditions and as directed by the DIA Project Manager.

1.07 SUBMITTALS

A. Submit:

1. Product Data: Manufacturer's technical product data on emergency lighting fixtures including scaled candlepower distribution curves for light fixtures.

2. Shop Drawings: Light fixture shop drawings in booklet form with separate sheet for each fixture, assembled in luminaire "type" alphabetical (or numerical) order, with proposed fixture and all accessories clearly indicated on each sheet.

3. Maintenance Data: Maintenance data and parts list for each emergency lighting fixture and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, and shop drawings in the maintenance manual.

B. Substitutions: Under provisions of Section 16010.

PART 2 - PRODUCTS

2.01 EMERGENCY LIGHTING FIXTURES

A. General: Lighting fixtures are to be of the sizes, types and ratings required; complete with, but not limited to, housings, energy efficient lamps, lamp holders, reflectors, and wiring.

1. DIA standard battery powered Emergency Lighting Unit shall be DUAL-LITE “EZ-2” to be wall mounted, as indicated on drawings.
   a. Self-contained battery, solid-state, fully automatic charger, and solid-state transfer/brownout circuit, with low-voltage battery disconnect.
   b. Battery: 4-volt pure-lead battery capable of supplying connected load for period of 1-1/2 hours to end voltage of 80 percent nominal battery voltage.
   c. Charger: Automatic battery charger with full recharging capability in 12 hours, or less after full discharge.
   d. Lamps: Two 5-watt, sealed beam type.
   e. Fixture shall be 120/277 VAC, 60Hz.
   f. Warranty: 5 years.

B. Exit Fixture

1. DIA Standard exit fixture shall be Crescent Lighting “LED Eclipse Series” Model CSGW32E with mounting as indicated on drawings.
   a. Fixture housing and matching canopy shall be constructed of white impact-resistant, scratchproof, corrosion-proof, UV-stable thermoplastic with a UL94-5VA Flame rating.
   b. The face shall be Steel Stencil with 6” letters and Universal chevron directional indicator knockouts.
   c. LED’s shall be energy efficient high intensity Green “GaN” LED’s.
   d. Fixture shall be 120/277 VAC, 60 Hz.
   e. All fixture shall be equipped with nickel cadmium batteries with a battery recharge system.
   f. Fixture shall meet UL 924, NFPA 70 and NFPA 101 codes.

PART 3 - EXECUTION

3.01 INSTALLATION OF EMERGENCY LIGHTING FIXTURES

A. Emergency lighting fixtures are to be installed at locations and heights per applicable codes. Install in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. All emergency lighting conductors are to be routed in a conduit separate from the normal power circuits.

3.02 ADJUSTING AND CLEANING

A. Emergency lighting fixtures shall be cleaned of dirt and debris upon completion of the installation.

3.03 GROUNDING

A. Equipment grounding connections shall be provided for emergency lighting fixtures. Connections are to comply with tightening torque specified in UL Std. 486A to assure permanent and effective grounds. Submit a report of torquing values to the DIA Project Manager.

3.04 DEMONSTRATION

A. Upon completion of the installation of emergency lights, and after building circuitry has been energized, the emergency lighting system shall be operated to demonstrate capability and compliance with all requirements and standards.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.01 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 16535

SECTION 16721

INTELLIGENT LIFE SAFETY FIRE MANAGEMENT SYSTEM

TERMINAL COMPLEX ADDITIONS AND MODIFICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers the fire detection and alarm system, and associated equipment for use in the New electrical room in the Central Plant. The Electrical Contractor shall provide all skilled labor, material, and equipment for the complete installation of the fire detection and alarm system additions and modifications as shown on the drawings and specified herein. The fire alarm system on this project is an extension of the existing fire alarm system. The Electrical Contactor shall acquire from the manufacturer the installation practices as published by the Manufacturer. Installation shall be in compliance with Manufacturer published installation guidelines except as noted in these specifications.

B. The Electrical Contractor shall be responsible to provide a complete installation and testing in compliance with DIA requirements, Denver Building Codes and Denver Fire Prevention Bureau requirements. If conflicts occur in this specification or between this specification and the contract documents, the most stringent requirement shall apply.

C. All documents submitted by the Electrical Contractor to the Code Agencies must be reviewed and accepted by the DIA Life Safety Team prior to submittal.

D. The most stringent interpretations of standards shall apply. All appendices and annex of standards shall apply.

1.02 RELATED DOCUMENTS

A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.03 RELATED SECTIONS

A. Technical Specification Division 1 - General Requirements.

B. Section 8110 – Steel Doors and Frames

C. Section 08710 - Hardware

D. Section 16010 - General Electrical Requirements

E. Section 16110 – Raceways

F. Section 16120 - Wires and Cables

G. Section 16135 - Boxes and Fittings

H. Section 16142 - Electrical Connections for Equipment

I. Section 16160 - Cabinets and Enclosures.

J. Section 16190 - Supporting Devices and Seals.

K. Section 16195 - Electrical Identification.

L. Section 16770 – Voice Paging System

1.04 REFERENCED STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1. Reference standards include all addenda and annexes and are not optional. Adherence to these standards will be strictly enforced.

B. National Fire Protection Association (NFPA):

1. NFPA 70 – National Electrical Code
2. NFPA 72 – National Fire Alarm Code.
3. NFPA 101 – Life Safety Code
4. NFPA 13 – Installation of Fire Protection
5. Conform to requirements of NFPA applicable sections, appendices and annexes.

C. City and County of Denver Building and Fire Codes.

D. International Building Code (IBC) with the Denver Amendments

E. International Fire Code (IFC) with the Denver Amendments

F. Underwriters' Laboratories (UL):

1. UL-864 and other applicable standards.
2. Complete Fire Protection System: UL listed.

G. The American Disabilities Act (ADA).

1.05 SYSTEM DESCRIPTION

A. Systems to be installed shall include all programming, equipment, devices, and wiring required to provide operation as follows:

1. Install and place in operating condition an electrically-operated, electrically-supervised Addressable Fire Management System extension as described herein.
2. The system shall provide individually identified fire alarm sensors, indicating devices, and compatible monitor and control devices. Each initiating device shall be given a unique address, with operator-assigned English language descriptor.
3. The system shall operate as a low voltage, zone-annunciated Fire Management System and shall include but not be limited to the following to provide a complete operating system:
    a. Fire Alarm System software updates and modifications
    b. Color Graphics Panel (CGP) and network software modifications to all site wide CGP’s.
    c. Building emergency power supplies
    d. Fire Alarm equipment and devices
    e. conduit, boxes, fittings and accessories
    f. connection to and interface with equipment and devices monitored or controlled by fire alarm system

g. record documents to include plan drawings, panel schedules, hard copy of programming

h. testing

1.06 QUALITY CONTROL

A. The General Contractor and Electrical Contractor shall be fully responsible for daily quality control of all system installation, coordination with trades, and coordination with DIA Maintenance and Engineering. Observation by DIA of work identified in Paragraph 3.06 does not take the place of the Contractor's Quality Control Program.

1.07 SUBMITTALS

A. Provide submittals in accordance with the provisions of Division 1, General Requirements of the Technical Specifications and as required by Denver Building and Fire Departments.

B. In accordance with and in addition to the requirements with 1.07A, provide the following submittal information.

1. Manufacturer's literature describing all products and materials that will be used in the system.

2. Engineered Shop drawings per Part 2 of this Specification Section. Assure review and acceptance by the DIA Life Safety Team prior to submittal for permit. The initial submittal shall be accompanied by (2) compact disks (CD's) each containing all documents in CADD format.

3. Operating and Maintenance Manuals: Provide copies, as specified in Division 1. If not specified, provide a minimum of 3 copies in separate 3 ring binders.

4. The Fire alarm shop drawings shall include a list of all new initiating device components and all new notification devices.

C. Individual installer NICET Level 2 certifications. Submit NICET certifications for all shop and field installers\programmers prior to any installation. A copy of all certifications shall be maintained on the project site.

D. "As Built" Plans shall be provided in the same format and manner as described above. Each set shall be equipped with a plan holder equal to "Stacor Plan Clamps" for the appropriate size drawings.

1.08 PERMITS AND APPROVALS

A. Obtain acceptance of permit documents by the DIA Life Safety Team prior to application for permit. Allow 10 working days for review by DIA Life Safety Team.

B. Obtain all necessary permits from the City and County of Denver Building Department.

C. Include with submittal for permit all cut sheets on all proposed devices, building address.

1.09 TESTING, REPORTS, AND CERTIFICATIONS

A. Testing, Reports and Certifications per Part 3 of this Specification Section.

1.10 PROJECT RECORD DRAWINGS

A. Submit as-built documents in conformity with the provisions of Division 1.

B. Contractor shall maintain on site accurate as-built drawings indicating dimensioned locations of constructed raceway, box and device locations. Any modifications to work depicted on the Engineered shop drawings shall be noted. Documents shall be updated daily and shall at all times be available for DIA review. NOTE: CHANGES TO PERMITTED DOCUMENTS MUST BE RESUBMITTED TO AND ACCEPTED BY THE CODE AGENCIES AND DIA LIFE SAFETY TEAM PRIOR TO PRE TEST.

C. Submit legible copies per Division 1 of documents identified in paragraph (B) above. “As Built” Plans shall be provided in the same format and manner as described. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size drawings.

D. Submit CONFORMED Engineered shop drawings per Division 1. Include two (2) electronic copies. (Reference Paragraph 2.05).

1.11 OPERATION AND MAINTENANCE DATA

A. Submit data under provisions of Division 1.

B. Include operating instructions, and maintenance and repair procedures.

C. Include letter from system programmer certifying that the system is operational and in compliance with NFPA 72.

1.12 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Division 1.

B. Store and protect products under provisions of Division 1.

1.13 WARRANTY

A. All components, parts and assemblies supplied by the manufacturer shall be guaranteed against defects in materials and workmanship for a period of 24 months following Substantial Completion. Submit warranty per Division 1 requirements.

B. Warranty service shall be provided by a trained specialist of the equipment manufacturer, who shall be based in a fully staffed, fully stocked (replacement parts and test equipment) office, located within 50 miles of the site.

1.14 SPARE PARTS

A. The Contractor shall at the time of system testing maintain on site spare stock of 5% of all device types installed.

B. At the time of pre-testing, deliver to the DIA Life Safety Team spare parts. The quantity shall be 1% of each type of device installed but no less that 1 of each type of device installed.

PART 2 - PRODUCTS

2.01 GENERAL

A. All equipment shall be new, standard components, regularly manufactured by Edwards Systems Technology (EST). All equipment shall be compatible with the existing Fire Alarm System. All equipment removed shall be transmitted to the DIA Life Safety Team.

B. All systems and components shall have been thoroughly tested and proven in actual use.

C. All equipment shall be listed and labeled by Underwriters Laboratories.

D. Where equipment of different manufacturers is used, such equipment shall be UL listed and labeled as an integrated fire alarm system and certification of compatibility with EST systems. (i.e. pre action sprinkler systems)

2.02 REMOTE DEVICES

A. General

1. Each device shall be assigned a unique address via easily understood decade switch. Address selection by jumpers is not acceptable.

2. Devices shall receive power and communication from the same pair of wires. For fault-tolerant circuits, any separate power wiring shall also be made fault-tolerant.

3. Each device shall contain screw terminals with rising plates for positive termination of up to #14 AWG wire, except for AV devices which have screw terminals for #12 AWG wire.

4. All sensors shall be of the intelligent type. All sensors shall mount on a common base.

5. Conventional fire alarm initiating devices (manual pull stations, waterflow and tamper switches, pressure switches) shall each be individually addressable via addressable modules, and shall report to the FAMP or FARP.

B. Analog Sensors: Each sensor shall contain a LED which blinks each time it is scanned by the FAMP or FARP. If the FAMP or FARP determines that the sensor is in alarm, it shall command the sensor LED to remain on to indicate alarm. All sensors not visible from the corridor shall have a remote light mounted in the public corridor and all intermediate rooms/doors as shown on the drawings. Each sensor shall contain a magnetically-actuated test switch such that the circuit can be tested from the sensor location. Display analog sensor values on the CGP system. Each sensor shall be capable of being tested for alarm via command from the FAMP/FARP or PCFC.

1. Provide Photo-electronic Smoke Sensors as indicated on the plans. Sensors shall contain an optical sensing chamber with properly selected factory-set sensitivities between 0.5% and 3.7% per foot obscuration.

2. Provide Thermal Sensors as indicated on the Drawings. Sensors shall meet with the approval of the authority having jurisdiction.

C. Monitor Modules: The Monitor Module shall provide an addressable input for N.O. or N.C. contact devices including but not limited to manual stations, water-flow switches, sprinkler supervisory devices, temperature sensors, door contacts, fire\smoke dampers, intrusion detectors, etc. The Monitor Module shall provide a supervised initiating circuit. An open-circuit fault shall be annunciated at the FAMP, FARP, PCFC, and applicable CGP. Upon determination of an alarm condition, the LED shall be latched on. The Module shall contain a LED which blinks upon being scanned by the FAMP or FARP. Upon determination of an alarm condition, the LED shall be latched on. The Module shall mount in a standard electrical box.

1. Monitor / Control module must located at the motor center and identify the appropriate electrical service which it is supplied from and the termination point\device.

D. Control Modules: The Control Module shall provide an addressable output for a separately-powered alarm-indicating circuit or for a control relay. The Control Module shall provide a supervised indicating circuit where indicated on the plans. An open-circuit fault shall be

annunciated at the FAMP, FARP, PCFC, and applicable CGP. The Control Module shall provide a control relay where indicated on the plans. The relay contacts shall be SPST (Form "C" rated at 2 amps @ 28 VDC). Voltage on detector contacts shall not exceed 24 Volts. The module shall contain an LED which blinks upon being scanned by the FAMP or FARP. Upon activation of the Module, the LED shall be latched on. The module shall mount in a standard electrical box.

E. Fault Isolator Module: The Fault Isolator Module shall detect and isolate a short-circuited segment of a fire-alarm loop.

F. Manual pull stations: shall be addressable, and shall be an approved double action, mounted on standard electrical box. Provide common key for reset.

G. Magnetic door-holders shall be wall- or floor-mount on a standard electrical box.

2.03 OTHER DEVICES

A. Horn/Strobes and Speaker/Strobes:

1. Electronic fire alarm signals shall be combination horn and strobe type or strobe only type where shown on drawings. The audible signal and strobe shall operate independently or in unison.

2. The horn shall provide for minimum sound level to meet the requirements of NFPA-72 at 10 feet, except for mechanical rooms and tunnels, for which minimum sound level shall be 100 dBA at 10 feet. Audible signal shall be continuous or temporal as directed by the Denver Fire Prevention Bureau, as driven from the FAMP's and FARP's.

3. The strobe shall provide candela per NFPA 72.

4. Devices shall be mounted on ceiling or in wall as indicated on Contract Documents, and shall be UL listed for specific mounting configuration. Column-mounted devices in equipment rooms shall be surface-mounted. Mounting height of devices on column or wall shall comply with NFPA and ADA requirements.

B. Control Relays: Provide control relays compliant with Code requirements. Provide control relays as required to accomplish functions such as fan shut-down, damper positioning, device release, etc. Relays shall have 24 VDC coils, with DPDT contacts rated at 10A, minimum, at 120 VAC, shall be provided with screw terminals, and shall be UL listed as fire alarm control accessories. Relay enclosures shall provide conduit knockouts at top and bottom, and shall have manufacturer's standard finish. Control relays shall be installed near the associated fire alarm system control modules. Control relays shall be individually commandable by the system to respond automatically in the event of an alarm by related sensors or other devices. Manual control of fans, dampers and required relays shall be provided, as well as automatic control where required. Control sequences shall be as indicated on related mechanical systems control drawings.

C. Fire alarm remote indicators shall be red LED type, mounted on a standard plate fitted to a standard electrical box. Plates shall be labeled with the name of the equipment served and the device number. Remote indicators shall be located above doorways leading to the room that the indicator monitors. Remote indicators installed for monitoring of mechanical equipment shall be installed within 7’0” of floor level and directly beneath the equipment.

2.04 WIRING

A. All Fire Alarm System wiring shall comply with NEC and NFPA requirements for power limited wiring. Fire Alarm System wiring shall be jacketed twisted pair solid wire. All wire

shall be plenum rated.

WIRE COLORS

DEVICE	COLOR	SIZE AWG*
Horn	black/red	12, 14
Strobe	brown/red	12
Initiating Circuits	black/red	14, 18
Zas	red/white	18
Remote Light	yellow/purple	18
120 VAC	Black/white/green	12 min

*Minimum size – verify voltage drop
Subject to compliance with EST and NEC requirements,
local suppliers include but are not limited to the following:
Liberty, Westpenn, ALLCABLE

B. Stranded wire shall be used on all Genesis series AV circuits. Stranded wire shall be FPLP sheathed twisted pair. Stranded wire shall be terminated using spade lugs or solder.

C. Signaling line circuits, notification line circuits and power circuits shall be in separate conduits or approved raceways.

D. For raceway requirements refer to Section 16110. Install insulated throat connectors or bushings on all raceway connections.

2.05 ENGINEERED SHOP DRAWINGS

A. System shop drawing preparation: The Contractor shall contract with a firm that is an Authorized Registered Edwards Systems Technology (EST) distributor. This distributor must have permanently employed certified designer\installers qualified for the specific equipment being provided or modified for the following:

B. Resource Project Drawings: The Contractor shall deliver to EST Certified Installer the following

1. Hard copy documents: One complete set of all specifications and drawings.

2. Magnetic Drawings: At the time of execution of the Contract with the Owner, the Contractor shall request from the Owner in writing the Consultant generated electronic media (CD) all project drawings related to Fire Alarm System. This shall include but not be limited to all Electrical drawings, Power drawings, Communications drawings, Control Drawings, and Mechanical Drawings. All drawings shall be in AutoDesk AutoCAD format (Release 2000 minimum.).

C. Field Verification:

1. Field Verification: The Electrical Contractor and EST Certified Installer shall field investigate and assure that system modifications or additions include any modifications required to system capacity. No more that 85% capacity shall be utilized for any circuit.

D. Shop drawings:

1. The shop drawings shall be executed under the supervision of a Colorado Licensed Electrical Engineer and shall be stamped and submitted for DIA Life Safety Team acceptance prior to submittal for Code Agency review and Approval.

2. Shop drawings shall clearly depict new work. Existing work shall be depicted in lower line weight than depiction of new work to assure clarity of work scope. New work will also be “bubbled” for clarity including delta markings to track sequence of changes. Bubbles will be removed at time of Record Drawing development. Shop drawings

shall be constructed on existing record drawings, maintaining the same sheet number.

3. Shop drawings shall include but not be limited to all device types and detailing, battery calculations, charge rate calculations, wiring diagrams, riser diagrams, plans and device addresses. Devices shall be dimensionally located from building column lines. Device addresses shall only be assigned after consultation with the DIA Life Safety Team. List new addresses on drawing cover sheet.

4. A construction demolition, phasing, implementation.

E. Shop Drawing format:

1. All drawings shall be scalable at 1/8 inch per foot for full size drawings. Full size drawings shall be plotted on 34 x 44 paper.

2. Half size drawings shall be scalable at 1/16 inch per foot and shall be plotted on 17 x 22 inch paper.

F. Record Drawings:

1. Conform engineered shop drawings to project record drawings as provided by the Contractor, including accurate and dimensionally correct locations of raceway, box, and device locations.

2. Prepare quantities as required by the Contractor and in compliance with Division 1.

3. Include two (2) copies of electronic media (CD) of record drawings.

4. Install (2) copies of half size drawings in the Building Fire Command Center.

5. As Built" Plans shall be provided in the same format and manner as described. Each set shall be supplied with a plan holder equal to "Stacor Plan Clamps" for the appropriate size drawings.

2.06 ENGINEERED SYSTEM PROGRAM AND COMPUTER GRAPHICS MODIFICATIONS

A. System Programming and Graphics Modifications: The Contractor shall contract with EST Certified Installer for the following:

B. Notifications: The Electrical Contractor shall coordinate with the DIA Life Safety Team for escorted access to devices requiring software and graphics loading and updating.

C. Loading and updating shall be in accordance with DIA Life Safety Team procedures. All systems updates shall be completed at least five (5) working days in advance of the scheduled Pre Test of the system modifications. Provide DIA Life Safety Team five at least (5) working days notice for requesting access to devices for loading. The requested time shall not be during night time, City Holidays or on a Wednesday. The requested time may or may not be approved depending on other scheduled activities. Scheduling shall by prioritized by request submittal.

D. Software Modifications: Provide Software modification in compliance with NFPA 72 and consistent with DIA Life Safety Team Requirements. This includes but is not limited to:

1. Confirm with DIA Life Safety Team the current program prior to development of software modifications.

2. Prepare modified software based on current sequence of operations criteria as provided by DIA Life Safety Team.

3. Provide complete review of all of the program and certify in writing the program is complete without error.

4. Development, installation and testing of customized programming software

modifications for complete system modifications, including but not limited to software modifications for Fire Alarm Master Panel, Fire Alarm Remote Panel, and IRC3 installations. Provide update of Message and Zone files in hard copy form and install hard copies in FCC hard copy records system.

E. Graphics Modifications: Color Graphics Panel (CGP)

1. Color graphics updates shall conform to DIA Life Safety Team Standards. Graphics updates shall include but not be limited to building plans, building sections where required, device locations, and device identification. Add appropriate ISA's and descriptions of locations.

2. Recover data base (Reconcile database) to all CGP locations at the following facilities: ARFF 1, Terminal, AOB, Concourse A, B, and C.

3. The CGP updates shall be graphically noted to identify that the added graphics is work "Under construction". This annotation shall be removed at time of system acceptance by the Denver Fire Department.

F. Operation of software during testing: Provide onsite presence of software author during all system testing as defined in paragraph 3.06 below.

PART 3 - EXECUTION

3.01 PRE WORK MEETING

A. The Contractor shall coordinate and arrange a pre work meeting with the DIA Project Manager, DIA Project Inspectors and DIA Life Safety team one week in advance of the beginning of any work. The Contractor shall assure attendance of trades installing fire alarm system and systems controlled or monitored by the fire alarm system. The Contractor shall review the Contractor's construction demolition, phasing, implementation and testing plans and schedule.

B. Meeting Notes: Meeting notes shall be accurately recorded by the DIA Project Manager and distributed within three (3) working days after the meeting.

3.02 GENERAL

A. The Electrical Contractor shall provide continual supervision of fire alarm wiring and equipment installation by a Installation quality control individual that maintains a minimum of NICET Level 2 Certification. The work shall be performed by skilled technicians properly licensed and trained for this work.

B. The Contractor shall be responsible for providing all additional raceways or wiring required, but not shown on the contract drawings. Included shall be all wiring required between control/auxiliary relays and monitor modules for the equipment to be controlled (i.e., EP/PE switches, motor control centers, individually mounted motor controllers, tamper switches, flow switches, and any other devices to which wiring connections are required for producing a complete and operational system).

C. Conduit: Conduits shall be installed in accordance with Section 16110- Raceways and Fittings. All alarm wiring shall be installed in metal conduit, minimum of ¾" EMT. Conduit shall be color coded 5'0" O.C. with red paint. Powder activated fasteners shall not be used. Raceways shall not be cast in concrete.

D. Boxes: As specified on fire alarm shop drawings. Outlet, pull and junction boxes shall be painted red on the exterior and shall be installed in accordance with Section 16135 –

Electrical Boxes and Box Fittings. Box covers shall be painted red and identified by initiating and signaling line system numbers.

E. Wire and Cable:

1. All wiring shall be installed in metal conduit or within equipment.

2. Conductors shall be installed in accordance with Section 16120 and requirements of this Specification Section. Fire Alarm Conductors installed within equipment enclosures shall be carefully cabled and laced.

3. "Star Taps" will not be accepted.

4. "T" taps:

a. "T" taps shall be limited to one per ZAS line.

b. Conductors shall protrude at least 8" beyond the face of the box for connections and inspection.

c. "T" taps shall not be placed within 20'0" of any device.

d. Isolation modules: Isolation Modules shall be installed at each leg of approved "T" Taps. Approved "T" taps shall be installed in minimum 8x8 lockable cabinet with hinged cover with CAT-45 key lock. Cabinet shall be painted red and located within 7'0" of the floor. Terminal strips shall be installed for wiring termination and properly labeled.

5. Individual conductors shall be tagged with markers indicating circuit number and type. Markers shall be used on all conductors at each outlet or pull box at each equipment enclosure. Reference Specification Section 16195 – Electrical Identification.

F. Device installation:

1. Detectors: All devices shall be installed to be fully accessible for testing and replacement. Elevated device locations shall be coordinated with other trades to assure direct access via ladders or lifts. Devices may not be placed above conduit, duct work, lights, etc.

2. All modules and individual devices shall be permanently marked with the system unique computer address. The marking shall be red numbers/letters on white background 3/8" high. When addresses are applied to the detector bases they shall be located at the manufactures point of test indicated on the detector.

3.03 SYSTEM INTERRUPTION

A. Interruption Request: Contractor must obtain all required signatures and written approval from DIA Maintenance Control for interruption and or disconnection of any fire alarm devices.

B. Prior to any disconnection of equipment or devices, notify the DIA Project Manager. The DIA Life Safety Team must be notified in writing at least 5 working days in advance of planned activity to coordinate Fire Alarm Master Panel modifications. The time and date of the request shall be accepted or modified to coordinate with other DIA activities. Disconnection without notification and coordination may result in system damage and Fire Alarm activation.

C. Fire Watch: The Contractor is responsible for maintaining a DFD approved fire watch during the work on a system that has been interrupted, and until such time the equipment has been restored.

3.04 SEQUENCE OF OPERATION

A. General: The operation of the fire alarm system in each of the functional areas of the facilities is managed by the DIA Life Safety TeamThe sequence of operations undergoes continual modifications for the following facilities:

1. Concourse A, B, or C
2. Terminal Building
3. Airport Office Building and Central Plant
4. AGTS Tunnel and Maintenance Facility
5. Baggage Tunnel

B. The Contractor's fire alarm programmer shall consult with the DIA Life Safety Team prior to the beginning of any programming modifications or additions.

C. Sequence of operation for HVAC and Fire Protection and security are indicated on the Designer of Record Contract Drawings.

3.05 INTERFACE WITH OTHER SYSTEMS

A. HVAC: Electrical Contractor shall coordinate, provide and assure complete connection and interface with HVAC systems modified and installed as part of this Contract.

B. Fire Protection: Contractor shall coordinate, provide and assure complete connection and interface with Fire Protection system devices installed under this Contract.

3.06 TESTING AND CERTIFICATION

A. iIt shall be the responsibility of the Contractor to arrange for meetings, inspections and testing between the DIA representatives, Code Agency representatives. The Contractor shall provide qualified construction personnel knowledgeable of all NFPA Fire Alarm testing requirements during system testing. The Contractor may employ a company specializing in the maintenance, testing and central station monitoring of fire alarm systems. Testing of the installation shall comply with the following sequence of activities:

B. Raceway, boxes and Conductor Inspection by DIA: Contractor shall complete construction and installation of all raceways, boxes, devices, conductors, contactors and connectors in accordance with Construction Documents. Installation of all equipment or devices monitored or controlled by the Fire Alarm System shall be complete except for connections. All pull boxes, device boxes and equipment boxes shall be left open for inspection. Conductors shall be installed and labeled in accordance with Contract Documents. Conductors shall be tested prior to attachment of devices in compliance with NFPA 72, including but not limited to:

1. Record of all testing
2. Resistance
3. Ground faults
4. Short circuit fault
5. Stray Voltage

C. Meg-Ohm testing shall not be performed on any low voltage (50V and less) fire alarm circuits.

D. Contractor shall be in the presence of DIA Electrical Inspection Team.

E. Fire Alarm System Device(s) Installation: Installation of all equipment or devices monitored or controlled by the Fire Alarm System shall be complete and operational at this time, except for connection to the existing building Fire Alarm System. Fire Alarm devices and controlled equipment shall be installed and labeled per Contract Documents, including device numbers per approved Fire Alarm shop drawings. All devices shall be dust protected except during testing.

F. Fire Alarm System Program and CGP updates: The Contractor shall provide 5 working days notice to the DIA Life Safety Team the time requested for installation of the Fire Alarm System program modifications and CGP updates as identified in Paragraph 2.06 of this Specification Section.

G. Pretest / System Connection: Building finishes shall be complete. The Contractor shall be responsible for all costs associated with damage to the existing Fire Alarm system due to incorrect wiring or installation. The Contractor shall provide all equipment required for testing. The Contractor shall perform all testing in accordance with NFPA and published manufacturer recommendations.

1. Request for Pretest / Connection: The Contractor shall submit a written request for System Connection and Testing 5 working days in advance of the requested pretest time. Pre-testing time may be required during night time, and shall not be performed during City Holidays or on a Wednesday. The Contractor shall include with the Pre-test request the following:

a. Certification the system has been installed in compliance with Contract Documents and NFPA 72. Certification shall comply with DFD requirements and NFPA 72.

b. Written verification by the Fire Alarm System Programmer the Programming is complete and ready for testing.

c. One legible copy of Fire Alarm Shop drawing as-builts

d. One legible copy of Manufacturer's testing procedures for each device.

e. List of each Fire Alarm Device Installed including address if provided on shop drawings.

f. all of the above items are non-returnable

H. System Connection and Testing:

1. Connection: The Contractor shall make connection to the existing Fire Alarm System ONLY in the presence of the DIA Life Safety Team.

2. Testing - General: All systems and devices monitored and or controlled by the Fire Alarm System shall be complete, tested and operational. All Fire Sealants shall be in place. All pre-testing shall be performed in the presence of the DIA Life Safety Team. The Building Fire Command center shall be manned by DIA Life Safety Team, Contractor's representative, and the Contractor's programmer. Testing shall include but not be limited to:

a. The functional operation of each re-settable initiating device (manual stations, detectors, etc.) and circuit.

b. The functional operation of each and every alarm device and circuit.

c. The functional operation of each monitored device circuit.

d. The functional operation of each control circuit, including fan controls.

e. The supervision functions of each initiating, indicating, monitoring, control and

supply circuit.

3. Functional building hardware and equipment testing: Each building device or equipment monitored by the Fire Alarm System shall be operated so as to cause an alarm or trouble on the Fire Alarm System. Each building device or equipment activated and/or controlled by the Fire Alarm System shall be operated through activation by the Fire Alarm System and or/Fire Alarm devices.

4. Voice Paging Testing and Horn/Strobe Testing: The Contractor shall provide audio meters to certify compliance with City and County of Denver Code Requirements. Voice paging modifications and or additions shall be complete per specification section 16770. Voice paging shall be tested concurrent to testing of Fire Alarm System.

5. Sequence Testing: After testing of devices and equipment verifies correct device operation, fire alarm sequence testing shall proceed. Each sequence of operation shall be tested, including sequences linked with activation of devices in adjacent areas that command operation or activation of devices in the new area of construction. At the completion of successful testing, the Contractor shall submit certification in compliance with NFPA 72 that the system is functional and operational.

6. Request for Code Agency inspection: After successful testing, the Contractor shall Contact the Denver Fire Department. See Paragraph I below.

7. The programmer shall certify in writing the following:

   a. each device is correctly labeled in the filed and on the CGP

   b. all wires are correctly labeled

   c. all boxes are correctly labeled indicating ZAS and AV circuits

   d. program sequence is correct and compliant with Code requirements

   e. verify Electrical Contractor device and conduit record documents

   f. all sequences driven by the programming sequence have been checked and are without error.

I. DFD Proof Testing: All system alterations and additions must be tested and accepted by the Denver Building Department and the Denver Fire Department. The Contractor is responsible for all fees for testing. Proof testing of installations or additions to the fire alarm systems in public areas requires night testing to minimize operational disruptions. Proof Testing shall not be performed during City Holidays or on a Wednesday

1. DFD Notification: The Contractor (after successful pre-testing is completed) shall provide a written notice to the Denver Fire Department for testing five days in advance of the time and date requested for the test date. The Contractor shall copy the Project Manager concurrently. The request for testing shall include itemization of devices and systems to be tested in the format as required by the Denver Fire Department. Night testing and/or re-testing by the Denver Fire Department requires an additional fee established by Denver Fire Department. This cost is to be part of this section's scope.

2. The Electrical Contractor responsibilities at the time of the Proof test: The Electrical Contractor shall make available the Stamped set of drawings with changes approved by the Denver Fire Department Fire Prevention Engineer. The Contractor shall provide the following:

   a. all equipment necessary for testing:

      1) Magnets

      2) Audio meter

3) Canned smoke

4) Communication source

5) Ladders

b. documentation

1) Original # 3 & # 3A permits including building department stamped prints.

2) One copy of marked up as-built drawings installed in Building Fire Command Room.

3) Contractor's written certification the system installation complies with NFPA requirements.

c. spare parts: 5% of all devices installed

d. The Electrical Contractor representatives for each trade shall be available at the test and shall activate and monitor devices for the test. Contractor shall be prepared to modify or repair system(s) installation at time of the Proof Test if directed by the DFD. Testing shall include all devices installed and shall include activation/shut down of equipment controlled or monitored by the installation (i.e. fill of dry sprinkler systems, smoke fans, fire doors, etc.)

3. Pre Proof Test Meeting: Contractor shall review constructed area with DFD. General scope and systems modifications shall be reviewed. Contractor shall introduce the representative of each trade. Review of items listed in paragraph 2 above shall be completed. Incomplete preparation and/or incomplete submittals noted in paragraph 2 at the time of the Proof Test may be cause for DFD cancellation of the Proof Test. The Contractor shall pay all fees for re-testing.

4. Two Denver Fire Inspectors shall observe and direct the proof test and sign off the 3A PERMIT and FIRE ALARM AND SPRINKLER INSPECTION REPORT subject to acceptance.

3.07 PRE-INSPECTION CHECK LIST - FIRE ALARM SYSTEM CONNECTION

A. Purpose: This is a punch list for contractors doing new installations and alterations; it is to be a quick and easy reference page to aid the contractor in avoiding the most common mistakes made during the installation of fire alarm system upgrades.

B. This is designed to save the contractor extra time and costs associated with having to re-install the system in order to comply with the specifications. It designed to save the tenant money by avoiding extended periods of construction. It will eliminate maintenance department repairs to the DIA Life Safety System which develop because of improper installation. Note: This check list is not meant to change or be a substitute for the construction documents or specifications.

1. MARKING YES AND initialing each item below, indicates compliance.

2. MARKING NO requires an explanation of reason.

3. NOTE:

a. These are the installing contractor's responsibility.

b. This check off sheet must be present and complete before the final DFD test may begin.

INSPECTION CHECKLIST

Item	YES	NO	Requirement	Initials
1			A proper “FIRE ALARM SYSTEM” shut down request was prepared and submitted before making any contact to the alarm system	
2			An accurate and complete load test was performed for each affected NAC circuit and its power source, and the recorded results are attached to this check list. Circuits and power source are verified good so as to not cause “roll over” or any degradation to existing system.	
3			All conduits and junction boxes have been correctly identified.	
4			Were the signaling line circuits (ZAS) and notification circuits (NAC) are run in separate conduits.	
5			Fan /damper control circuits were run in separate conduits from fire alarm circuits and a Voltage barrier installed in the junction box where they meet.	
6			The specified - RED / WHITE - FPLP signaling line circuit (ZAS) wire was used for all detectors, monitor & control modules, and remote pull boxes.	
7			The specified - RED / BLACK - FPLP notification circuit (Horn) wire was used for all horns and the correct end of line resistor installed as shown on the drawings.	
8			The specified - RED / BROWN - FPLP notification circuit (STROBE) wire was used for all strobes and the correct end of line resistor installed as shown on the drawings.	
9			The specified -YELLOW / PURPLE - FPLP control circuit (REMOTE) indicator wire was used for all remote light key operated test stations and installed as shown on the drawings.	
10			The specified - RED / BLACK - FPLP control circuit operation / monitor wire was used for all control and monitor modules as shown on the drawings.	
11			The connection points for both the ZAS and NAC circuits are as shown on the approved shop drawings. If no, list who was contacted and approved these changes for both Life Safety and MCS. Explain:	
12			All required end of line resistors been installed at all monitored circuits in the correct manner.	
13			There are no Star or Tee taps used while installing these system revisions. This means more than two wires under one wire nut or terminal.	
14			All addressable devices are addressed & labeled per the approved shop drawings.	
15			All device I.D. Labeled per the approved shop drawings.	
16			The correct settings for Horn volume and Strobe intensity were verified as set per the drawings or at the lowest level.	
NOTE: Step 17 can not be performed until the answers to all of the above questions are **YES.**				

INSPECTION CHECKLIST

Item	YES	NO	Requirement	Initials
17			A resistance test, clear of all ground and shorts must be performed in the presence of the Life Safety representative prior to connection of any conductors to the buildings fire alarm system.	
Contractor's licensed & NICET certified Representative:				
Date:				

Contractor's Final Check Off for DFD Inspection.
[to be done at time of inspection]

A representative from the installing company with a current DFD fire alarm license must be present at the test.

Permitted /stamped plans with card are present and in hand at the test.

All required testing materials are available for the test. These include, but are not limited to: ladders; extension cords; canned smoke; heat gun; poles.

All appropriate parties are present, and all access issues have been arranged. These include: owner Rep.; Alarm Company Rep. (MCS or other); Smoke Tester (if applicable); Hood contractor; HVAC representative.

PART 4 - MEASUREMENT

4.01 METHOD

A. No separate measurement shall be made for work under this section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment will be made for work under this section except for services provided in paragraphs 2.05 and 2.06 of this Specification Section. Reference Allowances in the Contract Bid form. The cost for all other work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 16721

SECTION 16770

VOICE PAGING SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Extent of work shall be shown on drawings, including locations, elevations and detail construction.

1.02 RELATED DOCUMENTS

A. Drawings, general and special conditions, Division 1 – General Requirements and other applicable technical specifications apply to this Section.

1.03 RELATED SECTIONS

A. Technical Specification Division 1 - General Requirements

B. Division 16 - Electrical

1.04 REFERENCE STANDARDS

A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.

B. A listing of the applicable reference standards is contained in Section 01091.

C. In addition to all applicable local and state codes, the work shall be in accordance with the latest revisions of all applicable standards and specifications of the following:

1. NFPA – National Fire Protection Association
2. NAB - National Association of Broadcasters
3. UL - Underwriters Laboratories
4. EIA - Electrical Industries Association
5. NEC - National Electrical Code

1.05 SYSTEM DESCRIPTION

A. Components provided under this Contract shall be compatible with and connected to the existing Innovative Electronic Designs, Inc. IED 500 Mainframe located in the center core of each concourse, or Room 45B08 in the Terminal.

B. The Voice Paging System (VPS) provides paging and background music to public areas of the airport facilities except the AGT platforms and tenant lease space. A line level input and dry contact closure cause tenant sound system announcements to mute and an emergency message can be sent. Voice paging must be provided to all non-public support areas and parking areas. The system is used for general announcements and emergency announcements throughout Concourses A, B, and C, Terminal, AGTS Tunnel, Office Tower and Central Plant.

C. The monitor/test system is capable of monitoring and/or testing all audio or DC signal, speaker level outputs, or system wiring to insure integrity and reliable operation. All line-level zone inputs and outputs, equalizer inputs and outputs, amplifier inputs and outputs must be monitored for correct operation.

D. The output of each amplifier must go through a terminal cabinet. This network allows loudspeaker loads to be disconnected from the amplifier outputs for manual measurement of load impedances by maintenance personnel.

E. All loudspeakers operate on a 70 Volt distributed system. Higher voltage distribution (100 Volt or higher) may be used to reduce conduit cable fill and remain within the allowed 0.5 dB line loss limit. The loudspeakers shall be grouped in modular zones allowing maximum flexibility for paging area assignment.

F. All microphone stations, ambient noise sensors, and loudspeakers shall be hardwired to the local P.A Rooms. Match Existing equipment and installer techniques.

G. Local P.A. Rooms within a building are connected together via copper cable to the building VPS Control Room. Spare copper cable for new installations may not exist.

H. Terminal cabinets provide a demarcation point between field speaker cabling and speaker cabling to the back of the amplifiers. Cables shall be terminated to terminal strips inside the cabinets.

1.06 SYSTEM OPERATION

A. The following functional capabilities are required for the DIA Voice Paging System:

1. The system is capable of automatic or manual audible testing of microphone inputs, IED headend audio outputs, ambient noise sensor frame outputs, equalizer outputs amplifiers and loudspeaker systems.

2.

1.07 QUALIFICATIONS

A. Manufacturers' Qualifications: Paging control system, microphone stations, amplifiers, ambient noise system equipment, monitoring hardware: Innovative Electronic Designs, Inc.

B. The VPS shall be installed by a Contractor who has been regularly engaged in the installation of electronic equipment for at least 5 years and certified to install IED systems. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.

C. A resume of qualification shall be submitted with the Contractor’s bid indicating the following:

1. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.

2. A technical resume of experience for the Contractor’s Engineer and on-site installation foreman who will be assigned to this project.

3. Similar documentation will be required of any subcontractor who will assist the Contractor in performance of this work. All proposed subcontractors must demonstrate equal or superior experience or technical qualifications to the Special Systems Contractor in order to contract for any part of the installation or testing of the system.

4. Contractor shall be an authorized installer and dealer of the specified equipment with a service facility within 100 miles of the project site.

D. Contractor shall submit proof that the primary system programmer to be used in the programming of the systems has attended a programming school hosted by the manufacturer of the computerized systems to be provided under this section within the past two years. Attendance shall have been within the one year prior to the date of project notice to proceed.

1.08 SUBMITTALS

A. Provide submittals in accordance with Section 16010.

B. Shop Drawing Submittals:

1. Shop drawings shall be of scale suitable for use for fabrication. They shall show materials, finishes and panel/control markings. Installer shall make the following shop drawing submittals:

2. A complete list of equipment for the systems, including that required for items which are to be fabricated by the Installer.

3. A complete set of detailed technical descriptions describing and illustrating all components and materials.

4. A complete set of shop drawings of items which are to be fabricated by the Installer and/or which the Installer intends to fabricate or has fabricated, including but not limited to, the custom panels and receptacle plates.

5. System block diagrams with provisions for entry of future test results.

6. Equipment rack and console layouts.

7. Zone programming table with microphone station programming for each location.

8. Details of cable management and termination in terminal boxes junction boxes and equipment racks.

9. A wiring diagram showing the exact manner in which the Installer proposes to install the system. Show all switches, modifications to equipment, control circuits, and equipment rack layouts. Show all equipment/apparatus items which are required for performance of the required functions.

10. Drawings identifying all terminals, wiring color-coding and control functions.

C. The data submitted by the bidder shall be sufficiently detailed to enable the Owner's Representative to determine whether or not the equipment, materials and installation the Installer proposes to furnish comply with the requirements of this specification, and whether or not the Installer's organization is qualified by experience, and by capability of personnel, to execute the work described herein.

D. Closeout Documents: Two weeks prior to final acceptance testing, the Installer shall provide two sets of "as-built" prints of the following:

1. System block diagrams.

2. Equipment rack and console layouts.

3. System wiring diagrams.

4. Test reports, as specified herein.

5. Documentation, as specified herein.

6. Written warranty, as specified herein.

1.09 TESTING AND REPORTS

A. Electrical/Electronic Tests: At the job site, the Installer shall perform tests not conducted and certified by the manufacturer and, be prepared to repeat any or all tests as may be directed by the Owner's Representative during the period of final inspection and checkout. Furthermore, the Installer shall be prepared to perform work required to modify the performance of the system in accordance with this specification.

1. General Inspection and Adjustment: Make all measurements, and subsequently deliver documentation, to demonstrate that all individual components, not previously measured and certified by the manufacturer, are performing in accordance with each manufacturer's published specifications. Specifically, examine frequency response, total harmonic distortion and signal-to-noise ratio. Replace any components found to be defective.

2. Loudspeaker Line Impedance: Measure the impedance and the resistance of each loudspeaker line leaving the sound equipment racks with the line disconnected from its normal driving source. Maintain values within ± 10% of the value calculated for that circuit based upon the parallel impedances of the loudspeakers connected plus the resistance of the loudspeakers. Measure loudspeaker impedance at 250 Hz and 2,000 Hz.

3. Loudspeaker Ground Faults: Loudspeaker circuits shall be tested for any resistance to ground on each leg of the circuit and documented to be clear of faults before the amplifiers are connected.

4. Hum and Noise Level: Measure the hum and noise levels of the overall system. Adjust gain controls for optimum signal-to-noise ratio. The adjustment shall also be such that full amplifier output would be achieved with O dBm input. Terminate inputs with shielded resistors of 600 ohms, and disconnect the loudspeaker lines, terminating the power amplifier outputs with power resistors, for these measurements. The load resistors shall match the rated load impedance and output power of the amplifiers.

5. Power Output and Signal Level Adjustments: Measure the electrical distortion of the overall system. Adjust gain controls as for the hum and noise level test. Set variable equalizers for flat response. Apply 1,000 Hz sinewave signal at the input tested, at a level required to produce a full amplifier output. Use a distortion analyzer to measure the output level and total harmonic distortion of the amplification equipment. Make all measurements with loads actually incurred in system operation. Power amplifier loads shall be resistors equal to the nominal impedance of the output terminals used in the system.

6. Gain Control Settings: Establish tentative normal settings for all gain controls. All gain controls on rack-mounted equipment shall be adjusted for optimum signal-to-noise ratio and signal balance. Settings may require further adjustment by the Installer as a result of testing by the Owner's Representative. After final gain and attenuator settings have been established, mark all manual control settings with an adhesive indicator dot or arrow and record for future reference. Programmed settings shall be recorded in hardcopy format.

7. Freedom from Switching Transient Noise: Operate all control switches and relays, while listening for clicks and pops in the system outputs. Eliminate any found.

8. Fiber Optic Attenuation: Measure the fiber optic interface connection attenuation. Correct any connection or splice that exceeds the manufacturers specified maximum allowable dB loss.

9. Listening Test: Listen to normal program material to make certain that no remaining defects exist.

B. Acoustical Tests:

1. Make all necessary adjustments to ensure proper operation of the system.

2. Measure the overall space average acoustical frequency response within each area served. Test signals shall be broad band "pink" noise applied to any systems input. Measurements shall be made using 1/3 octave band filters centered on ANSI preferred frequencies.

3. Throughout the coverage area of the system, amplified sound levels shall not vary more than ± 5 dB as measured using an octave band of "pink" noise centered at 4,000 Hz as the test signal.

4. Measurements of system performance shall be made using a calibrated ANSI S1.4, Type 1 sound level meter set for "slow" meter damping and flat response. The microphone shall be positioned 5 feet above the floor within the area served by the system. All interior finishes and furnishings shall be in place, and the system gain shall be set to provide octave band levels at least 10 dB above background nose levels in any octave band at the measuring locations.

C. Report: Upon completion of above tests and any necessary adjustments, submit two copies of a written report presenting test results, including numerical values where necessary, for review by the Owner's Representative prior to acceptance testing, final tuning and demonstration. With this report, submit written certification that the installation conforms to the requirements stated herein, is complete in all respects, and is ready for inspection, testing and final tuning.

1.10 DOCUMENTATION

A. Submit documents under the provisions of Section 16010.

B. Project Record:

1. Installer shall supply asbuilts in AutoCad format, latest version. Modify existing asbuilts if available and build new asbuilts in similar format to the existing asbuilts. Provide one half sized set to keep in the equipment room, 3 full sized sets and 4 cd’s with soft copy to DIA.

1.11 OPERATION AND MAINTENANCE DATA

A. Submit data under provisions of Section 16010

B. Maintenance Information:

1. Installer shall provide technical information for all electronic apparatus, including but not limited to schematic diagrams and parts lists, manufacturer's installation instructions, operating instructions and technical specifications.

2. Installer submittal shall include all system spreadsheets, as-built drawings and, shop drawings prepared and used by the Installer, as well as those which were not required to be submitted for approval. This shall include, but not be limited to, wiring diagrams, schedules for identification of building wiring and installation details useful to a maintenance technician.

C. Instruction Manuals:

1. Provide five (5) copies of an Instruction Manual containing the following:
   a. Table of Contents.
   b. Instructions for operating the system in all modes of operation and for fulfilling all functional requirements.
   c. List of settings and adjustments for semifixed controls.
   d. Manufacturer's sheets of specifications, operating instructions and service information arranged alphabetically by manufacturer and then by model number.
   e. Detailed complete wiring diagrams and one-line diagrams for the "as-built" system in reproducible format.
   f. Recommended preventive and remedial maintenance.
   g. Complete parts list.

1.12 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Division 1.

B. Store and protect products under provisions of Section 16010.

1.13 WARRANTY

A. Provide a written twenty-four(24)month warranty, signed by the Installer, due on the date of the final acceptance.

B. Include the following provisions:

1. Warranty all equipment and the installation to be free of faulty workmanship.
2. Warranty all components, including solid state devices, to be free of defects for a period of two (2) years from the date of final acceptance.
3. Paint and exterior finishes, fuses and lamps are excluded from above warranty, except when damage or failure results from defective materials or workmanship covered by the warranty.

1.14 SPARE PARTS

A. Contractor shall supply spare parts to the Owner in the amount of 10% of the equipment installed under this contract or one of each item whichever is greater. All spare stock shall be delivered in manufacturers standard shipment packaging, and each item shall be clearly identified as to package contents.

1. Type S6 Loudspeaker
2. Fuses (of each type/size used in system)
3. Connectors (of each type used in system)

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials, equipment and apparatus provided shall be new and of the latest design or model offered for sale by the manufacturer.

B. Acceptability for use in the systems shall be determined by the Owner's Representative. Such items shall be installed only after receipt of written approval of the Owner's Representative.

2.02 LOUDSPEAKERS

A. Type S6, Paging Horn (new and existing construction):

1. Loudspeaker type S6 shall be a high power paging horn consisting of a compression driver and an aluminum re-entrant horn flare with a symmetrical dispersion angle of 100 degrees. The frequency response shall be ±10 dB, 250 Hz to 6,500 Hz at the minimum, with a sensitivity of 107 dB at 1 meter with 1 watt 1 kHz input. Type S6 units shall have a power rating of 30 W and shall be supplied with a transformer with 2, 4, 7.5, 15 and 30 watt taps. An adjustable mounting bracket shall be provided which is suitable for mounting to a 4-inch octagonal electrical box and allows aiming of the device.

2. These loudspeakers shall be used in the Terminal Parking Garage, the AGTS Tunnel, Central Plant, mechanical rooms and other high noise environments.

3. Manufacturer: Atlas AP30T

B. Specifications Alternatives:

1. In the foregoing specifications for loudspeakers, and elsewhere in these specifications, reference is made to "70 volt" line transformers. Refer to paragraph 1.05-E for alternatives available to the Contractor.

2. For loudspeaker type S6 , the specified output taps for line transformers need not conform exactly with the values shown. Taps standard with the proposed manufacturer is acceptable provided that total range and intervals approximately conform to the specified values.

2.03 OTHER DEVICES

A. Wiring and Conductors:

1. Trunk loudspeaker cable, when installed in conduit, shall be 12 AWG stranded red/black twisted pair, with a green overall PVC outer jacket.
   a. Branch loudspeaker cable shall be 12 AWG stranded red/black twisted pair to the first loudspeaker in the home run. Cable shall be provided with a green overall PVC jacket.
   b. Cable thereafter shall be sized to provide no more than 0.5 dB loss but shall be no smaller than 14 AWG. Color code and jacket requirements shall be the same as used on trunk cable.
   c. Where installed in cable tray, loudspeaker cable shall be plenum rated.
   d. Manufacture:
      1) 12 AWG Cable – Tappan PLN1202TC GN.
      2) 2.14 AWG Cable – Tappan PLN1402TC

2. Control cable shall be installed in conduit and shall be low capacitance 22 AWG stranded four twisted pair with 100% aluminum polyester overall shield and drain wire. The nominal O.D. shall be 0.325" with a green outer jacket, nominal conductor D.C.R. shall be 24 ohm/1000 ft., the nominal capacitance shall be 15.5 pF/ft. between conductors and the nominal capacitance shall be 27.5 pF/ft. between one conductor and other conductors connected to shield.

3. The installation may involve localized conditions in which metallic-conductor cable systems will transition from conduit to tray installation, and vice versa, for limited

lengths of run. If a cable is transitioning from a room via tray into conduit for the remaining distance of the run, the wiring should be the type rated for use in conduit. If the majority of the cable run is in conduit, use cable rated for such use. If the majority of the cable run is in cable tray, use cable rated for use in tray.

2.04 CONNECTORS AND TERMINATIONS

A. Connectors utilized interconnect loudspeakers to cabling shall be nylon insulated butt crimp devices with a protective shell to contain exposed conductors. The crimping tool used with these connectors shall be specifically designed for use with the type of connector being utilized.

B. Wiring terminations to terminal blocks and loudspeaker screw terminal terminations shall be made using an appropriately sized insulated spade lug connection.

1. Manufacture: AMP Flexiblock System

C. Product Data:

1. Spade Lugs - Thomas and Betts or approved equal

PART 3 - EXECUTION

3.01 GENERAL

A. All work shall be provided complete, and the voice paging systems shall be fully operational as shown and described herein.

B. Modifications and additions to the existing VPS: Contractors must give DIA Maintenance and Engineering 48 hours notice before making any connections, deletions, or modifications to the existing sound system. DIA System Shutdown Request form must be used for this purpose.

C. Electrical Related Work:

1. Furnish and install all electrical conduit, wiring and outlets for electrical power to paging and announcement control equipment.
2. Furnish and install raceway, conduit, junction boxes and for audio signal and control wiring.
3. Furnish and install loudspeaker junction boxes and enclosures.

3.02 FABRICATION

A. Terminals and Terminations:

1. Terminal blocks shall be fully insulated, rated for the wire size to be terminated, suitable for mounting inside a electrical enclosure and, unless otherwise specified, be one of the following types:
   a. Terminal strips with interposing barriers between screw terminals.
   b. Terminal strips with gas-tight screw type clamp connectors.
2. Each terminal strip shall have a legibly marked permanent identification strip.

B. Structural Assemblies:

1. Loudspeaker mounting frames and brackets shall be fabricated and assembled in shop to the greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings.

2. Provide high-strength threaded fasteners for bolted connections and comply with AWS code for procedures, appearance and quality of welds and for methods used in correcting welding work.

3. Provide holes required for securing other components or assemblies to structural steel framing and for passage of other components through steel framing members as shown on final shop drawings. Cut, drill or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning.

4. In fabricating mounting brackets and other steel components requiring bends, the radii of the bends shall not be less than three times the thickness of the steel being bent.

3.03 INSTALLATION

A. Modifications and additions to the existing VPS: Contractors must give DIA Maintenance and Engineering one week notice before making any connections, deletions, or modifications to the existing sound system. DIA System Shutdown Request form must be used for this purpose.

B. Secure equipment firmly in place, including loudspeakers, amplifiers and cables. Make fastenings and supports adequate to support their loads with a safety factor of three.

C. Clearly, logically and permanently mark switches, connectors, jacks, relays, receptacles, cables and cable terminations.

D. The Installer shall take precautions to prevent electromagnetic and electrostatic hum. Install the equipment to provide safe operation.

E. Provide all cables necessary for interconnection of permanently mounted equipment. Use terminations required to achieve full function of equipment as specified herein.

F. Exercise care in wiring, to avoid damage to the cables and to the equipment. Make all joints and connections with rosin-core solder or with mechanical connectors approved for Class I wiring. Execute all wiring in strict adherence to standard broadcast procedures.

G. Run lines in separate metallic conduits or install cable tray dividers for microphone level circuits (up to -20 dBm), line level circuits (up to +30 dBm), loudspeaker circuits (above +30 dBm) and power circuits. Ground power conduits with heavy wire to the power system ground. Use only cables which are insulated from the conduit and from each other for the entire conduit length. Connect conduits mechanically and electrically to the sound system ground point. Do not splice lines in conduit.

H. Ground audio cable shields only at the power amplifier inputs. Terminate shields at the "floating" end with insulating collars or heat shrink tubing. Preserve continuity of shields at connecting points. Connect all audio grounds in this system to a common point and the racks to a building earth cable sized for DC resistance of less than 0.1 ohm.

I. Provide factory technical support to supervise preliminary testing of system during installation, at start-up, and at time of final inspection testing.

3.04 MAINTENANCE SERVICE

A. Replace defective materials and repair faulty workmanship within 48 hours of discovery during the period of the warranty.

3.05 SYSTEM DEMONSTRATION

A. Upon approval of the test report by the Owner's Representative, and at a time established by the Project Engineer, demonstrate the operation of each major component of the system and the completed installation. After demonstration, assist as required in the following acceptance tests:

1. Listening Tests: These tests shall include speech intelligibility survey and subjective aural evaluations by observers at various positions under various operating conditions, using live speech and/or recorded music material.

2. Equipment Tests: Any measurements of frequency response, distortion, noise or other characteristics and any operational tests deemed necessary may be performed on any item or group of items to determine conformity with these requirements.

3. If the need for adjustment or modification becomes evident during demonstration and testing, accomplish adjustments or alterations until the installation operates fully in accordance with the requirement of this specification.

PART 4 - MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. No separate measurement shall be made for work under this section.

PART 5 - PAYMENT

5.01 METHOD OF PAYMENT

A. No separate payment is made for work under this section. The cost of the work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 16770

Denver International Airport

CENTRAL UTILITY PLANT CHILLER ADDITION

City Design Project #: CE-03024-09
City Construction Project #: 201310046-00

Issue for Construction

Project Address:

Cental Utility Plant: 26920 E 86th Ave. (S17-1)
Denver, Colorado 80249

Issue Date:
23 JULY, 2013

Burns & McDonnell
Engineering Co.

Dennis Whitney P.E.
9785 Maroon Circle, Suite 400
Centennial, CO 80112
Ph: 303-721-9292
Fax: 303-721-0563
BMcD Project Number: 67715

CITY & COUNTY
of DENVER

DENVER
INTERNATIONAL
AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT
CHILLER ADDITION

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	AM	IFC	23.8.13	DMW

SCALE:

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: D. WHITNEY

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO.

SHEET TITLE
COVER

SHEET NO.
G0.00

CADD FILE NO.

CODE INFORMATION

APPLICABLE CODES:

INTERNATIONAL BUILDING CODE, 2009 EDITION, AS AMENDED BY: BUILDING CODE FOR THE CITY AND COUNTY OF DENVER, 2011 EDITION. APPLICABLE NATIONAL FIRE PROTECTION ASSOCIATION DOCUMENTS.

OCCUPANCY GROUPS AND OCCUPANT LOAD FOR EGRESS

USE	OCCUPANCY GROUP	OCCUPANCY LOAD IN SQ.FT./OCCUPANT
MECHANICAL, ELECTRICAL, AND PLUMBING CENTRAL PLANT FOR FACILITY	F-1	F-1

BUILDING INFORMATION

BUILDING CONSTRUCTION	TYPE I-A
NUMBER OF STORIES	1 (AT GRADE), 3 (BELOW GRADE)
LOWER LEVEL AREA	43,874 S.F.
AREA OF WORK	6,286 S.F.

FIRE RESISTIVE REQUIREMENTS (IBC 2009, TABLE 601)

3 HOUR	EXTERIOR BEARING WALLS
0,N.C.	EXTERIOR NON-BEARING WALLS
3 HOUR	INTERIOR BEARING WALLS
0,N.C.	INTERIOR NON-BEARING WALLS
3 HOUR	STRUCTURAL FRAME, COLUMNS AND PRIMARY BEAMS
2 HOUR	SHAFT ENCLOSURES, EXIT STAIRS, ELEVATORS
2 HOUR	FLOOR-CEILING ASSEMBLIES
1.5 HOUR	ROOF-CEILING ASSEMBLIES
0,N.C.	ROOF MORE THAN 25 FT ABOVE ANY FLOOR

FIRE SUPPRESSION SYSTEM

HYDRAULICALLY DESIGNED AUTOMATIC SPRINKLER SYSTEMS IN ACCORDANCE WITH NFPA

STANDPIPE SYSTEM

CLASS 1 WET STANDPIPE PROVIDED THROUGHOUT THE PASSENGER TERMINAL IN ACCORDANCE WITH NFPA 14

SMOKE CONTROL SYSTEMS

CONTROL ZONES PROVIDED TO CONTAIN AND EXHAUST SMOKE IN THE AREA OF FIRE ORIGIN USING ASHRAE AND OTHER GUIDELINES ADOPTED BY NFPA 92A AND 92B

DRAWING INDEX

GENERAL DRAWINGS
G0.00 COVER
G0.01 PROJECT INFORMATION
G1.01 VICINITY MAP AND SITE PLAN

ARCHITECTURAL DRAWINGS
AD2.01 LOWER LEVEL PUMP ROOM DEMOLITION PLAN
A2.02 LOWER LEVEL PUMP ROOM FLOOR PLAN

STRUCTURAL DRAWINGS
S0.01 STRUCTURAL GENERAL NOTES
S1.02 LOWER LEVEL STRUCTURAL PLAN
S5.01 STRUCTURAL DETAILS
S5.02 STRUCTURAL DETAILS
S5.03 STRUCTURAL DETAILS
S5.04 STRUCTURAL DETAILS
S5.05 PIPE SUPPORT DETAILS
S1.03 CHILLER PIPING SUPPORT PLAN
S1.01 OVERALL - EAST CURB AND SLAB PLAN
S1.00 OVERALL - WEST CURB AND SLAB PLAN
S5.06 PIPE SUPPORT DETAILS
S1.04 LOWER LEVEL PUMP ROOM PIPING SUPPORT

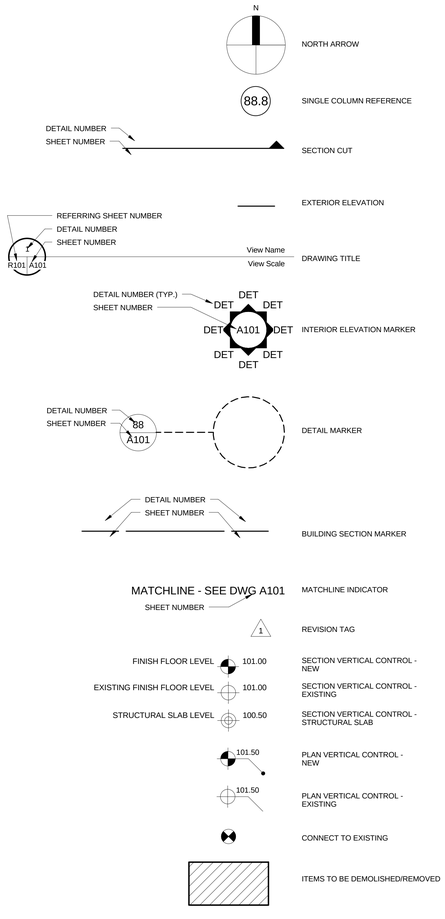
MECHANICAL DRAWINGS
M0.01 MECHANICAL LEGEND AND ABBREVIATIONS
M1.01 LOWER LEVEL GENERAL ARRANGEMENT
MD2.02 LOWER LEVEL CHILLER ROOM MECH DEMO PLAN
MD2.03 BREAK AND TOOL ROOM HVAC DEMO PLAN
M2.01 LOWER LEVEL WEST MECHANICAL PLAN
M2.02 LOWER LEVEL EAST MECHANICAL PLAN
M2.03 ELECTRICAL ROOM HVAC PLANS
M3.01 MECHANICAL SECTIONS
M3.02 MECHANICAL SECTIONS
M3.03 RTU RELOCATION SECTIONS
M4.01 CONDENSER WATER FLOW DIAGRAM
M4.02 CHILLED WATER FLOW DIAGRAM
M4.03 RTU FLOW DIAGRAM
M6.01 MECHANICAL DETAILS
M6.02 MECHANICAL DETAILS
M7.01 MECHANICAL SCHEDULES

ELECTRICAL DRAWINGS
E0.01 ELECTRICAL LEGEND
ED3.02 DEMO PLAN WEST LOWER LEVEL
ED3.03 DEMO PLAN EAST LOWER LEVEL
ED3.05 MCC ROOM DEMO PLAN
E3.01 OVERALL LOWER LEVEL PLAN
E3.02 POWER PLAN WEST LOWER LEVEL
E3.03 POWER PLAN EAST LOWER LEVEL
E3.04 ELECTRICAL ROOM PLANS
E3.05 MCC ROOM PLAN
E3.06 CHILLER POWER PLAN
E3.07 INSTRUMENT AND CONTROLS PLAN
ED5.01 HGMC-A DEMO ONE-LINE DIAGRAM
ED5.02 HGMC-B DEMO ONE-LINE DIAGRAM
E5.01 HGMC-A ONE-LINE DIAGRAM
E5.02 HGMC-B ONE-LINE DIAGRAM
E5.03 MCCB2 ONE-LINE DIAGRAM
E6.01 MCC ROOM PANEL BOARD SCHEDULES 1
E6.02 MCC ROOM PANEL BOARD SCHEDULES 2
E6.03 SCHEMATIC DIAGRAMS 1
E6.04 SCHEMATIC DIAGRAMS 2

PROJECT NOTES:

1. THE INTENT OF THIS PROJECT IS TO ADD TWO NEW CHILLERS, NEW PUMPS, NEW ELECTRICAL ROOM, AND ALL ASSOCIATED PIPING, CABLEING AND SUPPORTS TO THE CENTRAL UTILITY PLANT.
2. CONTRACTOR SHALL FURNISH ALL THE NECESSARY COMPONENTS AND ACCESSORIES TO PROVIDE COMPLETE SYSTEMS IN ACCORDANCE WITH THESE DRAWINGS AND THE SPECIFICATIONS.
3. CONTRACTOR IS RESPONSIBLE FOR VERIFYING EXISTING CONDITIONS PRIOR TO COMMENCEMENT OF WORK.
4. CONTRACTOR SHALL COORDINATE ALL MAINTENANCE AND REQUIRED CLEARANCES OF NEW CHILLERS, PUMPS, AND ELECTRICAL EQUIPMENT PRIOR TO DELIVERY TO THE PROJECT SITE.
5. CONTRACTOR SHALL COORDINATE ALL SYSTEM OUTAGES WITH THE DIA PROJECT MANAGER.
6. THE EXISTING CHILLERS, HEAT EXCHANGERS, AND ASSOCIATED PUMPS SHALL NOT BE TAKEN OUT OF SERVICE DURING CONSTRUCTION. THE CENTRAL UTILITY PLANT SHALL REMAIN FULLY OPERATIONAL FOR THE PROJECT CONSTRUCTION DURATION.
7. CONTRACTOR SHALL COORDINATE WITH CENTRAL UTILITY PLANT STAFF AND DIA PROJECT MANAGER PRIOR TO INSTALLATION OF ANY EQUIPMENT OR PIPING.

PROJECT SYMBOLS



CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	AM	IFC	2/13,13	DWM

SCALE: 12" = 1'-0"

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: D. WHITNEY

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

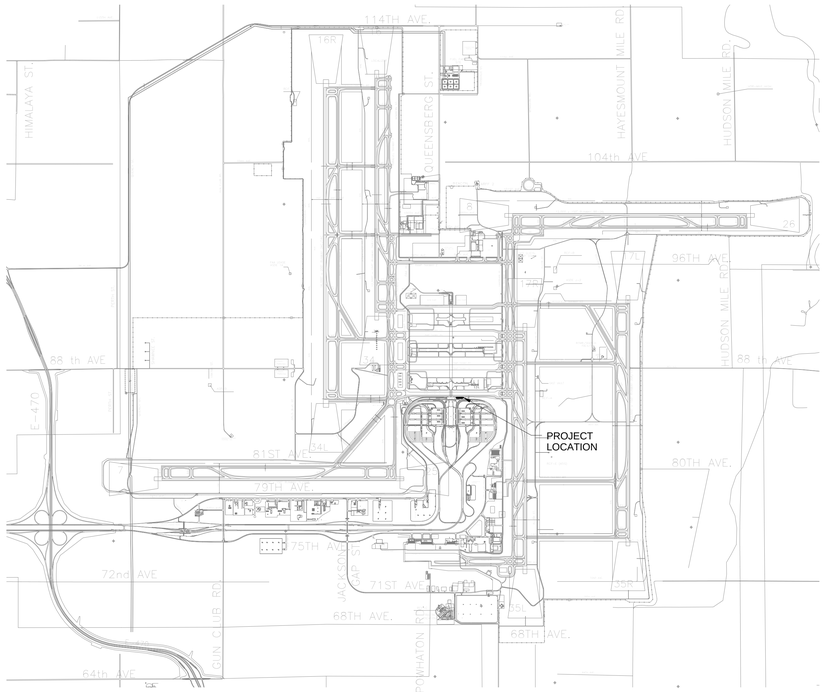
CONST. CONTRACT NO. 20131046-00

VOLUME NO.

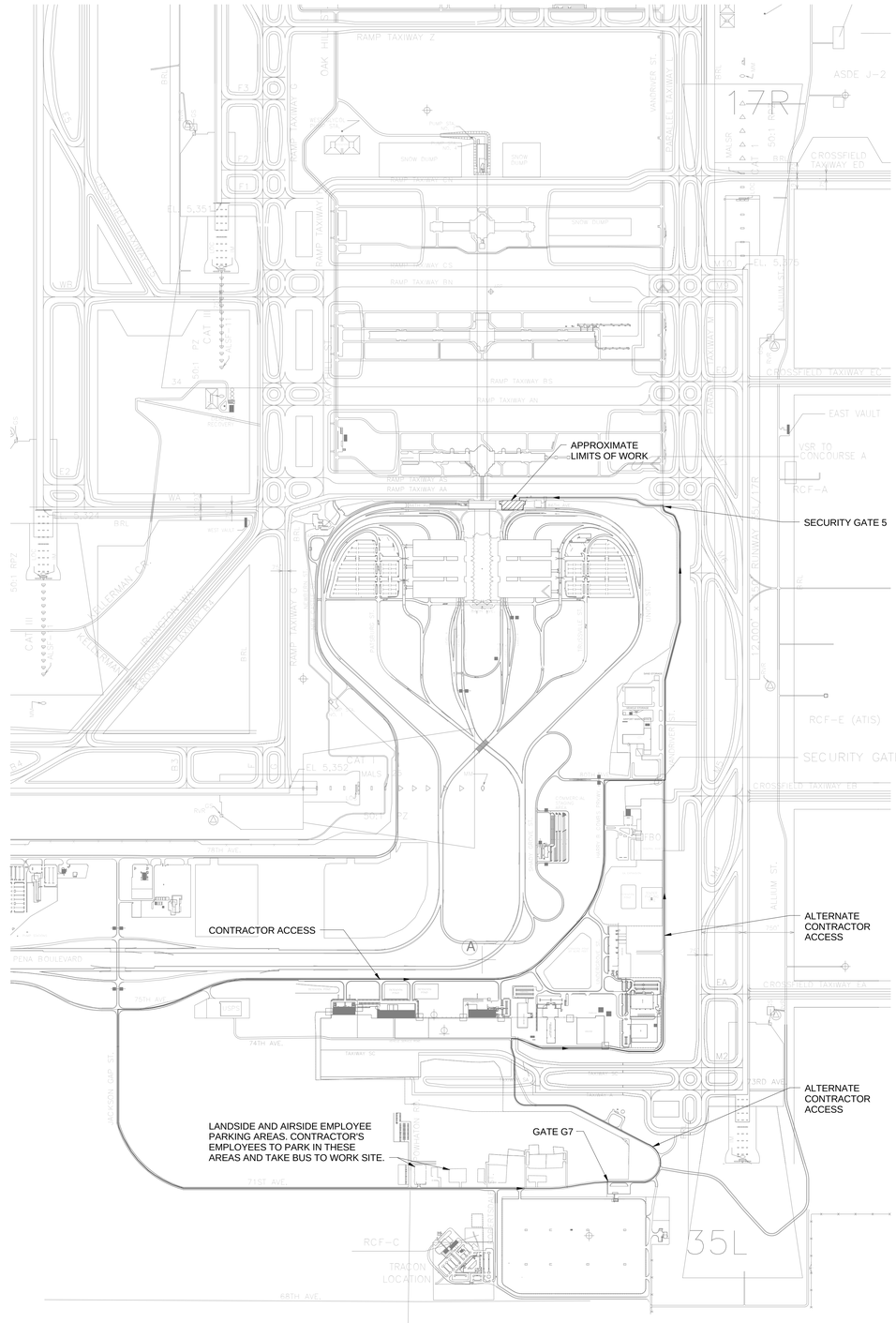
SHEET TITLE: PROJECT INFORMATION

SHEET NO. G0.01

CADD FILE NO.



1 G1.01 VICINITY MAP
1" = 3000'-0"



2 G1.01 SITE PLAN
1" = 800'-0"

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	AM	IFC	2.8.13	DMW

SCALE: As indicated

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: D. WHITNEY

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

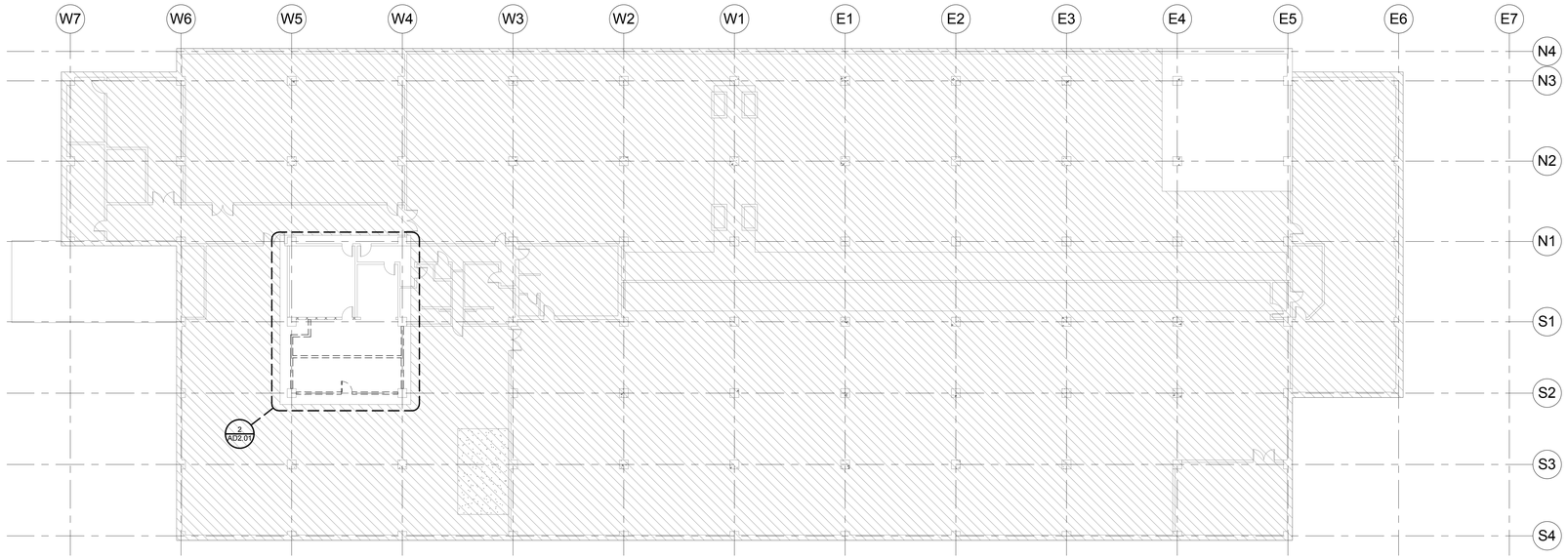
CONST. CONTRACT NO. 201310046-00

VOLUME NO.

SHEET TITLE
VICINITY MAP AND SITE PLAN

SHEET NO.
G1.01

CADD FILE NO.



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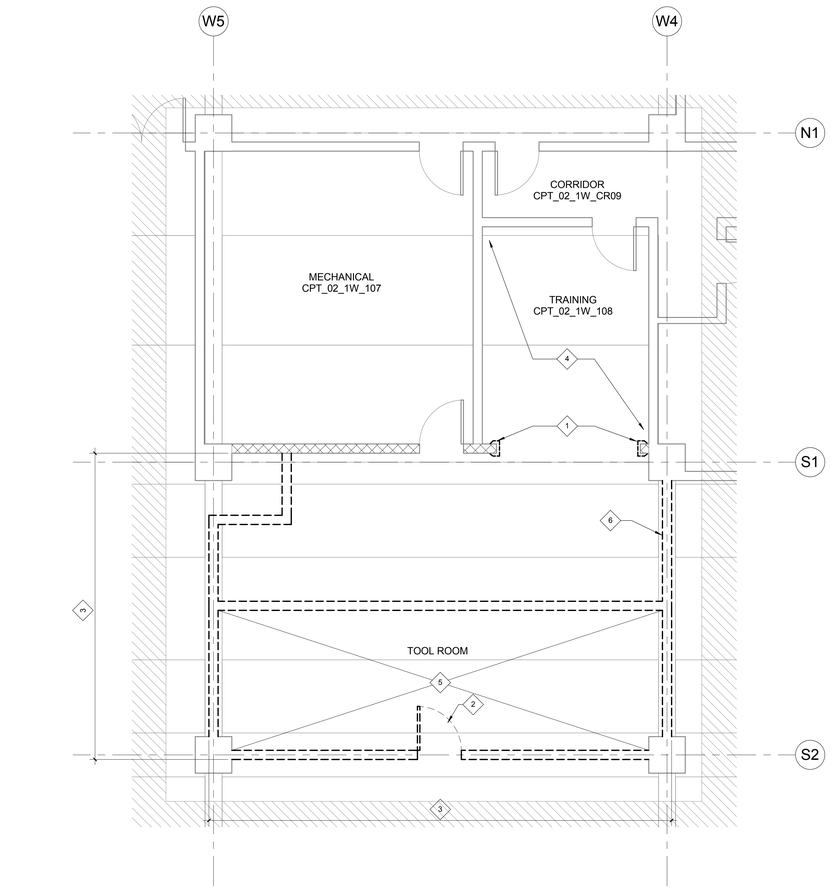
1 AD2.01

LOWER LEVEL OVERALL-DEMOLITION PLAN

1/16" = 1'-0"

0' 8' 16' 32' 64'



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2 AD2.01 AD2.01

ENLARGED DEMO PLAN-TRAINING

1/4" = 1'-0"

0' 2' 4' 8'

DEMOLITION SHEET NOTES

1. ALL WORK DEMOLISHED SHALL BE REMOVED FROM THE PREMISES, EXCEPT ITEMS TO BE REUSED OR RETURNED TO THE OWNER, OR UNLESS NOTED OTHERWISE.
2. THE CONTRACTOR SHALL REMOVE FROM PREMISES CONDUITS LEFT AFTER WALL DEMOLITION, INCLUDING SWITCH BOXES, PLATES, BRIDGES OR ANY COMMUNICATION OR POWER WIRING AND EQUIPMENT.
3. IN ALL AREAS WHERE DEMOLITION (REMOVAL OF TILE, CARPETING, PARTITIONS, ETC.) CAUSES AN UNEVENNESS IN SLAB, THE CONTRACTOR SHALL PATCH TO LEVEL THE SLAB TO RECEIVE NEW FINISHED FLOORING, AS NOTED.
4. THE CONTRACTOR SHALL PROTECT ADJACENT BUILDING PROPERTY FROM DUST AND DEBRIS WHILE DEMOLITION AND CONSTRUCTION ARE IN PROGRESS.
5. ALL PROJECTING PLUMBING, FLOOR AND WALL ELECTRICAL AND COMMUNICATION OUTLETS, AND OTHER PROJECTING ITEMS WHICH ARE BEING REMOVED SHALL HAVE ALL PIPING, CONDUCTORS AND WIRING REMOVED BACK TO PANEL OF ORIGIN OR MAIN BRANCH.
6. UPON COMPLETION OF THE DEMOLITION WORK, ALL AREAS ARE TO BE LEFT BROOM CLEAN.
7. REMOVE EXISTING FLOOR FINISHES, CEILINGS AND CEILING MOUNTED FIXTURES AND DEVICES IN AREAS OF DEMOLITION.
8. REMOVE EXISTING SLAB OR FOUNDATIONS TO COORDINATE WITH NEW STRUCTURAL WORK, AS DEFINED IN THE STRUCTURAL DRAWINGS
9. ALL DEMOLITION IS TO BE COORDINATED WITH THE DRAWINGS FOR NEW CONSTRUCTION TO ENSURE EXTENT OF AREAS OR ITEMS TO BE REMOVED.

LEGEND

EXISTING TO REMAIN, NOT PART OF WORK

EXISTING WALL TO REMAIN

EXISTING DOOR TO REMAIN

EXISTING TO BE REMOVED

EXISTING DOOR AND FRAME TO BE REMOVED. SALVAGE FOR REUSE IN NEW LOCATION, IF POSSIBLE

KEYNOTES

1. REMOVE STEEL TRIM AROUND EDGES OF WALL OPENING AND ANY CONCEALED ELEMENTS WITHIN. EXPOSE EXISTING WALL FRAMING AND EDGE OF GYP. BOARD, IF OCCURS, IN PREPARATION FOR NEW CONSTRUCTION.
2. SALVAGE EXISTING DOOR, FRAME AND HARDWARE, AND RETURN TO OWNER.
3. REMOVE HAROLID OVER ENTIRE AREA OF DEMOLITION
4. ALL CEILING, FLOOR FINISH, AND MILLWORK ELEMENTS WITHIN THIS AREA IS TO BE PROTECTED AND IS TO REMAIN.
5. REMOVE ALL RACKS, TOOLS AND EQUIPMENT WITHIN THIS SPACE, PRIOR TO DEMOLITION, AND RETURN TO OWNER.
6. SALVAGE EXISTING FLAT SCREEN T.V. AND WALL MOUNT BRACKET FOR REINSTALLATION IN TRAINING ROOM.

KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

IRON HORSE ARCHITECTS
475 17th STREET, SUITE 720
DENVER, CO 80202

CENTRAL UTILITY PLANT CHILLER ADDITION

IRON HORSE ARCHITECTS
475 17th Street, Suite 720
DENVER, CO 80202
PHONE: 720-855-7272
FAX: 720-855-7536
www.iron-horse-architects.com

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	PC	IFC	23JL13	PC

SCALE: As indicated

DATE: 12/12/12

DRAWN BY: P.CLARIDGE

CHECKED BY: P.CLARIDGE

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

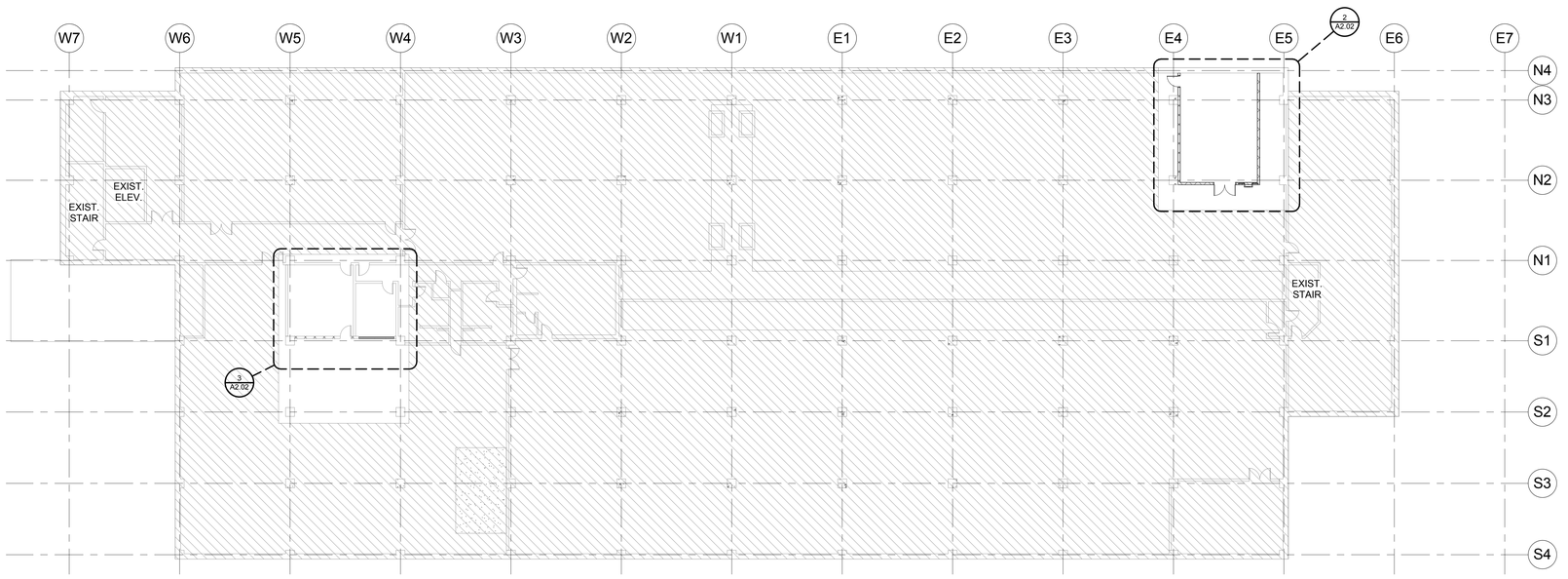
SHEET TITLE

LOWER LEVEL PUMP ROOM DEMOLITION PLAN

SHEET NO.

AD2.01

CADD FILE NO.

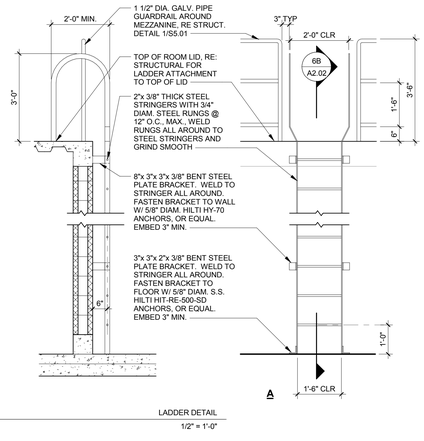


N

1
A2.02 A2.02

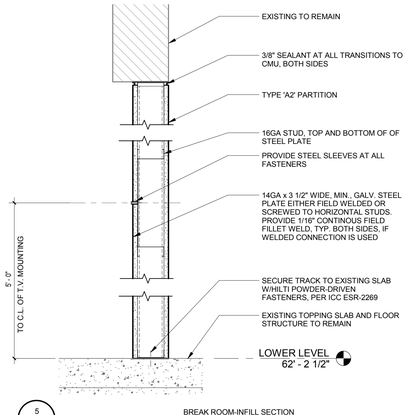
LOWER LEVEL OVERALL-CONSTRUCTION PLAN
1/16" = 1'-0"

0' 8' 16' 32' 64'



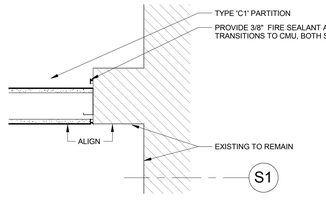
6
A2.02 A2.02

LADDER DETAIL
1/2" = 1'-0"



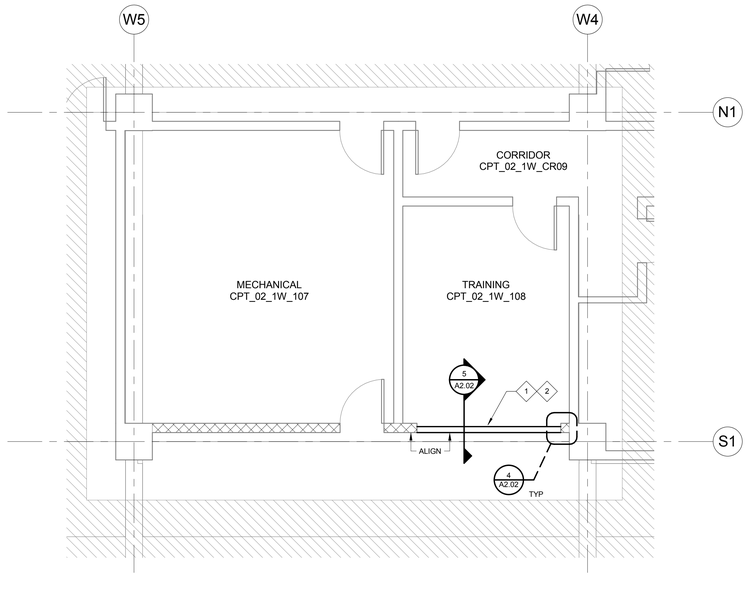
5
A2.02 A2.02

BREAK ROOM-INFILL SECTION
1 1/2" = 1'-0"



4
A2.02 A2.02

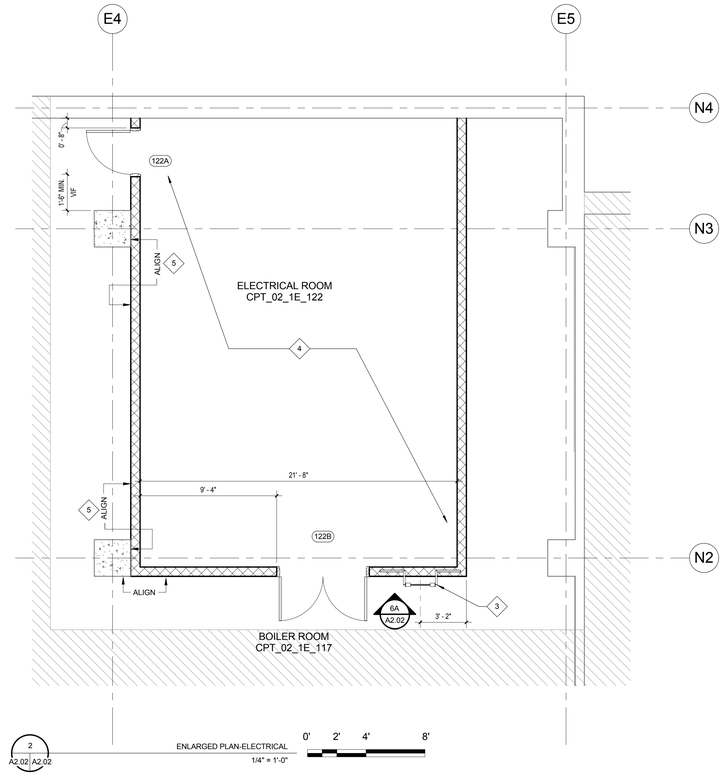
BREAK ROOM-INFILL PLAN DETAIL AT EXISTING
1 1/2" = 1'-0"



3
A2.02 A2.02

ENLARGED PLAN-TRAINING
1/4" = 1'-0"

0' 2' 4' 8'



2
A2.02 A2.02

ENLARGED PLAN-ELECTRICAL
1/4" = 1'-0"

0' 2' 4' 8'

CONSTRUCTION SHEET NOTES

1. ALL FIRE RATED PARTITIONS SHALL EXTEND FROM TOP OF STRUCTURAL FLOOR SLAB TO BOTTOM OF STRUCTURE ABOVE.
2. WALLS SHOWN ALIGNED WITH BASE BUILDING STRUCTURE SHALL BE FLUSH AND SMOOTH WITH BASE BUILDING STRUCTURE, UNLESS NOTED OTHERWISE.
3. REFER TO MEP DRAWINGS FOR NEW MECHANICAL, ELECTRICAL, PLUMBING AND EQUIPMENT AND MODIFICATIONS AT DEMOLISHED AREAS.
4. REFER TO STRUCTURAL DRAWINGS FOR CMU CONNECTION DETAILS.
5. REFER TO SPECIFICATIONS FOR DOOR HARDWARE INFORMATION.
6. NEW GYPSUM BOARD PARTITIONS ARE TO RECEIVE (2) COATS, FLAT INTERIOR PAINT FINISH IN COLOR TO MATCH EXISTING, ADJACENT WALLS.
7. CONTRACTOR IS TO OBTAIN #3B ACCESS CONTROL PERMIT FOR ALL ACCESS CONTROLLED DOORS.

LEGEND

EXISTING TO REMAIN, NOT PART OF WORK

EXISTING WALL TO REMAIN

EXISTING DOOR TO REMAIN

NEW STEEL STUD CONSTRUCTION PARTITION TYPE "A2" - 3 5/8" STUDS @ 24" O.C. W/(1) LAYERS 5/8" GYP. BOARD EACH SIDE, W/ACOUSTIC SEALANT AT ALL SIDES.

NEW CMU CONSTRUCTION PARTITION TYPE "N3" - NOMINAL 8"x8"x16" CMU, 2-HOUR RATED, ON 8" CONCRETE CURB. RE: STRUCTURAL FOR REINFORCING AND CONNECTION DETAILS

NEW 3'-0" x 7'-2" HOLLOW METAL DOOR AND FRAME, 90 MIN. RATED. REFER TO SPECIFICATIONS FOR HARDWARE. CONFIRM HARDWARE OPERATION WITH DIA PROJECT MANAGER.

NEW 3'-0"PR x 7'-2" HOLLOW METAL DOOR AND FRAME, 90 MIN. RATED. REFER TO SPECIFICATIONS FOR HARDWARE. CONFIRM HARDWARE OPERATION WITH DIA PROJECT MANAGER.

KEYNOTES

1. NEW LOCATION FOR EXISTING FLAT SCREEN T.V. MOUNTED WITH CENTERLINE AT 60" A.F.F. PROVIDE METAL STUD BLOCKING WITHIN WALL FOR EXISTING MOUNTING BRACKET. SEE DETAIL NOTED.
2. PROVIDE NEW POWER, DATA AND CABLE OUTLETS @ 66" A.F.F., CENTERED IN OVERALL LENGTH OF WALL. FOR FLAT SCREEN T.V.
3. 2'-0"W WALL MOUNTED STEEL LADDER, BOLTED INTO CMU WALL AND AT FLOOR, FOR ACCESS TO MECHANICAL EQUIPMENT ON ROOM LID.
4. PROVIDE SPRAY-ON FIREPROOFING AT UNDERSIDE OF NEW COMPOSITE DECK OVER THIS ROOM TO ACHIEVE 2-HOUR RATING.
5. CONTRACTOR TO LAYOUT CHALK LINES TO CONFIRM THAT WALL CONSTRUCTION CAN MEET ALIGNMENTS NOTED. IF EXISTING CONDITIONS PRECLUDE ALIGNMENT WITH BOTH EXISTING COLUMNS, RUN NEW WALL CONTINUOUSLY PAST FACE OF COLUMNS, UNINTERRUPTED. FILL GAPS UP TO 1" WIDE WITH BACKER RODS AND CONTINUOUS SEALANT, FROM FLOOR TO TOP OF LID. GAPS LARGER THAN 1" TO BE FILLED WITH CONTINUOUS GROUT AND TOOLED SMOOTH.

KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

IRON HORSE ARCHITECTS
475 17th STREET, SUITE 720
DENVER, CO 80202

CENTRAL UTILITY PLANT CHILLER ADDITION

IRON HORSE ARCHITECTS
475 17th Street, Suite 720
DENVER, CO 80202
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FAX: 720-855-7539
www.iron-horse-architects.com

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	PC	IFC	23JL13	PC

SCALE: As indicated

DATE: 12/12/12

DRAWN BY: P. CLARIDGE

CHECKED BY: P. CLARIDGE

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE
LOWER LEVEL PUMP ROOM FLOOR PLAN

SHEET NO.
A2.02

CADD FILE NO.

01-GENERAL REQUIREMENTS

1. GOVERNING DESIGN CODES:

A. INTERNATIONAL BUILDING CODE (IBC-09)
B. 2011 DENVER AMENDMENTS TO THE 2009 INTERNATIONAL BUILDING CODE
C. AISC MANUAL OF STEEL CONSTRUCTION (13TH EDITION)
   MEMBER DESIGN BASIS IS LOAD AND RESISTANCE FACTOR DESIGN (LRFD)
   CONNECTION DESIGN BASIS IS LOAD AND RESISTANCE FACTOR DESIGN (LRFD)
D. BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE (ACI 318-08)
E. MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES (ASCE7-05)
F. NORTH AMERICAN SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS (NAS-01)

02-INSTRUCTIONS AND COORDINATION

1. COORDINATION:

A. ANY DIFFERENCES BETWEEN THE ARCHITECTURAL AND STRUCTURAL DRAWINGS SHALL BE REPORTED TO THE DIA PROJECT MANAGER BEFORE PROCEEDING WITH THE WORK.
B. CONFLICTS WITHIN THE STRUCTURAL DRAWINGS OR BETWEEN THE STRUCTURAL DRAWINGS, GENERAL NOTES AND/OR SPECIFICATIONS SHALL BE REPORTED TO THE DIA PROJECT MANAGER FOR RESOLUTION BEFORE PROCEEDING WITH MODIFICATIONS OR ADJUSTMENT.
C. IT IS THE CONTRACTOR'S RESPONSIBILITY TO COORDINATE MECHANICAL AND ELECTRICAL EQUIPMENT PURCHASED WITH INFORMATION SHOWN ON THE STRUCTURAL DRAWINGS INCLUDING, BUT NOT LIMITED TO, EQUIPMENT LOCATION, SIZE, WEIGHT, OPENINGS AND SUPPORT REQUIREMENTS. REPORT DIFFERENCES TO THE ARCHITECT AND ENGINEER BEFORE PROCEEDING WITH THE WORK.
D. EXISTING CONDITIONS: THE STRUCTURAL DRAWINGS HAVE BEEN PREPARED USING AVAILABLE INFORMATION OF EXISTING CONDITIONS.
   IT IS THE CONTRACTOR'S RESPONSIBILITY TO COMPARE THE EXISTING CONDITIONS TO THE INFORMATION SHOWN ON THE DRAWINGS AND NOTIFY THE ARCHITECT OF ANY DIFFERENCES BEFORE PROCEEDING WITH THE WORK.
E. WHERE ATTACHMENTS TO EXISTING STRUCTURE REQUIRE THE REMOVAL OF FIREPROOFING MATERIAL, FIREPROOFING SHALL BE REPLACED PER SPECIFICATION SECTION 07 81 00 APPLIED FIREPROOFING.
F. MANY PIPE SUPPORTS HAVE THE ABILITY TO BE SHIFTED HORIZONTALLY IN THE FIELD BY SMALL DISTANCES IN ORDER TO AVOID CONFLICTS WITH EXISTING INFRASTRUCTURE. ALL PROPOSED SHIFTS OF SUPPORT LOCATIONS SHALL BE COORDINATED WITH AND APPROVED BY THE DIA PROJECT MANAGER AND THE STRUCTURAL ENGINEER.

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

SAN ENGINEERING, LLC
6099 S. WINDERMERE ST
LITTLETON, CO 80120

CENTRAL UTILITY PLANT CHILLER ADDITION

San Engineering LLC
Civil and Structural Engineering

ISSUE RECORD

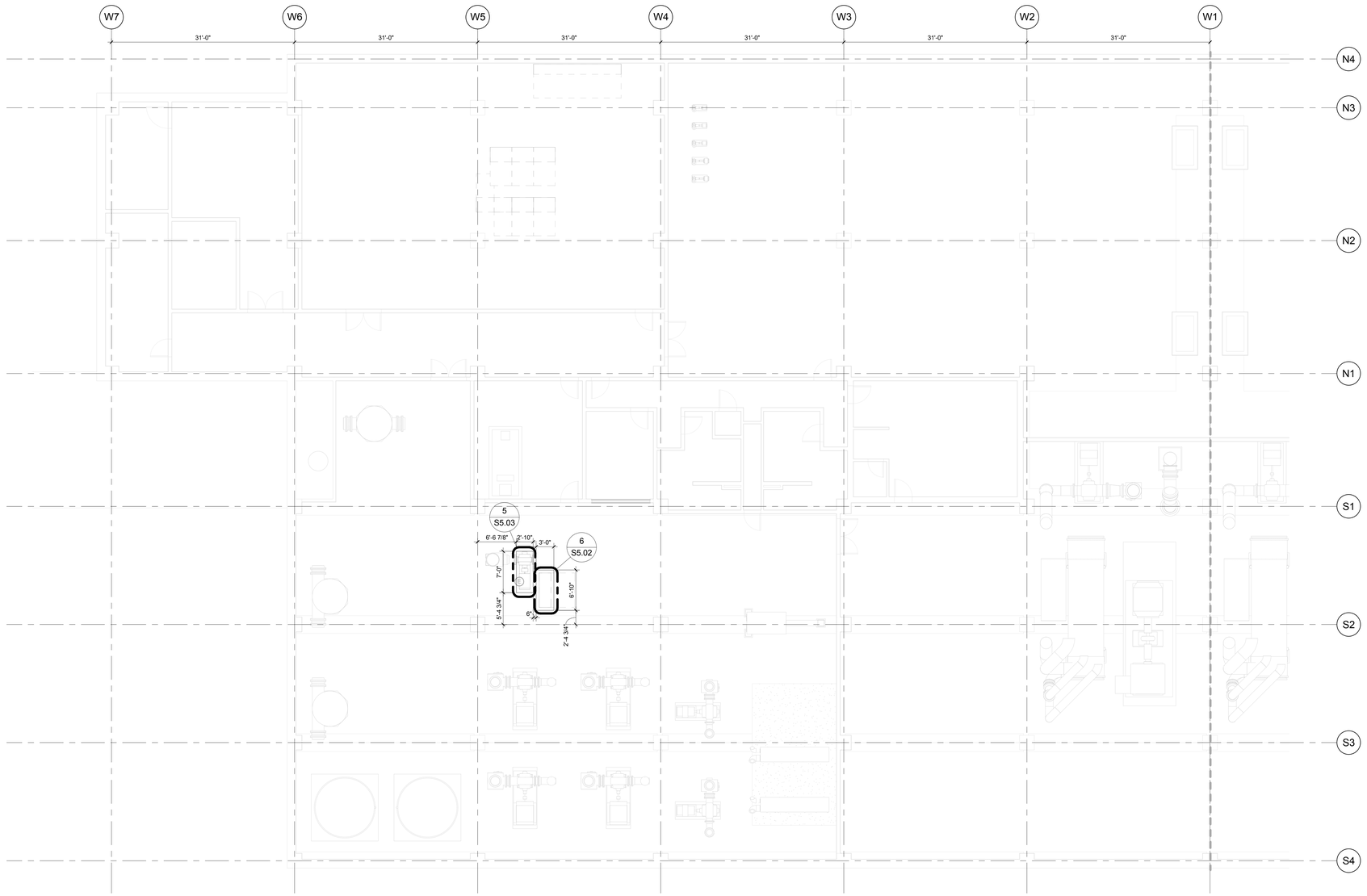
NO.	BY	PURPOSE	DATE	CKD
00	JJM	IFC	23JL13	TMM

SCALE: 3/4" = 1'-0"
DATE: 10/23/12
DRAWN BY: JJM
CHECKED BY: TMM
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01

SHEET TITLE
STRUCTURAL GENERAL NOTES

SHEET NO.
S0.01

CADD FILE NO.



1
S1.00

LOWER LEVEL WEST OVERALL
1/8" = 1'-0"

0 4' 8' 16'
SCALE IN FEET

N

KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

SAN ENGINEERING, LLC
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DATE: 10/23/12

DRAWN BY: JJM

CHECKED BY: TMM

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 20131004 6-00

VOLUME NO. 01

SHEET TITLE
OVERALL - WEST CURB AND SLAB PLAN

SHEET NO.
S1.00

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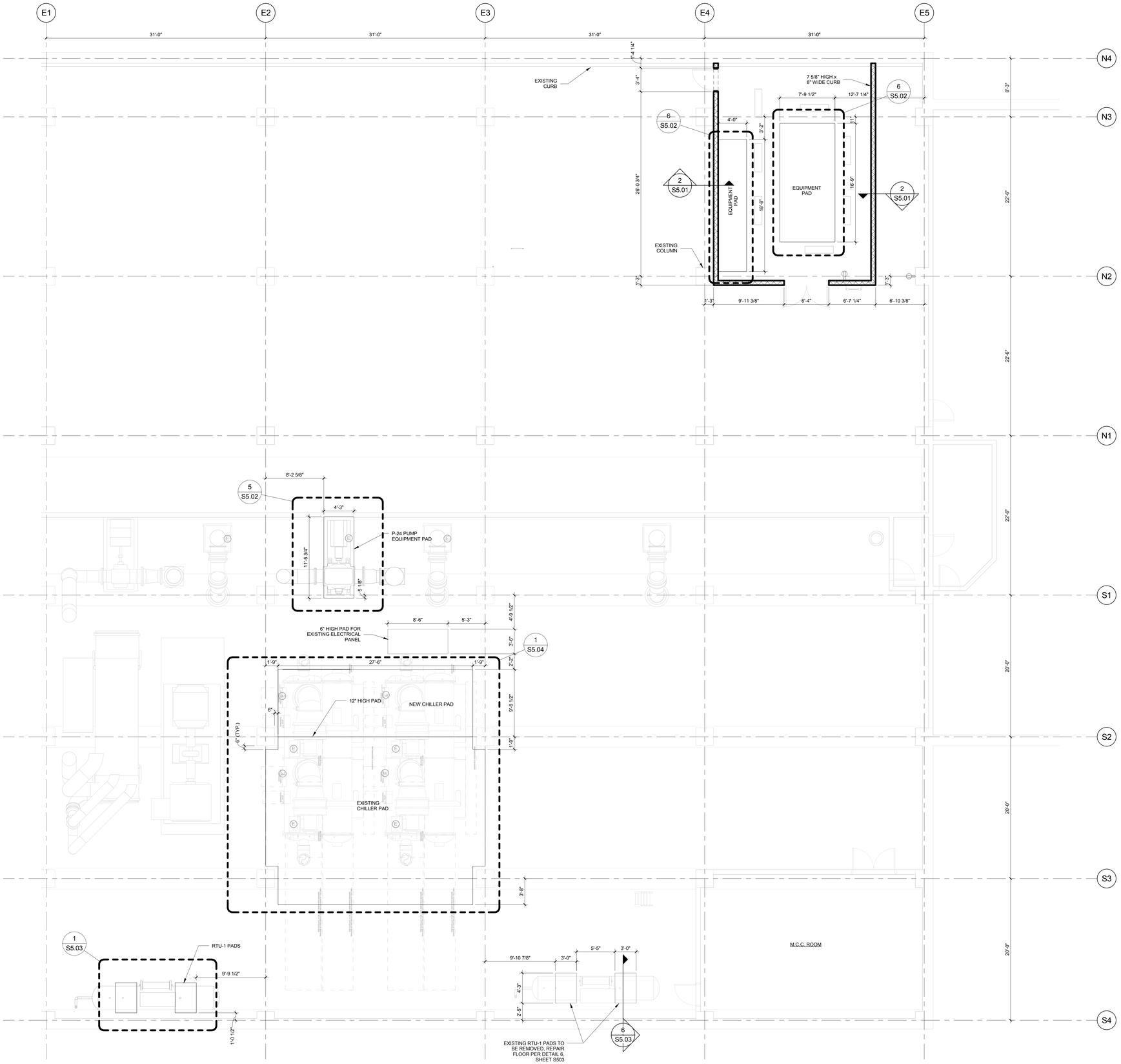


1 S1.01

LOWER LEVEL EAST OVERALL PLAN
3/16" = 1'-0"

0 4' 8' 12'
SCALE IN FEET

N

KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

SAN ENGINEERING, LLC
6099 S. WINDERMERE ST
LITTLETON, CO 80120

CENTRAL UTILITY PLANT CHILLER ADDITION

San Engineering LLC
Civil and Structural Engineering

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	JJM	IFC	23.8.13	TMM

SCALE: 3/16" = 1'-0"

DATE: 10/23/12

DRAWN BY: JJM

CHECKED BY: TMM

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

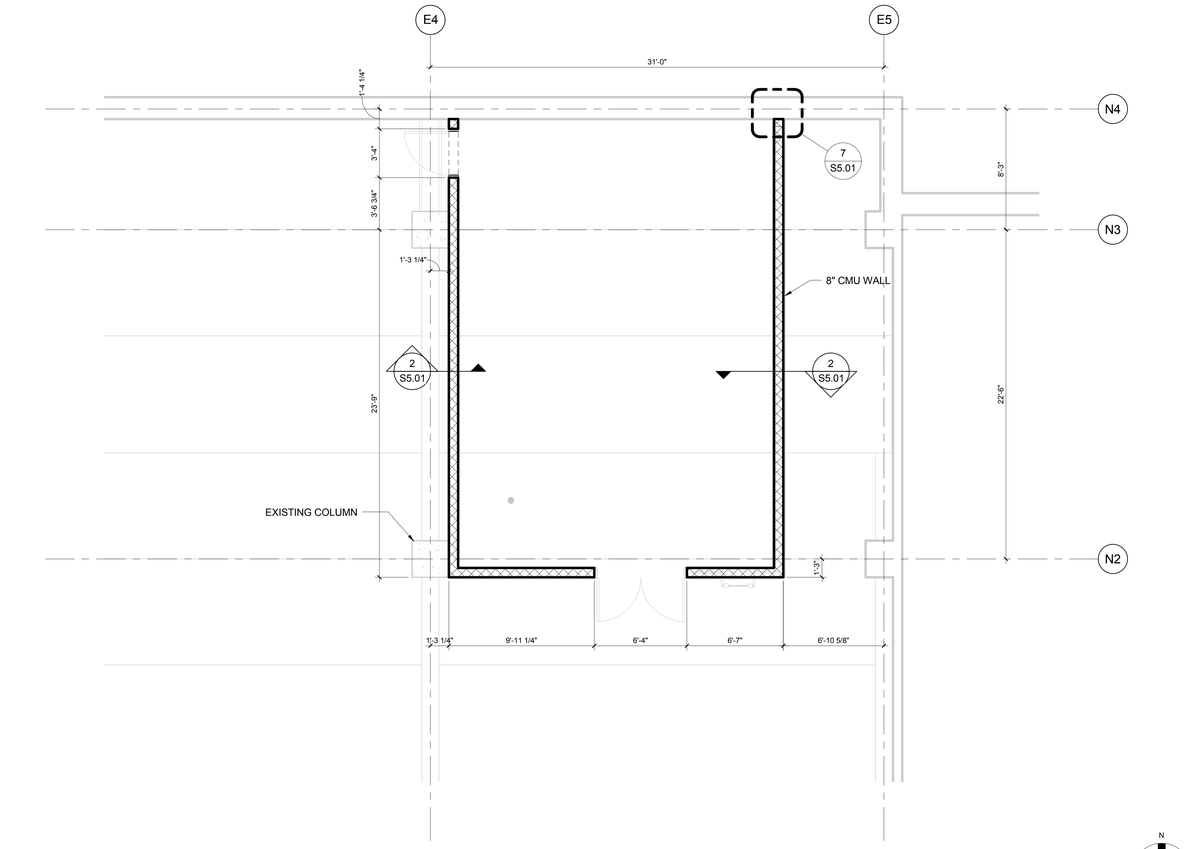
CONST. CONTRACT NO. 20131004 6-00

VOLUME NO. 01

SHEET TITLE
OVERALL - EAST CURB AND SLAB PLAN

SHEET NO.
S1.01

CADD FILE NO.



1
S1.02

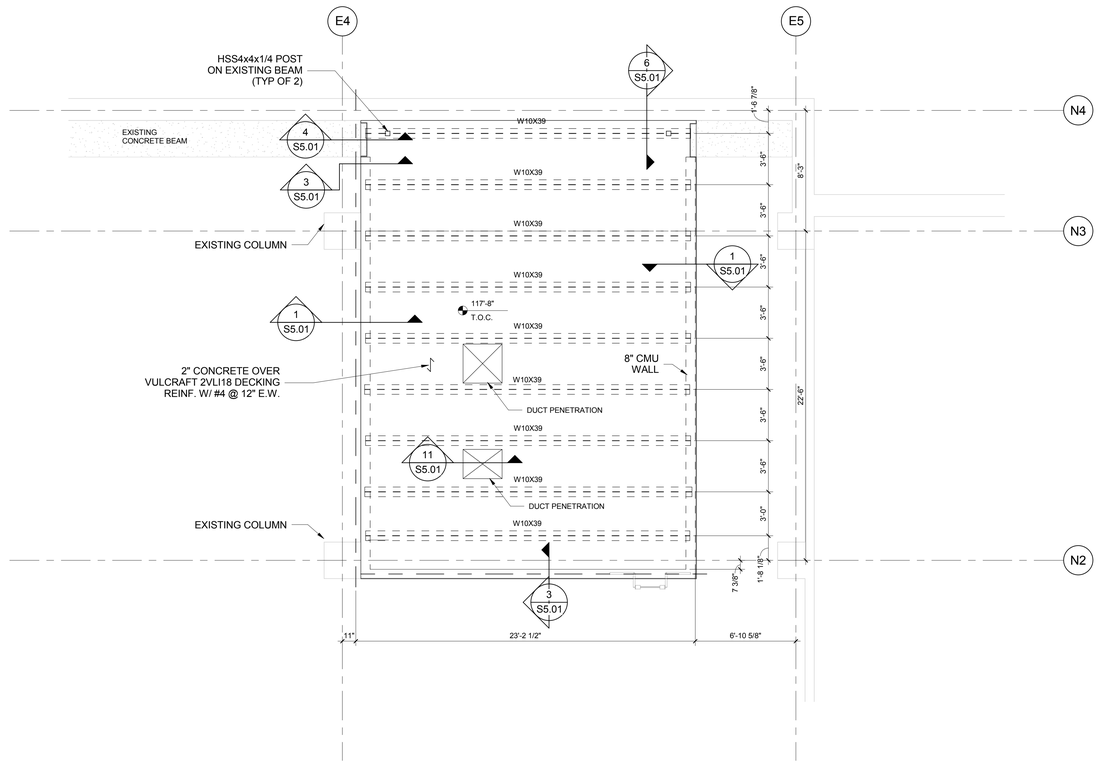
LOWER LEVEL-ELECTRICAL ROOM WALL PLAN

1/4" = 1'-0"

0 2' 4' 8'

SCALE IN FEET

N



2
S1.02

ELECTRICAL ROOM CEILING ROOF FRAMING PLAN

1/4" = 1'-0"

0 2' 4' 8'

SCALE IN FEET

N

KEY PLAN

CITY & COUNTY
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DESIGNER OF RECORD

SAN ENGINEERING, LLC
6099 S. WINDERMERE ST
LITTLETON, CO 80120

CENTRAL UTILITY PLANT CHILLER ADDITION

San Engineering LLC
Civil and Structural Engineering

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	JJM	IFC	23JL13	TMM

SCALE: 1/4" = 1'-0"

DATE: 10/23/12

DRAWN BY: JJM

CHECKED BY: TMM

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE
LOWER LEVEL
STRUCTURAL PLAN

SHEET NO.
S1.02

CADD FILE NO.

GENERAL SHEET NOTES

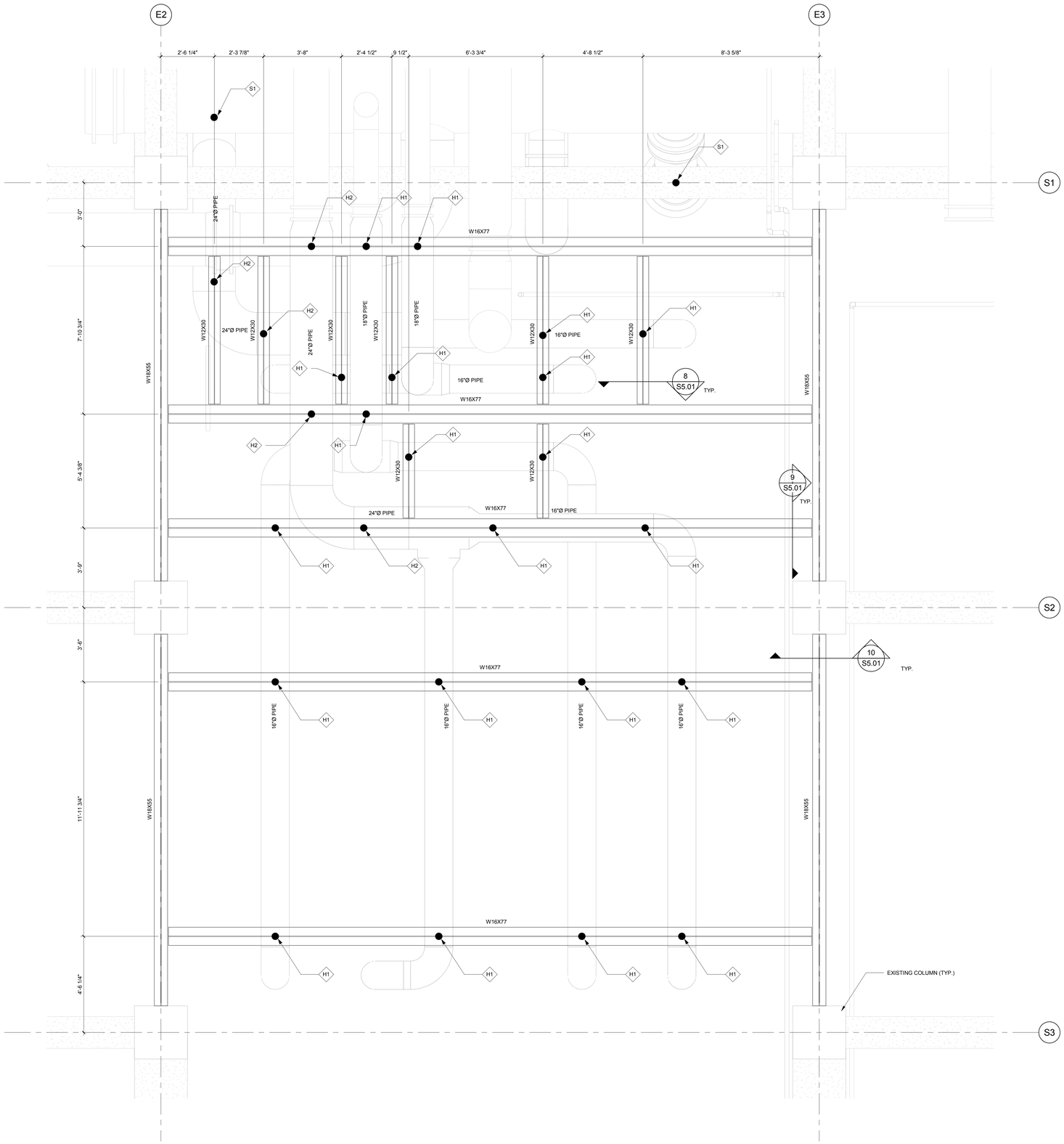
1. T.O.S. = 125'-8" UNLESS NOTED OTHERWISE.
2. CONTRACTOR TO FIELD VERIFY SITE ACCESS PRIOR TO FABRICATION. IF BEAMS REQUIRE SPLICES CONTACT STRUCTURAL ENGINEER PRIOR TO FABRICATION.

SHEET KEYNOTES

H1: HANGER TYPE 1; 16" OR 18" HANGER FROM STEEL BEAM RE: DETAIL 1/S506

H2: HANGER TYPE 2; 24" HANGER FROM STEEL BEAM RE: DETAIL 2/S506

S1: FLOOR SUPPORT TYPE 1; TYPICAL 24" STANCHION SUPPORT ON EXISTING FLOOR. RE: DETAIL 3/S506



1 S1.03

LOWER LEVEL PIPE ROUTES
1/2" = 1'-0"

0 1' 2' 4'
SCALE IN FEET

N

KEY PLAN

CITY & COUNTY of DENVER

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DESIGNER OF RECORD

SAN ENGINEERING, LLC
6099 S. WINDERMERE ST
LITTLETON, CO 80120

CENTRAL UTILITY PLANT CHILLER ADDITION

San Engineering LLC
Civil and Structural Engineering

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	JJM	IFC	23JL13	TMM

SCALE: 1/2" = 1'-0"

DATE: 10/23/12

DRAWN BY: JJM

CHECKED BY: TMM

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE
CHILLER PIPING SUPPORT PLAN

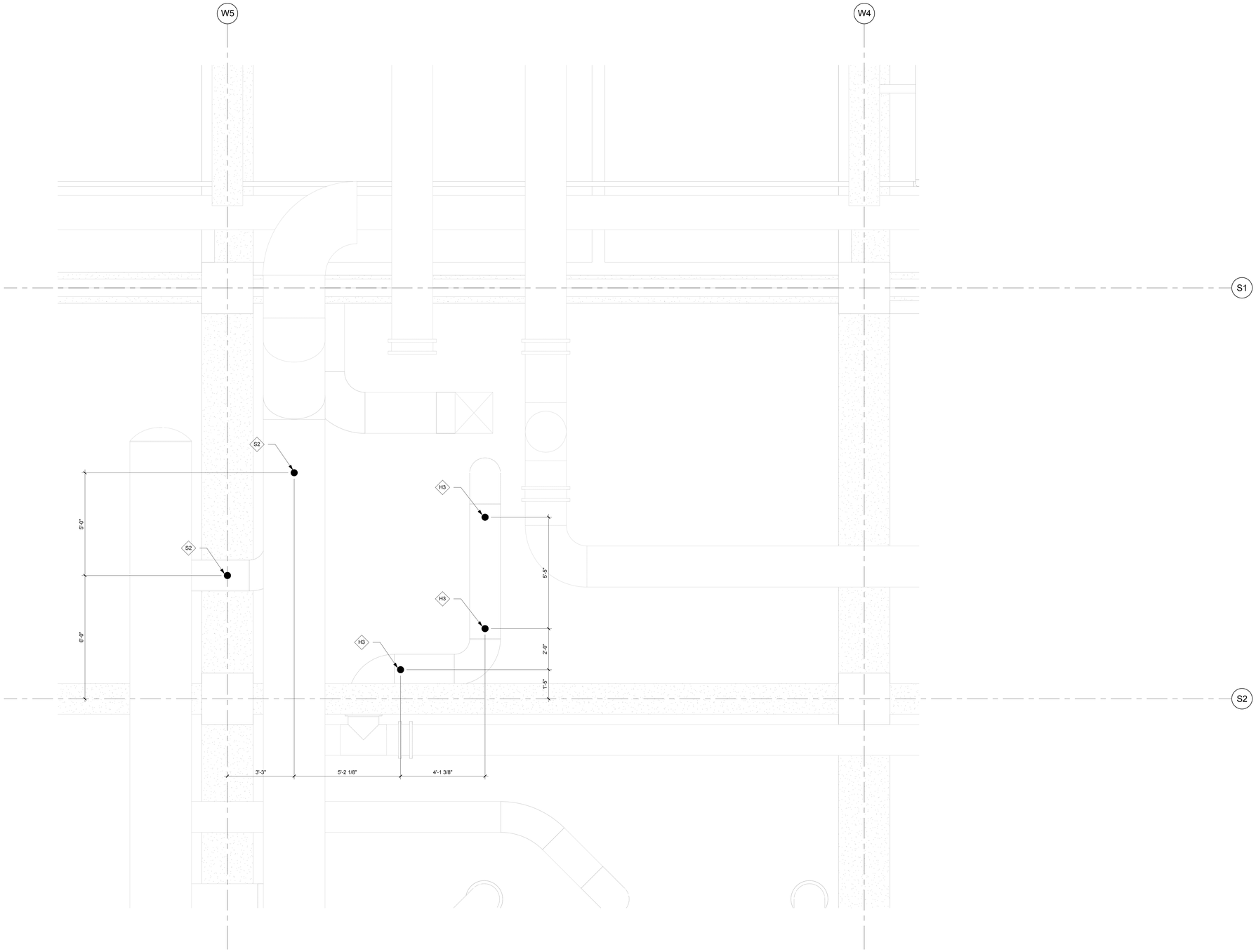
SHEET NO.
S1.03

CADD FILE NO.

SHEET KEYNOTES

H3: HANGER TYPE 3; 24" OR 18" HANGER FROM STEEL BEAM
RE: DETAIL 4/S506

S2: 18" STANCHION SUPPORT FROM CONCRETE FLOOR OR BEAM.
RE: DETAIL 7/S506



1 / S1.04

LOWER LEVEL PUMP ROOM PIPE SUPPORT PLAN
1/2" = 1'-0"

0 1' 2' 4'
SCALE IN FEET

N

KEY PLAN

CITY & COUNTY of DENVER

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CITY AND COUNTY OF DENVER SEAL

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SAN ENGINEERING, LLC
6099 S. WINDERMERE ST
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CENTRAL UTILITY PLANT CHILLER ADDITION

San Engineering LLC
civil and structural Engineering

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	JJM	IFC	23JL13	TMM

SCALE: 1/2" = 1'-0"
DATE: 10/23/12
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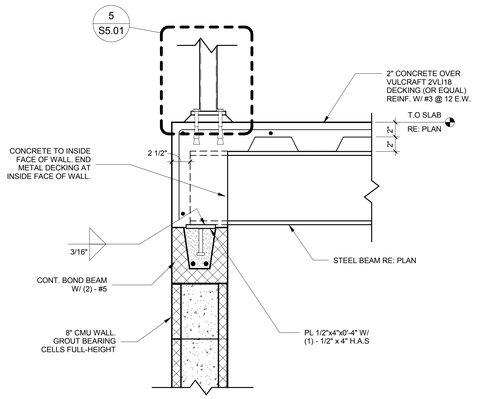
CHECKED BY: TMM
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01

SHEET TITLE
LOWER LEVEL PUMP ROOM PIPING SUPPORT

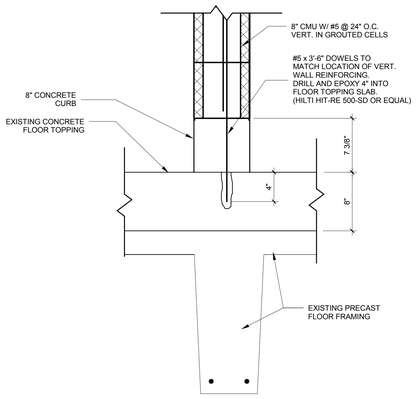
SHEET NO.
S1.04

CADD FILE NO.



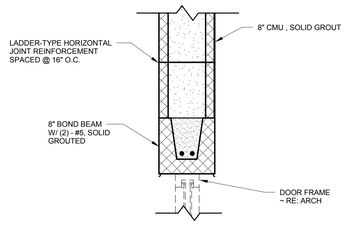
1 S1.02 S5.01 ROOF FRAMING CONNECTION

0 1/2" 1' 1 1/2" SCALE IN FEET 1 1/2" = 1'-0"



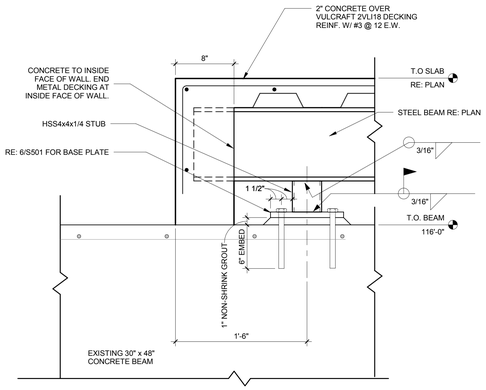
2 S1.00 S5.01 SECTION AT MASONRY WALL TO DOUBLE TEE

0 1/2" 1' 1 1/2" SCALE IN FEET 1 1/2" = 1'-0"



3 S1.02 S5.01 SECTION AT DOOR HEADER

0 1/2" 1' 1 1/2" SCALE IN FEET 1 1/2" = 1'-0"

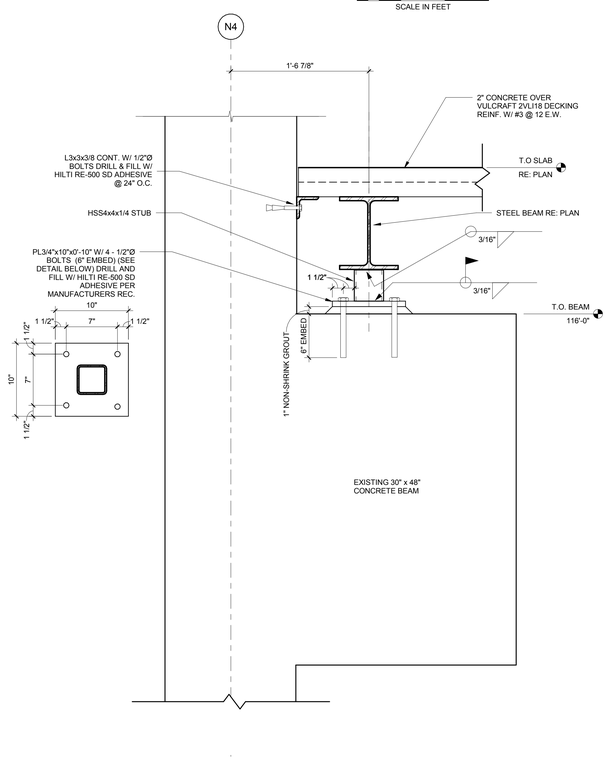


4 S1.02 S5.01 POST TO EXISTING BEAM CONNECTION

0 1/2" 1' 1 1/2" SCALE IN FEET 1 1/2" = 1'-0"

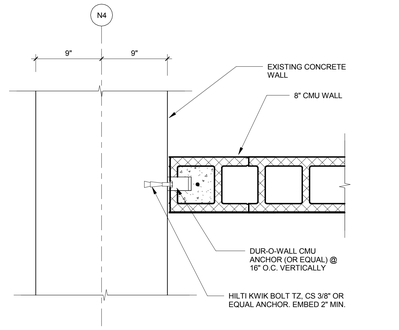
5 S5.01 HANDRAIL CONNECTION

0 1/2" 1' 1 1/2" SCALE IN FEET 1 1/2" = 1'-0"



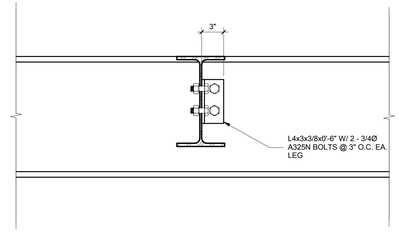
6 S1.02 S5.01 SECTION AT CONCRETE WALL

0 1/2" 1' 1 1/2" SCALE IN FEET 1 1/2" = 1'-0"



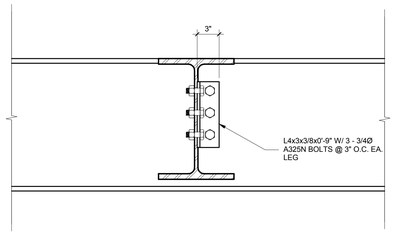
7 S1.02 S5.01 CMU WALL INTERFACE

0 1/2" 1' 1 1/2" SCALE IN FEET 1 1/2" = 1'-0"



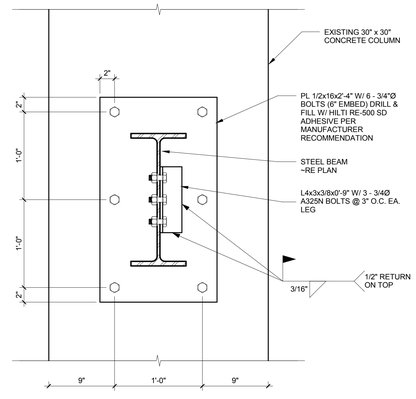
8 S1.03 S5.01 W12 CONNECTION TO W16

0 1/2" 1' 1 1/2" SCALE IN FEET 1 1/2" = 1'-0"



9 S1.03 S5.01 W16 CONNECTION TO W18

0 1/2" 1' 1 1/2" SCALE IN FEET 1 1/2" = 1'-0"

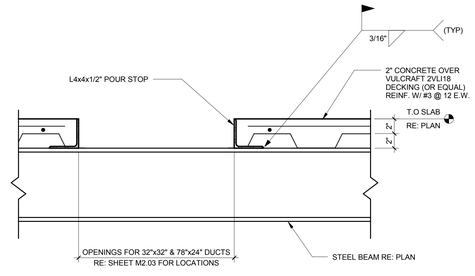


NOTES:

1. SPECIAL INSPECTION REQUIRED FOR POST INSTALLED ANCHORS.
2. PILOT DRILL HOLES PRIOR TO PLATE FABRICATION. ANY HOLE CAN BE MOVED 1" ANY DIRECTION TO MISS EXISTING COLUMN REBAR.
3. DO NOT CUT ANY REBAR.

10 S1.03 S5.01 W18 TO COLUMN CONNECTION

0 1/2" 1' 1 1/2" SCALE IN FEET 1 1/2" = 1'-0"



11 S1.02 S5.01 SLAB PENETRATION DETAIL

0 1/2" 1' 1 1/2" SCALE IN FEET 1 1/2" = 1'-0"

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

SAN ENGINEERING, LLC
6099 S. WINDERMERE ST
LITTLETON, CO 80120

CENTRAL UTILITY PLANT CHILLER ADDITION

San Engineering LLC
civil and structural engineering

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	JJM	IFC	23JL13	TMM

SCALE: 1 1/2" = 1'-0"
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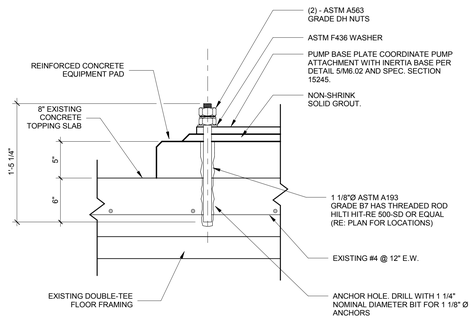
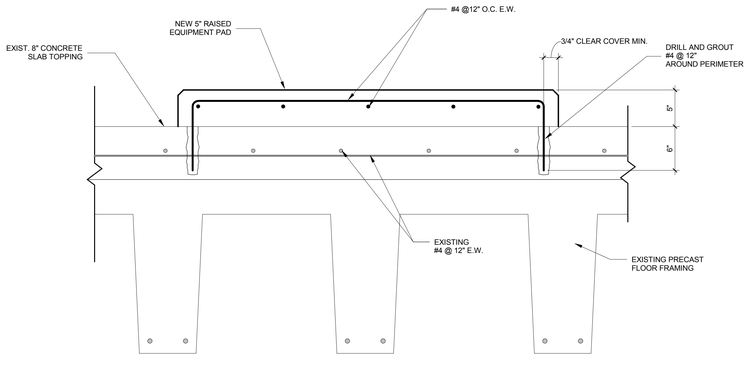
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01

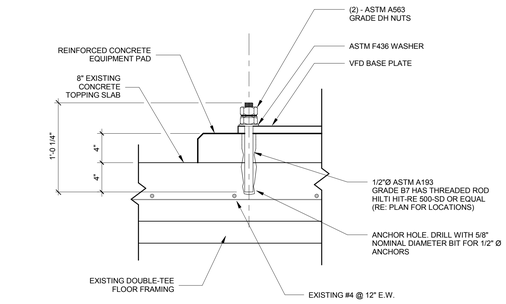
SHEET TITLE
STRUCTURAL DETAILS

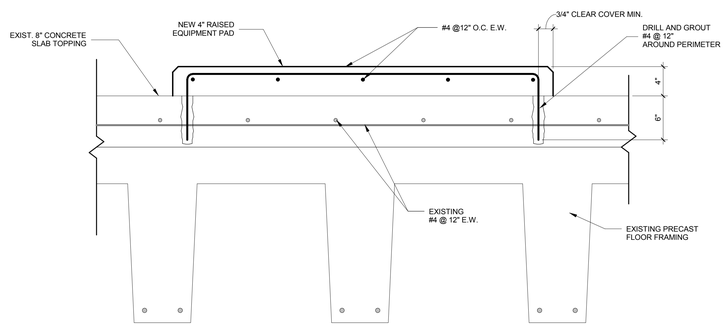
SHEET NO.
S5.01

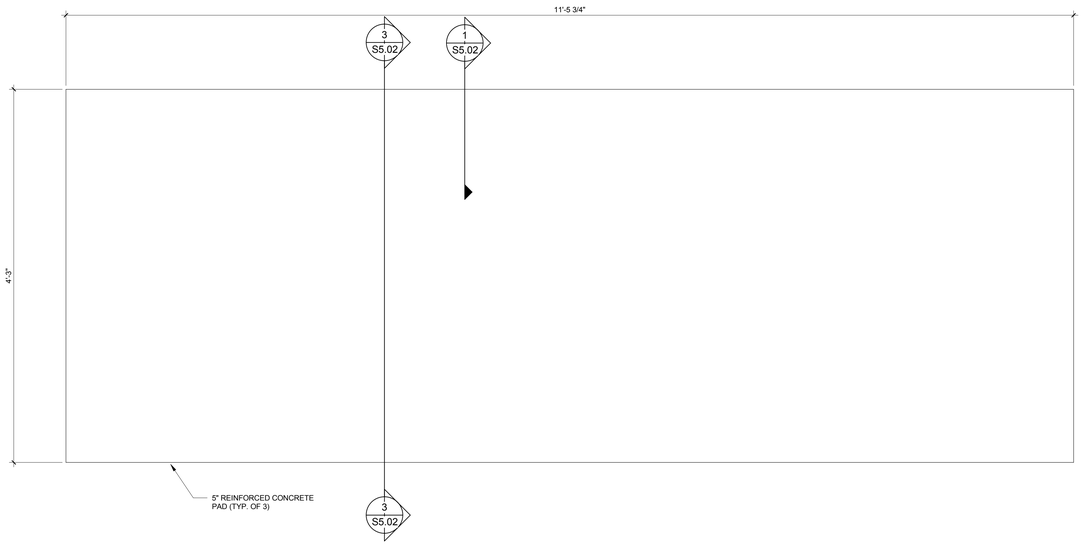
CADD FILE NO.

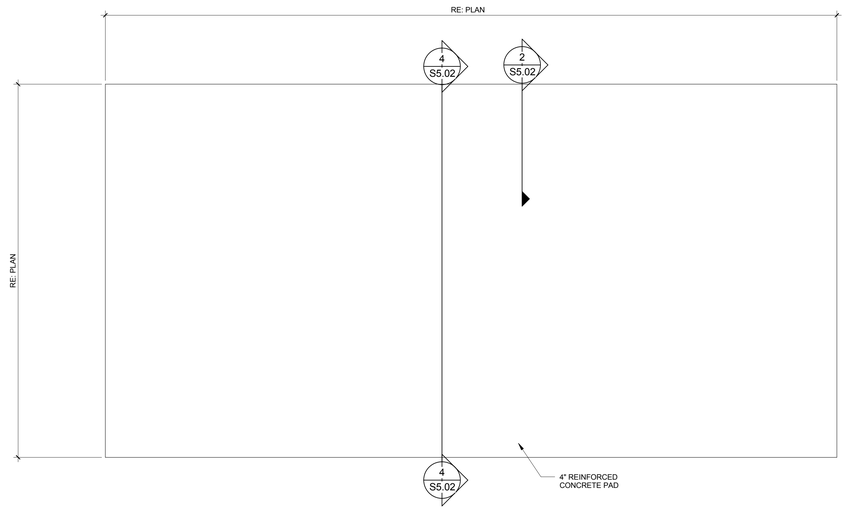












NOTES:

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2. IF EXISTING REINFORCEMENT IS ENCOUNTERED WHEN DRILLING DOWEL/ANCHOR EMBEDMENTS, "REBAR EATER" DRILL BITS MAY BE USED TO ACHIEVE THE DESIRED DEPTH.
3. WELDING TO ANCHOR BOLTS WILL NOT BE PERMITTED UNLESS SPECIFICALLY DETAILED.
4. BONDING AGENT SHALL BE SIKADUR 32 BY SIKA CORPORATION OR APPROVED EQUAL. PREPARATION AND INSTALLATION SHALL BE IN STRICT ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.
5. PRIOR TO GROUTING UNDER BASE PLATES, ALL BASE PLATES SHALL BE ADJUSTED INTO A SINGLE LEVEL PLANE USING LEVELING NUTS OR SHIM PLATES. THE TOP NUTS SHALL THEN BE TIGHTENED TO SECURE BASE PLATES.
6. REPAIR ANY FLOOR SURFACE DAMAGED BY REMOVAL OF EXISTING PAD WITH SIKA TOP 112 PLUS. (DAMAGED AREA SHALL BE CHIPPED TO A MINIMUM DEPTH OF 1"). PAINT REPAIRED SURFACES TO MATCH EXISTING ADJACENT SURFACES. PAINT SHALL BE IN ACCORDANCE WITH SPECIFICATION SECTION 09911.
7. AFTER GROUT HAS CURED, HOUSEKEEPING PADS SHALL BE PAINTED WITH EPOXY-BASED PAINT MATCHING THE EXISTING FLOOR COATING SYSTEM. AFTER THE EPOXY PAINTING IS COMPLETE, A SAFETY YELLOW STRIPE SHALL BE PAINTED AROUND THE PAD PERIMETER. THE YELLOW STRIPE SHALL BE 4" WIDE ON THE TOP SURFACE OF THE PAD AND SHALL EXTEND 4" DOWN THE SIDES FROM THE TOP EDGE. THE YELLOW PAINT SHALL BE COMPATIBLE WITH THE EPOXY PAINT SYSTEM. PAINT SHALL BE IN ACCORDANCE WITH SPECIFICATION SECTION 09911.
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CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

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6099 S. WINDERMERE ST
LITTLETON, CO 80120

CENTRAL UTILITY PLANT CHILLER ADDITION

San Engineering LLC
Civil and Structural Engineering

ISSUE RECORD

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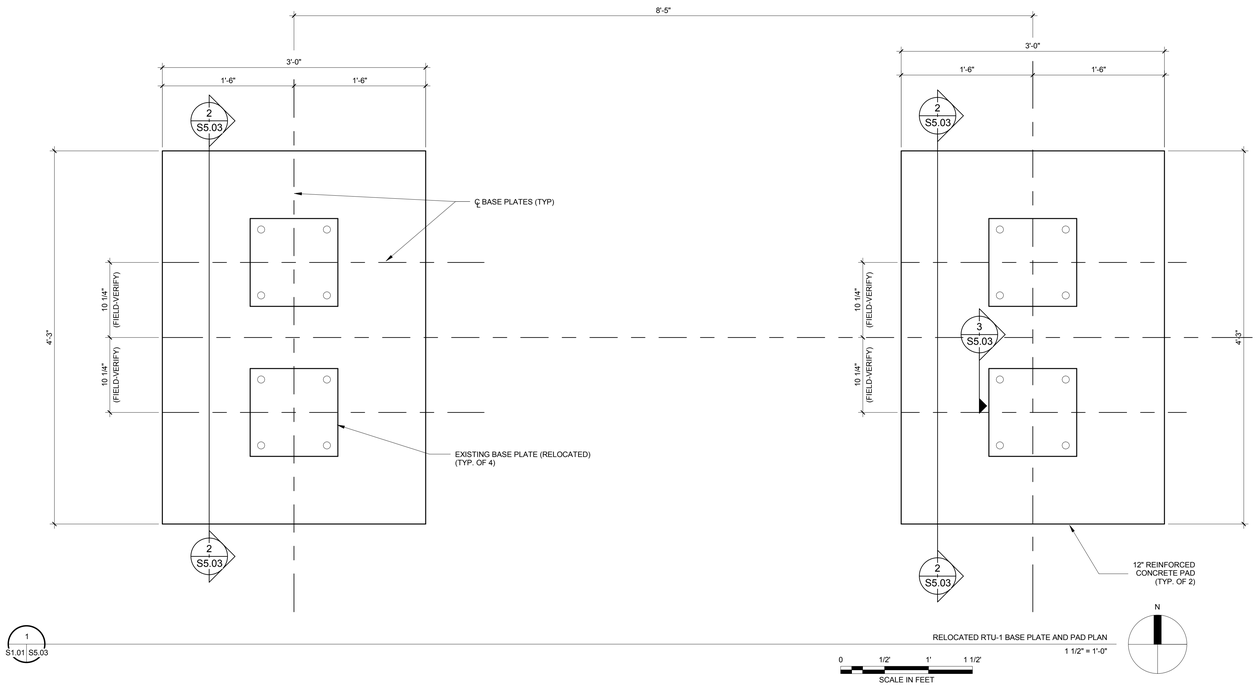
SHEET TITLE
STRUCTURAL DETAILS

SHEET NO.
S5.02

CADD FILE NO.



1 S1.01 S5.03 RELOCATED RTU-1 BASE PLATE AND PAD PLAN — 1 1/2" = 1'-0"

0 1/2' 1' 1 1/2" SCALE IN FEET

NOTES:

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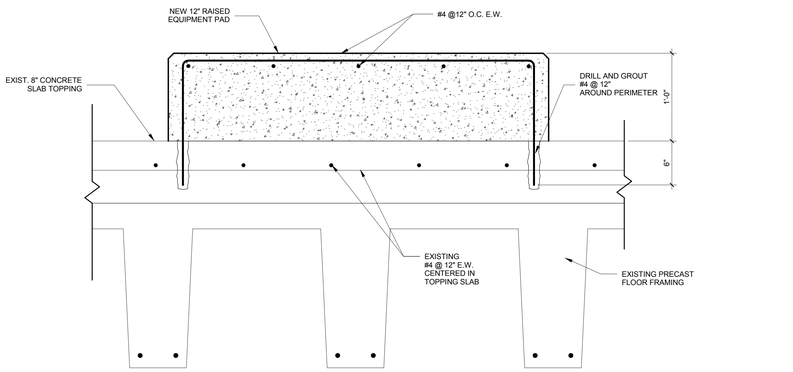
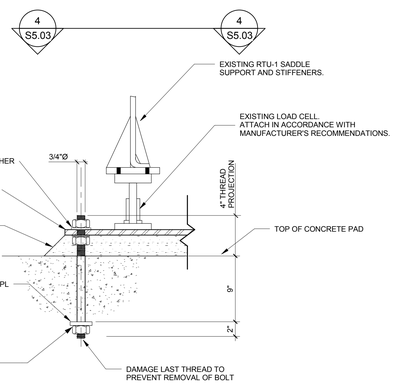


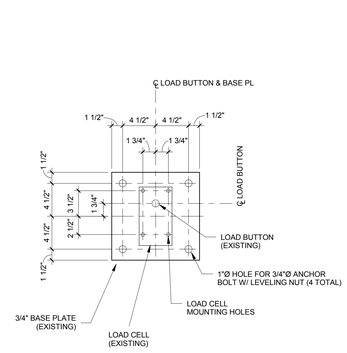
2 S5.03 S5.03 RTU-1 RAISED PAD SECTION — 1 1/2" = 1'-0"

0 1/2' 1' 1 1/2" SCALE IN FEET



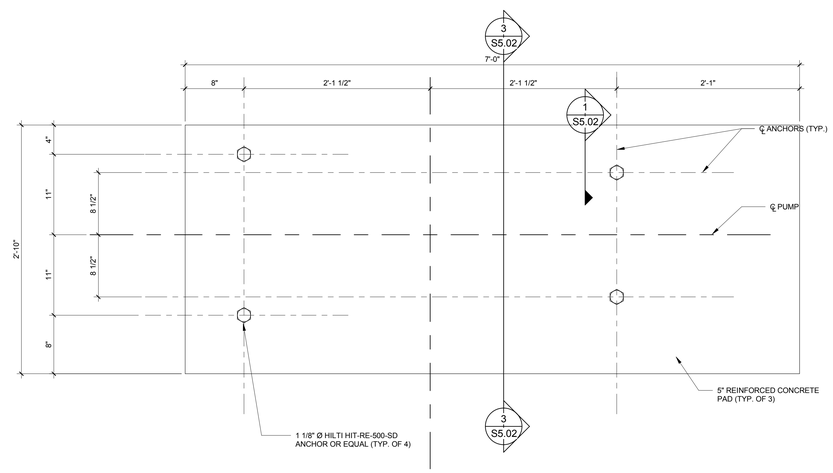
3 S5.03 S5.03 TYPICAL RTU-1 ANCHOR BOLT — 1 1/2" = 1'-0"

0 1/2' 1' 1 1/2" SCALE IN FEET



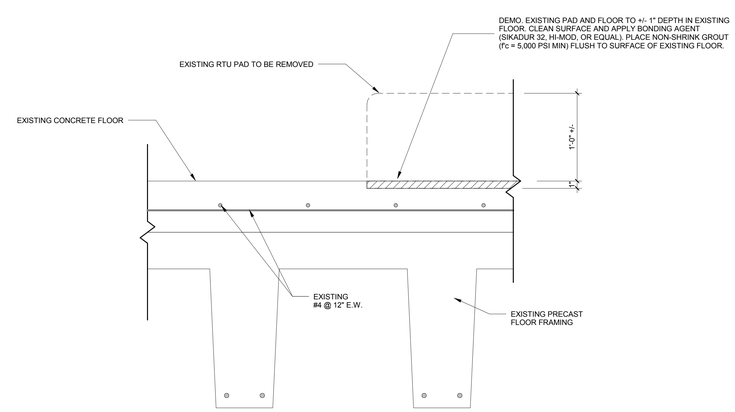
4 S5.03 S5.03 RTU-1 BASE PLATE PLAN — 1 1/2" = 1'-0"

0 1/2' 1' 1 1/2" SCALE IN FEET



5 S1.00 S5.03 PUMP P-11 ANCHOR AND PAD PLAN — 1 1/2" = 1'-0"

0 1/2' 1' 1 1/2" SCALE IN FEET



6 S1.01 S5.03 DEMO & REPAIR OF EXISTING RTU PADS — 1 1/2" = 1'-0"

0 1/2' 1' 1 1/2" SCALE IN FEET

CITY & COUNTY of DENVER

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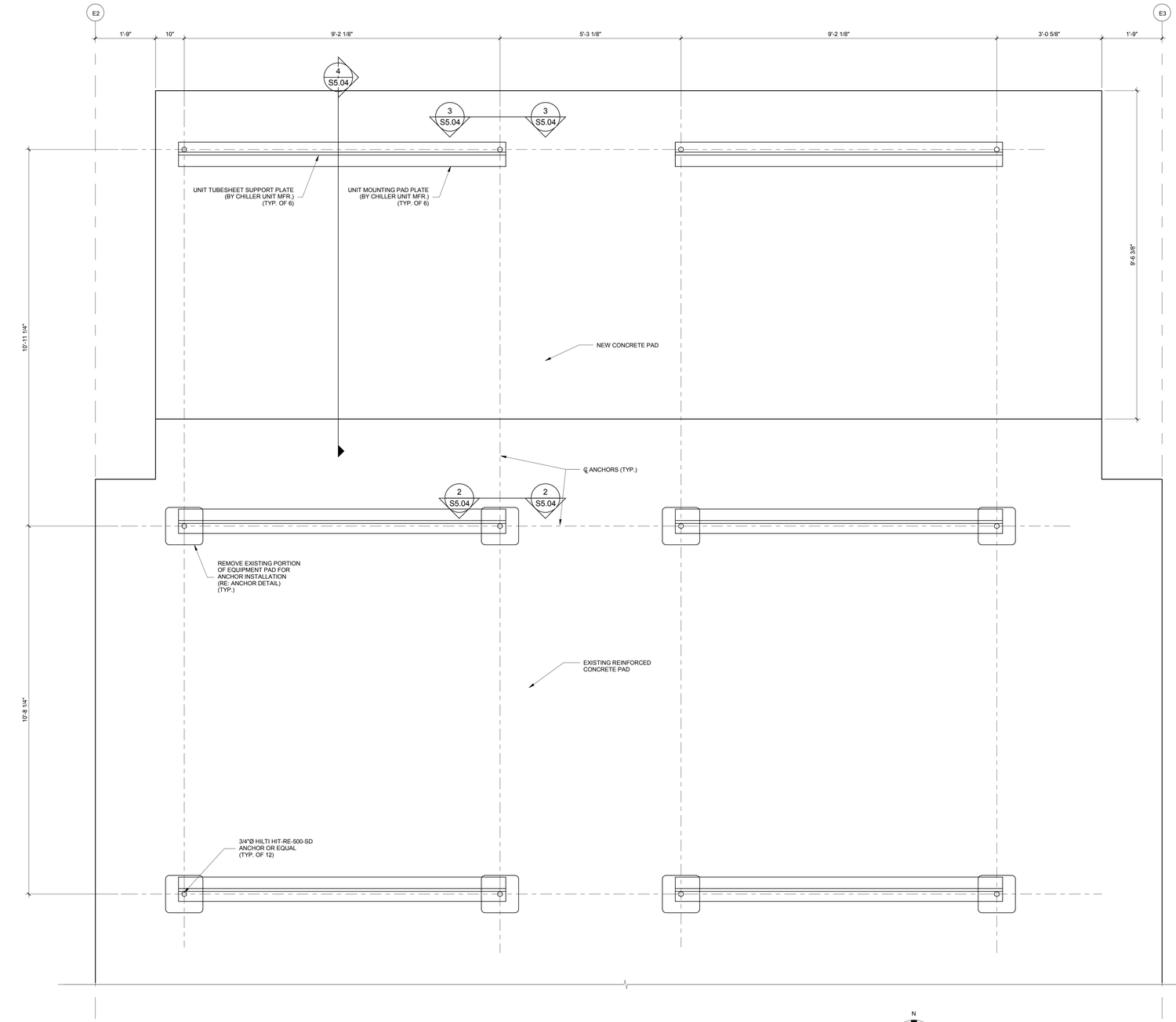
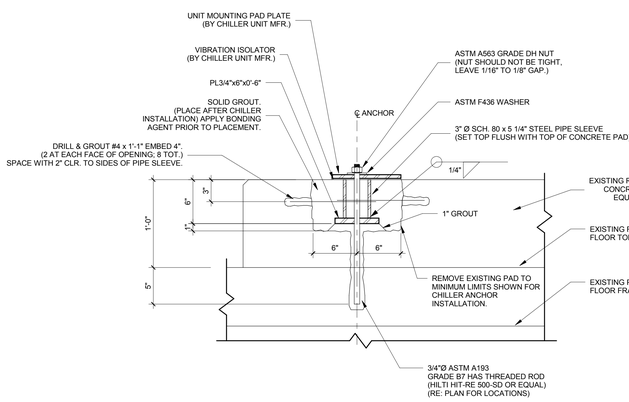


1 S1.01 | S5.04 CHILLER UNIT ANCHOR AND PAD PLAN 3/4" = 1'-0"

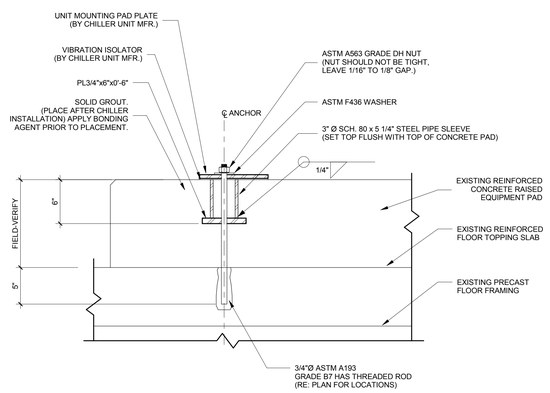
SCALE IN FEET 0 1' 2' 3'

N



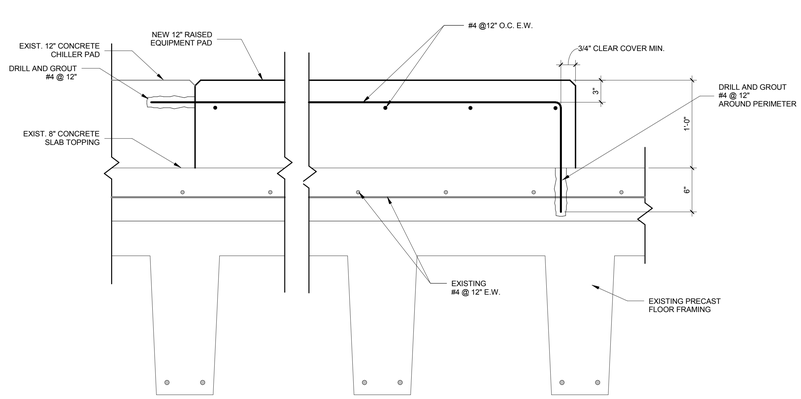
2 S5.04 | S5.04 CHILLER ANCHOR BOLT DETAIL @ EXISTING PAD 1 1/2" = 1'-0"

SCALE IN FEET 0 1/2' 1' 1 1/2'



3 S5.04 | S5.04 CHILLER ANCHOR BOLT DETAIL @ NEW PAD 1 1/2" = 1'-0"

SCALE IN FEET 0 1/2' 1' 1 1/2'



4 S5.04 | S5.04 RAISED PUMP PAD SECTION @ NEW SLAB 1 1/2" = 1'-0"

SCALE IN FEET 0 1/2' 1' 1 1/2'

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CITY AND COUNTY OF DENVER SEAL

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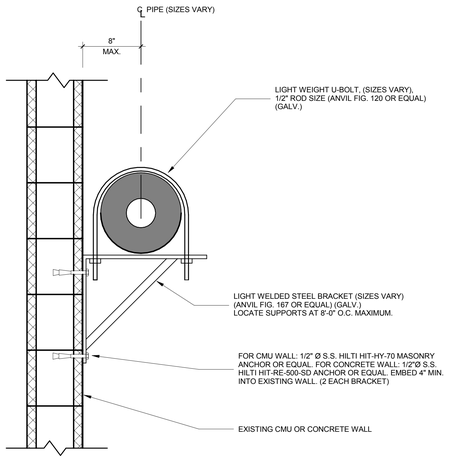
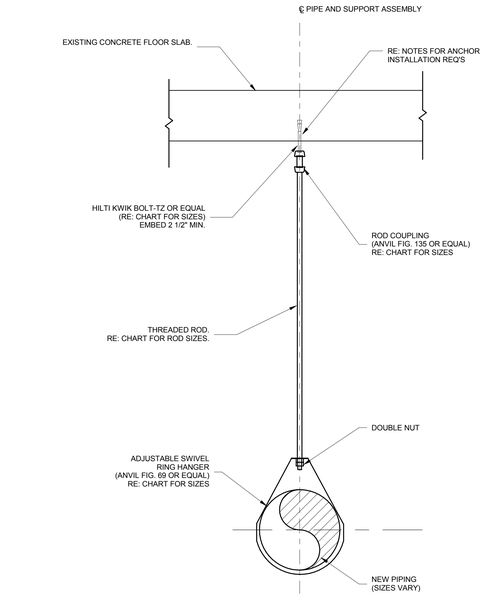


1 / S5.05 ALTERNATE PIPE SUPPORT DETAIL FOR PIPES SERVING RTU AND AHU-ER2

TO BE USED AT CONTRACTOR'S OPTION WHERE PIPING IS LOCATED NEXT TO EXISTING WALLS — 1 1/2" = 1'-0"

0 1/2" 1" 1 1/2"

SCALE IN FEET



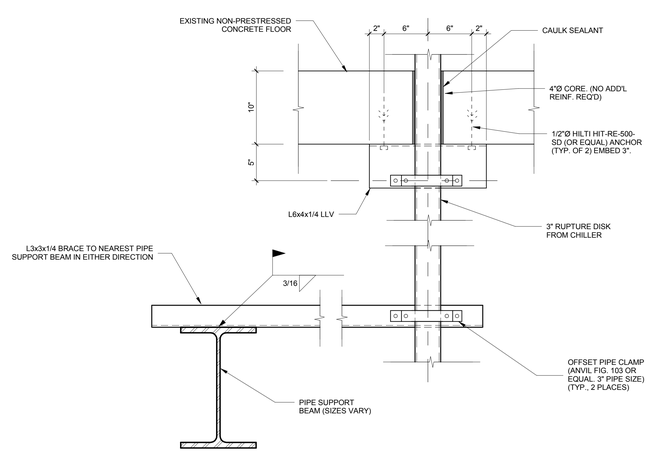
PIPING SUPPORT REQUIREMENTS FOR PIPES SERVING RTU AND AHU-ER2							
PIPE DIAMETER	MAXIMUM NEW PIPE LENGTH FOR REQUIRED SUPPORT	MAXIMUM SUPPORT SPACING	ANVIL FIG. 69 (OR EQUAL) HANGER SIZE	THREADED ROD SIZE	HILTI KWIK BOLT TZ-CS (OR EQUAL) SIZE	MIN. EMBEDMENT	MAX. EMBEDMENT
1" & 1 1/2"	4'-0"	6'-0"	1 1/2"	3/8"	3/8"	2-1/2"	3-1/2"
2"	6'-0"	6'-0"	2"	3/8"	3/8"	2-1/2"	3-1/2"
2 1/2"	7'-0"	6'-0"	2 1/2"	3/8"	3/8"	2-1/2"	3-1/2"
3"	8'-0"	6'-0"	3"	1/2"	1/2"	3"	4"

2 / S5.05 TYPICAL PIPING SUPPORT DETAIL FOR PIPES SERVING RTU AND AHU-ER2

3/4" = 1'-0"

0 1' 2' 3'

SCALE IN FEET



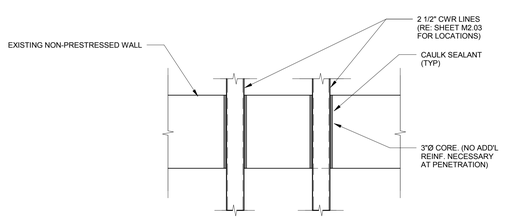
3 / S5.05 3" RUPTURE DISK SUPPORT AND FLOOR PENETRATION DETAIL

NOTE: RE: M3.02

1 1/2" = 1'-0"

0 1/2" 1" 1 1/2"

SCALE IN FEET



4 / S5.05 2 1/2" CWR WALL PENETRATION

1 1/2" = 1'-0"

0 1/2" 1" 1 1/2"

SCALE IN FEET

PIPE SUPPORT NOTES FOR PIPES SERVING RTU AND AHU-ER2:

1. PIPING SUPPORT REQUIREMENTS IN THE ACCOMPANYING DETAIL AND CHART ON THIS DRAWING APPLY ONLY TO NEW RTU-1 AND AHU-ER2 PIPING TO BE INSTALLED, AS SHOWN ON MECHANICAL DRAWINGS.
2. IF LENGTH OF ANY NEW PIPE TO BE INSTALLED IS LONGER THAN THE MAXIMUM INDICATED IN THE CHART, A MIMIMUM OF ONE SUPPORT SHALL BE INSTALLED, AND LOCATED AS NEAR TO THE MIDDLE OF THE NEW PIPE AS POSSIBLE.
3. LENGTHS OF NEW PORTIONS OF PIPE FOR PURPOSES OF SUPPORT LOCATIONS SHALL BE MEASURED BASED ON COMBINED HORIZONTALAND VERTICAL LENGTH, INCLUDING LENGTHS OF VALVES AND OTHER NEW COMPONENTS.
4. IF SUPPORT LOCATIONS MUST BE MOVED IN ORDER TO AVOID EXISTINGFRAMING, PIPING, CONDUIT, DUCTWORK, OR OTHER INFRASTRUCTURE, REVISED LOCATIONS SHALL BE APPROVED BY DIA PROJECT MANAGER AND ENGINEER PRIOR TO INSTALLATION.
5. PROPRIETARY ITEMS SPECIFIED IN THESE DETAILS SUCH AS PIPE SUPPORT COMPONENTS AND ANCHOR BOLTS MAY BE CONSIDERED EXAMPLES OF ACCEPTABLE ITEMS. ALTERNATE PRODUCTS MAY BE INSTALLED, PROVIDED THEY MEET OR EXCEED ALL STRENGTH, DIMENSIONAL, AND DESIGN INTENT OF SPECIFIED ITEMS. PROPOSED SUBSTITUTIONS SHALL BE SUBMITTED TO DIA PROJECT MANAGER AND STRUCTURAL ENGINEER FOR APPROVAL PRIOR TO INSTALLATION.
6. PIPE SUPPORT COMPONENTS AND ANCHOR BOLTS SHALL BE INSTALLED IN STRICT ACCORDANCE WITH MANUFACTURERS' SPECIFICATIONS.
7. AT LOCATIONS OF PRECAST DOUBLE-TEE FRAMING, INSTALL ANCHORS ONLY IN TEE FLANGES. DO NOT INSTALL ANCHORS IN TEE WEBS.
8. SPECIAL INSPECTION IS REQUIRED ON ALL ANCHORS. SPECIAL INSPECTION SHALL ENSURE THAT ANCHORS ARE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS, AND SHALL ALSO ENSURE THAT ANCHORS ARE TORQUED PRIOR TO INSTALLING ROD COUPLING.
9. IT IS THE CONTRACTOR'S RESPONSIBILITY TO PROVIDE TEMPORARY SUPPORTS AS REQUIRED FOR ALL EXISTING AND NEW PIPING DURING ANY MODIFICATIONS OF EXISTING PIPING.
10. INSULATION SHALL BE CUT AND PATCHED AROUND PIPE SUPPORTS, LEAVING NO GAPS IN INSULATION.

PIPE PENETRATION NOTES:

1. PIPES 3"Ø OR SMALLER MAY PENETRATE WALLS AND SLABS WITHOUT ADDITIONAL STRUCTURAL REINFORCING.
2. COORDINATE FIRE STOPPING WITH ARCH.

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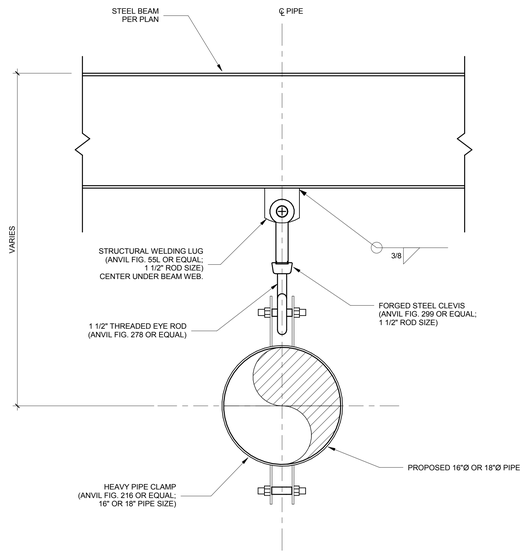
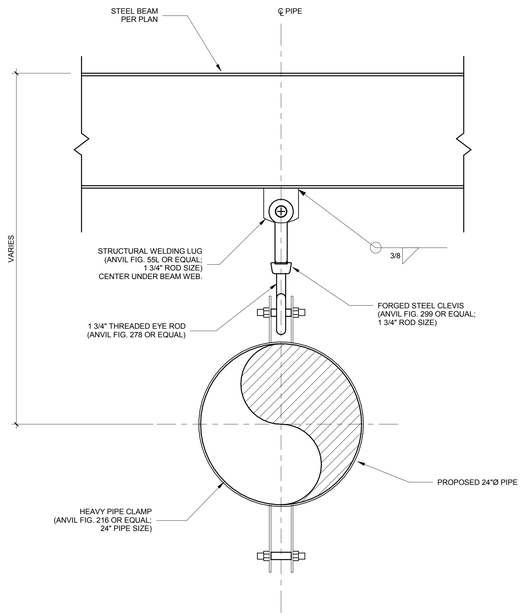
SHEET NO. S5.05

CADD FILE NO.



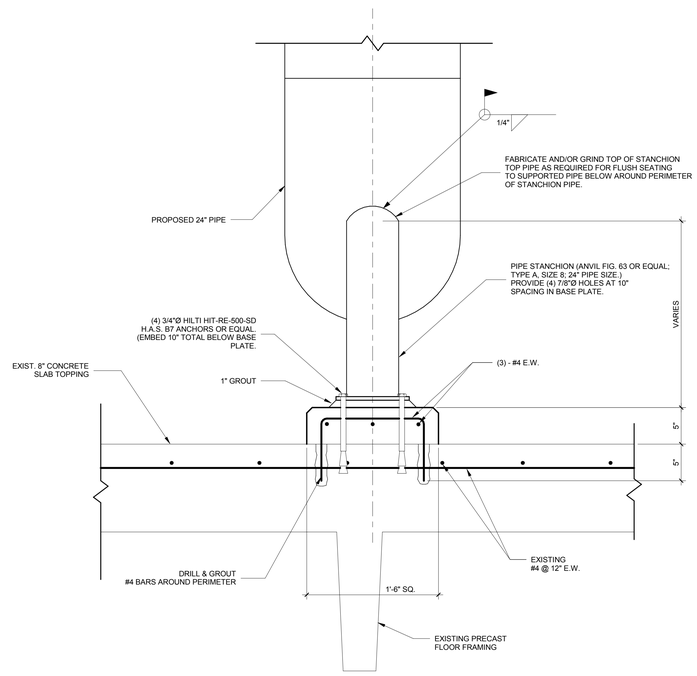
1 S5.06 — H1: TYPICAL 16" OR 18" PIPE HANGER ASSEMBLY HUNG FROM STEEL BEAM — 1 1/2" = 1'-0"

0 1/2" 1' 1 1/2"
SCALE IN FEET



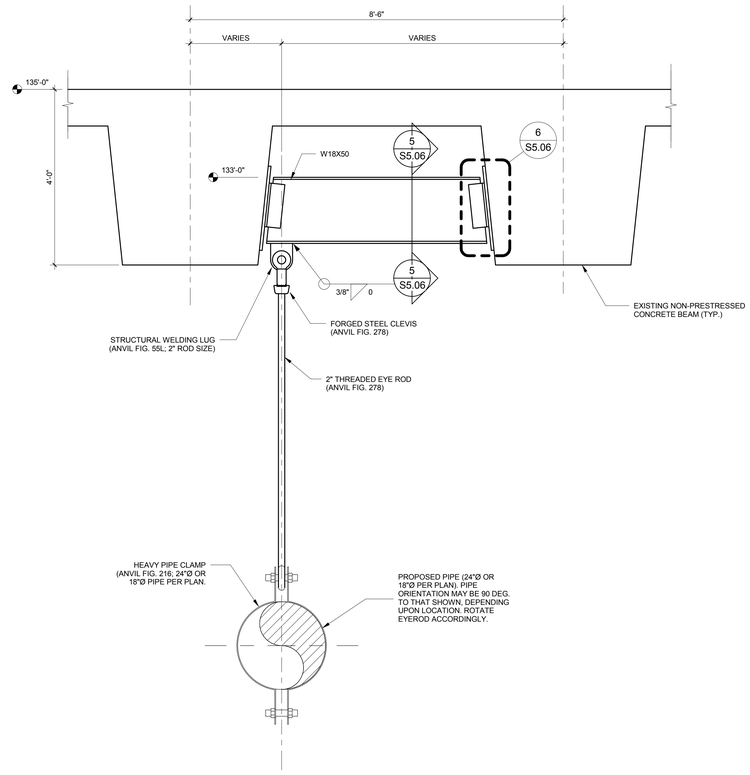
2 S5.06 — H2: TYPICAL 24" PIPE HANGER ASSEMBLY HUNG FROM STEEL BEAM — 1 1/2" = 1'-0"

0 1/2" 1' 1 1/2"
SCALE IN FEET



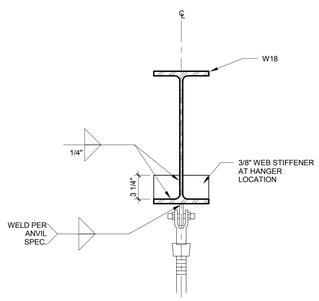
3 S5.06 — S1: TYPICAL 24" PIPE STANCHION SUPPORT ON EXISTING FLOOR — 1 1/2" = 1'-0"

0 1/2" 1' 1 1/2"
SCALE IN FEET



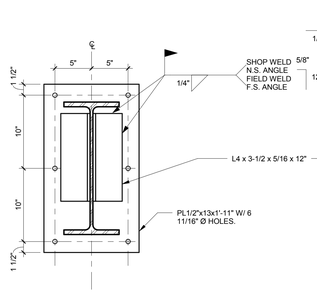
4 S5.06 — H3: PIPING SUPPORT SECTION — 3/4" = 1'-0"

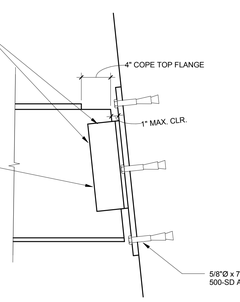
0 1/2" 1' 1 1/2"
SCALE IN FEET



5 S5.06 S5.06 — PIPING SUPPORT SECTION — 1 1/2" = 1'-0"

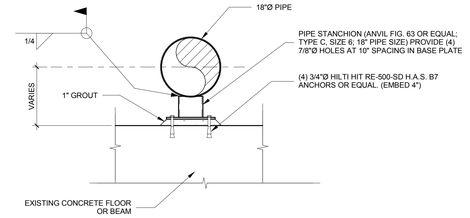
0 1/2" 1' 1 1/2"
SCALE IN FEET





6 S5.06 S5.06 — PIPING SUPPORT SECTION — 1 1/2" = 1'-0"

0 1/2" 1' 1 1/2"
SCALE IN FEET



8 S5.06 — S2: TYPICAL 18" PIPE STANCHION ON EXISTING FLOOR OR BEAM — 3/4" = 1'-0"

0 1/2" 1' 1 1/2"
SCALE IN FEET

PIPE SUPPORT NOTES:

1. LOCATE PIPING SUPPORT MEMBERS AS SHOWN. FIELD VERIFY ALL DEPENDENT DIMENSIONS AND CLEARANCES PRIOR TO FABRICATING OR ORDERING PIPING SUPPORT COMPONENTS.
2. IF SUPPORT LOCATIONS MUST BE MOVED IN ORDER TO AVOID EXISTINGFRAMING, PIPING, CONDUIT, DUCTWORK, OR OTHER INFRASTRUCTURE, REVISED LOCATIONS SHALL BE APPROVED BY DIA PROJECT MANAGER AND ENGINEER PRIOR TO INSTALLATION.
3. PROPRIETARY ITEMS SPECIFIED IN THESE DETAILS SUCH AS PIPE SUPPORT COMPONENTS AND ANCHOR BOLTS MAY BE CONSIDERED EXAMPLES OF ACCEPTABLE ITEMS. ALTERNATE PRODUCTS MAY BE INSTALLED, PROVIDED THEY MEET OR EXCEED ALL STRENGTH, DIMENSIONAL, AND DESIGN INTENT OF SPECIFIED ITEMS. PROPOSED SUBSTITUTIONS SHALL BE SUBMITTED TO DIA PROJECT MANAGER AND STRUCTURAL ENGINEER FOR APPROVAL PRIOR TO INSTALLATION.
4. PIPE SUPPORT COMPONENTS AND ANCHOR BOLTS SHALL BE INSTALLED IN STRICT ACCORDANCE WITH MANUFACTURERS' SPECIFICATIONS.
5. AT LOCATIONS OF PRECAST DOUBLE-TEE FRAMING, INSTALL ANCHORS ONLY IN TEE FLANGES. DO NOT INSTALL ANCHORS IN TEE WEBS.
6. SPECIAL INSPECTION IS REQUIRED ON ALL ANCHORS. SPECIAL INSPECTION SHALL ENSURE THAT ANCHORS ARE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS, AND SHALL ALSO ENSURE THAT ANCHORS ARE TORQUED PRIOR TO INSTALLING ROD COUPLING.
7. IT IS THE CONTRACTOR'S RESPONSIBILITY TO PROVIDE TEMPORARY SUPPORTS AS REQUIRED FOR ALL EXISTING AND NEW PIPING DURING ANY MODIFICATIONS OF EXISTING PIPING.
8. INSULATION SHALL BE CUT AND PATCHED AROUND PIPE SUPPORTS, LEAVING NO GAPS IN INSULATION.

CITY & COUNTY
of DENVER

DENVER
INTERNATIONAL
AIRPORT

DESIGNER OF RECORD

SAN ENGINEERING, LLC
6099 S. WINDERMERE ST
LITTLETON, CO 80120

CENTRAL UTILITY PLANT CHILLER ADDITION

San Engineering LLC
Civil and Structural Engineering

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	JJM	IFC	23JL13	TMM

SCALE: As indicated
DATE: 10/23/12
DRAWN BY: JJM
CHECKED BY: TMM
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 20131004600
VOLUME NO. 01

SHEET TITLE
PIPE SUPPORT DETAILS

SHEET NO.
S5.06

CADD FILE NO.

MECHANICAL SYMBOLS

EQUIPMENT SYMBOLS

PLATE & FRAME HEAT EXCHANGER

HORIZONTAL SPLIT CASE PUMP

VERTICAL TURBINE PUMP

CONTROLS/INSTRUMENTATION SYMBOLS

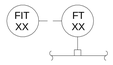
VARIABLE FREQUENCY DRIVE

MOTOR

TEMPERATURE ELEMENT

FLOW ELEMENT

PRESSURE TRANSMITTER



FLOW METER

SINGLE LINE PIPING SYMBOLS

REDUCER

PIPE CAP (BLIND FLANGE)

WYE STRAINER

PIPE CONTINUATION

VALVE SYMBOLS

AUTOMATED BUTTERFLY VALVE

SLIDE GATE VALVE

BALL VALVE

MANUAL BUTTERFLY VALVE

CHECK VALVE

SOLENOID VALVE

VALVE (IN PLAN OR SECTION VIEW)

MECHANICAL ABBREVIATIONS

AAV	AUTOMATIC AIR VENT
ABV	ABOVE
AC	AIR CONDITIONING
AFF	ABOVE FINISHED FLOOR
AHU	AIR HANDLING UNIT
APPROX	APPROXIMATE
ARCH	ARCHITECTURAL
AS	AIR SEPARATOR
AUTO	AUTOMATIC
B	BOILER
BEL	BELOW
BFV	BUTTERFLY VALVE
BHP	BRAKE HORSEPOWER
BLDG	BUILDING
BOP	BOTTOM OF PIPE
BTUH	BRITISH THERMAL UNITS PER HOUR
CFM	CUBIC FEET PER MINUTE
CH	CHILLER
CHP	CHILLED WATER PIPE
CONC	CONCRETE
CONN	CONNECTION
CONT	CONTINUATION
CPF	CHEMICAL POT FEEDER
CR	CONDENSER WATER RETURN
CS	CONDENSER WATER SUPPLY
CT	COOLING TOWER
CTF	COOLING TOWER FILTER
CWP	CONDENSER WATER PUMP
CWR	CHILLED WATER RETURN
CWS	CHILLED WATER SUPPLY
DB	DRY BULB
DDG	DIRECT DIGITAL CONTROL
DET	DETAIL
DIA, Ø	DIAMETER
DN	DOWN
DTR	DOWN THRU ROOF
DWG	DRAWING
EA	EACH, EXISTING AIR
EF	EXHAUST FAN
EL	ELEVATION
ELEC	ELECTRICAL
ENT	ENTERING
EQUIP	EQUIPMENT
ET	EXPANSION TANK
EXIST, (E)	EXISTING
FD	FIRE DAMPER
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
FLR	FLOOR
FOS	FUEL OIL SUPPLY
FPM	FEET PER MINUTE
FS	FLOW SWITCH
FSD	FIRE SMOKE DAMPER
FT	FLOOR, FEET
FV	FACE VELOCITY
°F	DEGREES FAHRENHEIT
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GPM	GALLONS PER MINUTE
HGT	HEIGHT
HORIZ	HORIZONTAL
HP	HORSEPOWER
HR	HOUR
HSC	HORIZONTAL SPLIT CASE
HVAC	HEATING, VENTILATING AND AIR CONDITIONING
HWP	HEATING HOT WATER PUMP
HZ	HERTZ
IA	INSTRUMENT AIR
ID	INSIDE DIAMETER
IN	INCH, INCHES
IN WG	INCHES WATER GAUGE
KW	KILOWATT
LB	POUND
LRA	LOCKED ROTOR AMPERES
LVG	LEAVING
M	MOTOR
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTER
MD	MOTORIZED DAMPER
MECH	MECHANICAL
MIN	MINIMUM
MISC	MISCELLANEOUS
MTD	MOUNTED
MTG	MOUNTING
MVD	MANUALLY OPERATED VOLUME DAMPER
NC	NORMALLY CLOSED
NG	NATURAL GAS
NO	NORMALLY OPEN
NTS	NOT TO SCALE
OA	OUTSIDE AIR
PA	PLANT AIR
PD	PRESSURE DROP
POC	POINT OF CONNECTION
POS	POSITIVE
PRESS	PRESSURE
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSIG	POUNDS PER SQUARE INCH GAUGE
PT	PRESSURE TRANSMITTER
PW	PLANT WATER
RA	RETURN AIR
REF	REFERENCE
REQD	REQUIRED
RET	RETURN
RG	RETURN GRILLE
RH	RIGHT HAND
RLA	RATED LOAD AMPS
RM	ROOM
RPM	REVOLUTIONS PER MINUTE
SA	STARTING AIR, SUPPLY AIR
SD	SUCTION DIFFUSER
SECT	SECTION
SG	SUPPLY GRILLE
SHT	SHEET
SMS	SHEET METAL SCREW
SOV	SHUT OFF VALVE
SP	STATIC PRESSURE
SPECS	SPECIFICATIONS
SQ	SQUARE
SS	STAINLESS STEEL
STD	STANDARD
STRUCT	STRUCTURAL
SW	SWITCH
TCV	TEMPERATURE CONTROL VALVE
TE	TEMPERATURE ELEMENT
TEMP	TEMPERATURE
TOS	TOP OF STEEL
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
UTR	UP THRU ROOF
V	VENT
VERT	VERTICAL
VFD	VARIABLE FREQUENCY DRIVE
W/	WITH
WB	WET BULB
WMS	WIRE MESH SCREEN
WT	WEIGHT

GENERAL NOTES

1. CONTRACTOR IS RESPONSIBLE FOR FURNISHING ALL THE NECESSARY COMPONENTS AND ACCESSORIES TO PROVIDE COMPLETE SYSTEMS IN ACCORDANCE WITH THESE DRAWINGS AND THE SPECIFICATIONS.
2. EQUIPMENT CAPACITIES SHOWN ON THESE DRAWINGS ARE FOR CONDITIONS AT AN ELEVATION OF 5,400 FT ABOVE SEA LEVEL. CONTRACTOR SHALL ENSURE THAT ALL EQUIPMENT FURNISHED IS PROPERLY DERATED TO OPERATE AT THE SITE CONDITIONS.
3. DUCT CONNECTIONS TO EQUIPMENT SHALL BE VERIFIED AND ADJUSTED TO MATCH ACTUAL EQUIPMENT FURNISHED.
4. CONTRACTOR IS RESPONSIBLE FOR VERIFYING EXISTING CONDITIONS PRIOR TO COMMENCEMENT OF WORK.
5. CONTRACTOR SHALL REFER TO ARCHITECTURAL, STRUCTURAL AND ELECTRICAL DRAWINGS TO COORDINATE MECHANICAL WORK WITH OTHER TRADES AS REQUIRED.
6. ALL EXISTING CHILLED WATER PIPING IN THE CENTRAL UTILITY PLANT IS INSULATED, AND ALL NEW CHILLED WATER PIPING SHALL BE INSULATED PER PROJECT SPECIFICATIONS. HOWEVER, FOR CLARITY, PIPE INSULATION IS NOT SHOWN IN THESE DRAWINGS.

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	AM	IFC	23JL13	DMW

SCALE: NONE

DATE: 10/23/12

DRAWN BY: A. MAHOBIAN

CHECKED BY: D. WHITNEY

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

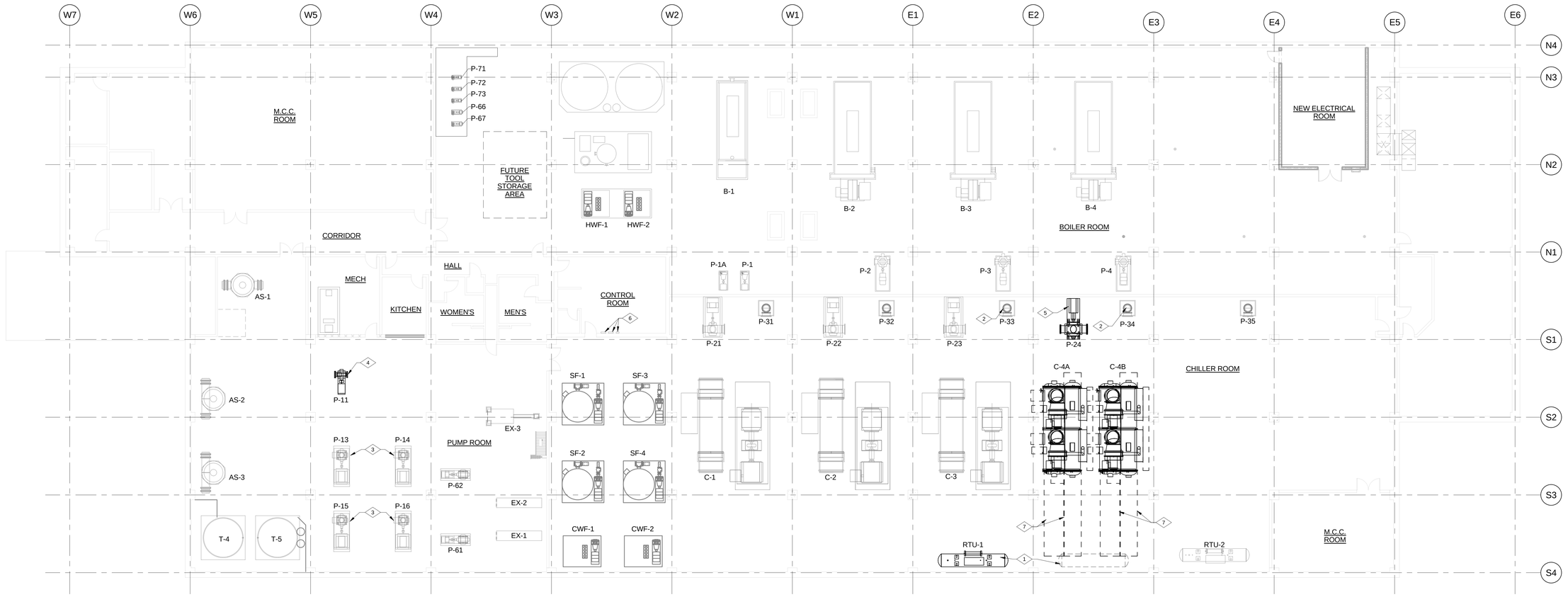
SHEET TITLE

MECHANICAL LEGEND AND ABBREVIATIONS

SHEET NO.

M0.01

CADD FILE NO.



1 M1.01 LOWER LEVEL NEW GENERAL ARRANGEMENT
3/32" = 1'-0"

0 8' 16' 24'
SCALE IN FEET

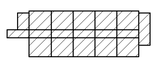
N

NOTES:

1. NEW CHILLERS (C-4A AND C-4B) SHOWN WITH MANUFACTURER CLEARANCES, CONTRACTOR IS RESPONSIBLE FOR COORDINATING WITH SUPPLIER TO MAINTAIN ALL REQUIRED CLEARANCES. CONTRACTOR SHALL TAKE THE TIME AND EFFORT NEEDED TO ACCURATELY PLACE THE NEW CHILLERS.

KEYED NOTES:

1. CONTRACTOR SHALL RELOCATE RTU-1 CURRENTLY LOCATED IN CHILLER BAY 4 TO CHILLER BAY 3. CONTRACTOR SHALL RELOCATE ALL ASSOCIATED PIPING AND ACCESSORIES, AND SHALL ENSURE RTU IS FULLY OPERATIONAL. SEE DWGS MD2.02, M2.02, M3.03, & M4.03 FOR RTU RELOCATION DETAILS.
2. EXISTING VERTICAL TURBINE PUMP SHALL RECEIVE A NEW VARIABLE FREQUENCY DRIVE (VFD). SEE ELECTRICAL DRAWINGS FOR DETAILS.
3. EXISTING CHILLED WATER PUMP TO RECEIVE VFD UNDER SEPARATE CONTRACT.
4. NEW CHILLED WATER PUMP SHALL BE PROVIDED WITH A VFD. SEE ELECTRICAL DRAWINGS FOR DETAILS.
5. NEW CONDENSER WATER PUMP SHALL BE PROVIDED WITH A VFD. SEE ELECTRICAL DRAWINGS FOR DETAILS.
6. EXISTING REFRIGERANT LEAK DETECTION SYSTEM LOCATED IN CONTROL ROOM. CONTRACTOR SHALL IDENTIFY WHICH ZONE IS ALLOCATED TO CHILLER BAY #4, AND SHALL REPROGRAM BACHARACH CONTROLLERS FOR THAT ZONE TO MONITOR REFRIGERANT R-123 IN LIEU OF R-22, AND RESET ALARM LEVELS FOR THAT ZONE TO BE 25 PPM (LEAK), 50 PPM (SPILL), AND 100 PPM (EVACUATE).
7. TUBE PULL CLEARANCE.



KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MARIOON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	AM	IFC	23JL13	DMW

SCALE: 3/32" = 1'-0"

DATE: 10/23/12

DRAWN BY: A. MAHOBIAN

CHECKED BY: D. WHITNEY

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

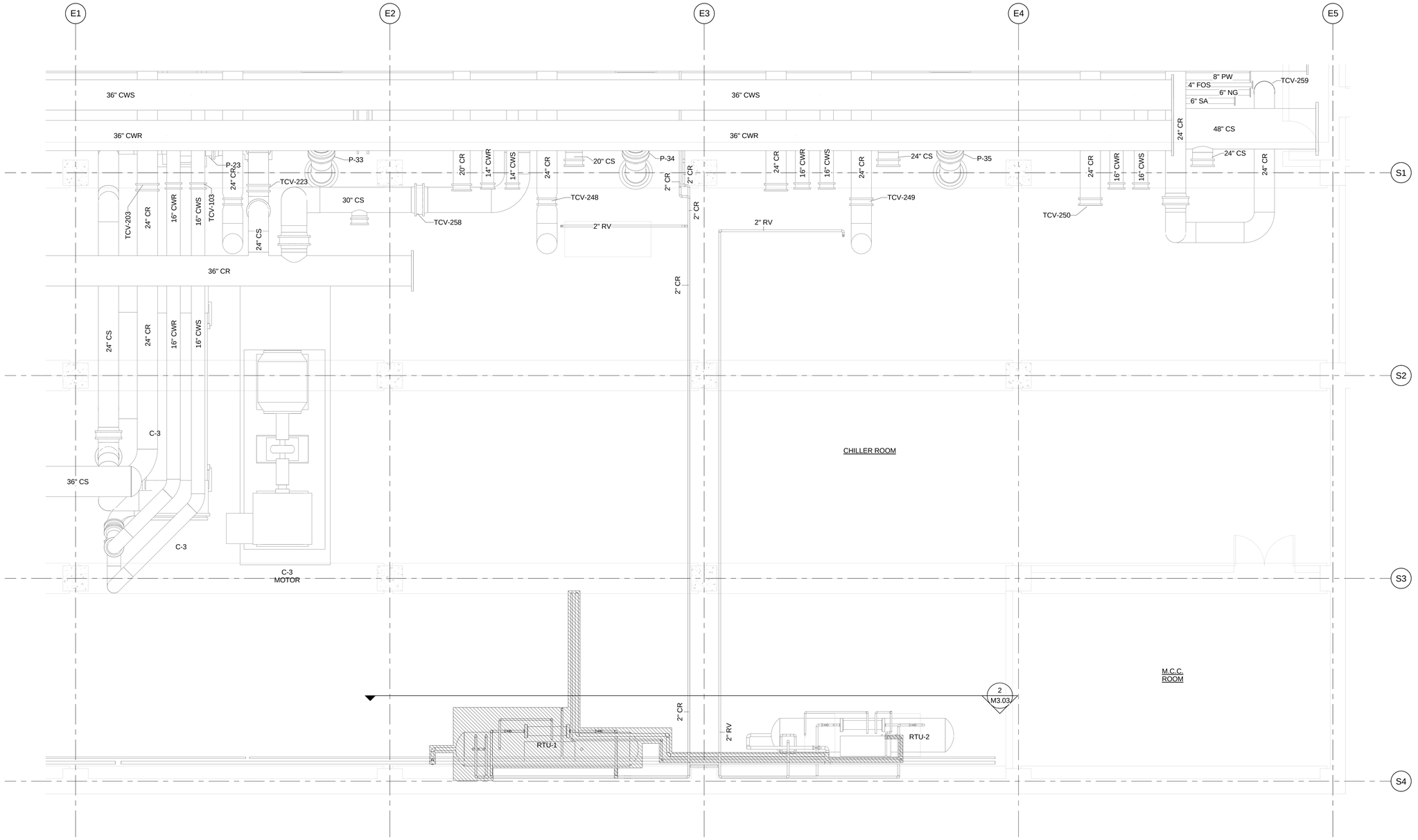
CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE
LOWER LEVEL GENERAL ARRANGEMENT

SHEET NO.
M1.01

CADD FILE NO.



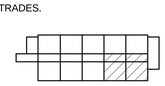
1 MD2.02 — LOWER LEVEL MECH DEMO PLAN
1/4" = 1'-0"

0 2' 4' 8'
SCALE IN FEET

N

NOTES:

1. REFER TO DEMOLITION SECTION AND FLOW DIAGRAM FOR EXTENTS OF DEMOLITION. CONTRACTOR SHALL RELOCATE RTU-1 AND ASSOCIATED PIPING TO POSITION SHOWN IN DWG M1.01. EXISTING PIPING ARRANGEMENT WILL BE MAINTAINED FOR NEW LOCATION. CONNECTING PIPING WILL BE EXTENDED TO NEW TIE IN LOCATIONS.
2. CONTRACTOR SHALL COORDINATE DEMOLITION WITH ALL OTHER TRADES.



KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
0	AM	IFC	7/31/13	DMW

SCALE: 1/4" = 1'-0"

DATE: 10/23/12

DRAWN BY: A. MAHOBIAN

CHECKED BY: D. WHITNEY

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

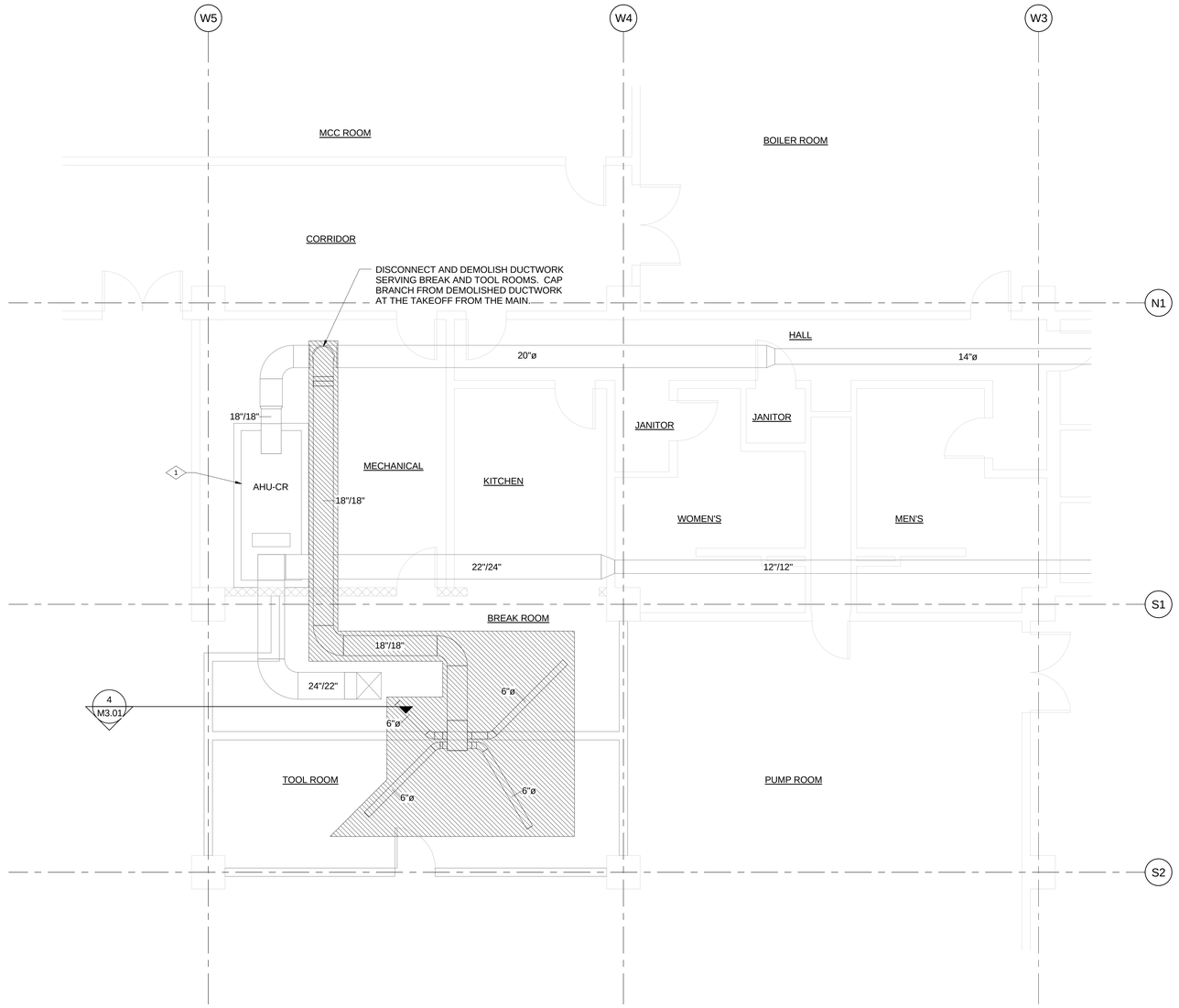
CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE
LOWER LEVEL CHILLER ROOM MECH DEMO PLAN

SHEET NO.
MD2.02

CADD FILE NO.



1 / MD2.03 — BREAK AND TOOL ROOM HVAC DEMO PLAN

1/4" = 1'-0"

0 2' 4' 8'

SCALE IN FEET

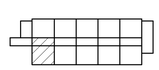
N

NOTES:

1. CONTRACTOR SHALL COORDINATE DEMOLITION WITH ALL OTHER TRADES. COORDINATE DEMOLITION WITH ARCHITECTURAL, STRUCTURAL, AND ELECTRICAL DEMO PLANS.
2. CONTRACTOR SHALL DEMOLISH ALL DUCTWORK, DIFFUSERS, REGISTERS, AND GRILLES.

KEYED NOTES:

1. AHU-CR WILL NEED TO BE RE-BALANCED ONCE DUCTWORK SERVING BREAK ROOM AND TOOL ROOM IS DISCONNECTED AND THE MAIN DUCT REPAIRED. AHU-CR SHALL BE RE-BALANCED TO AS-BUILT CONDITIONS OF 44,000 CFM @ 2.71" E.S.P.



KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
0	AM	IFC	7/31/13	DMW

SCALE: 1/4" = 1'-0"

DATE: 10/23/12

DRAWN BY: A. MAHOBIAN

CHECKED BY: D. WHITNEY

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

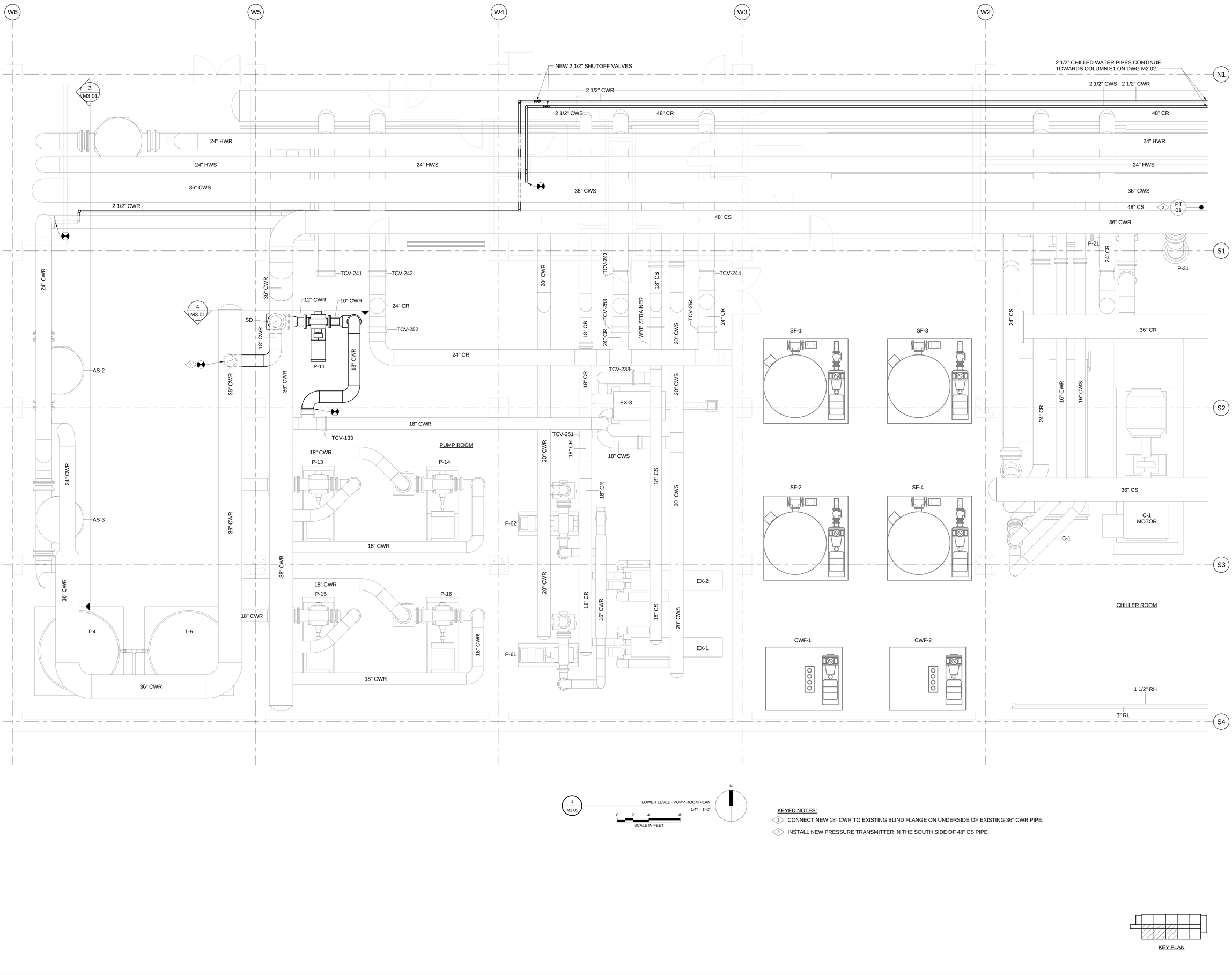
SHEET TITLE

BREAK AND TOOL ROOM HVAC DEMO PLAN

SHEET NO.

MD2.03

CADD FILE NO.



1 M2.01 LOWER LEVEL - PUMP ROOM PLAN

1/4" = 1'-0"

0 2' 4' 8'

SCALE IN FEET

N

KEYED NOTES:

1. CONNECT NEW 18" CWR TO EXISTING BLIND FLANGE ON UNDERSIDE OF EXISTING 36" CWR PIPE.
2. INSTALL NEW PRESSURE TRANSMITTER IN THE SOUTH SIDE OF 48" CS PIPE.

KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	AM	IFC	2.8.13	DMW

SCALE: 1/4" = 1'-0"

DATE: 10/23/12

DRAWN BY: A. MAHOBIAN

CHECKED BY: D. WHITNEY

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

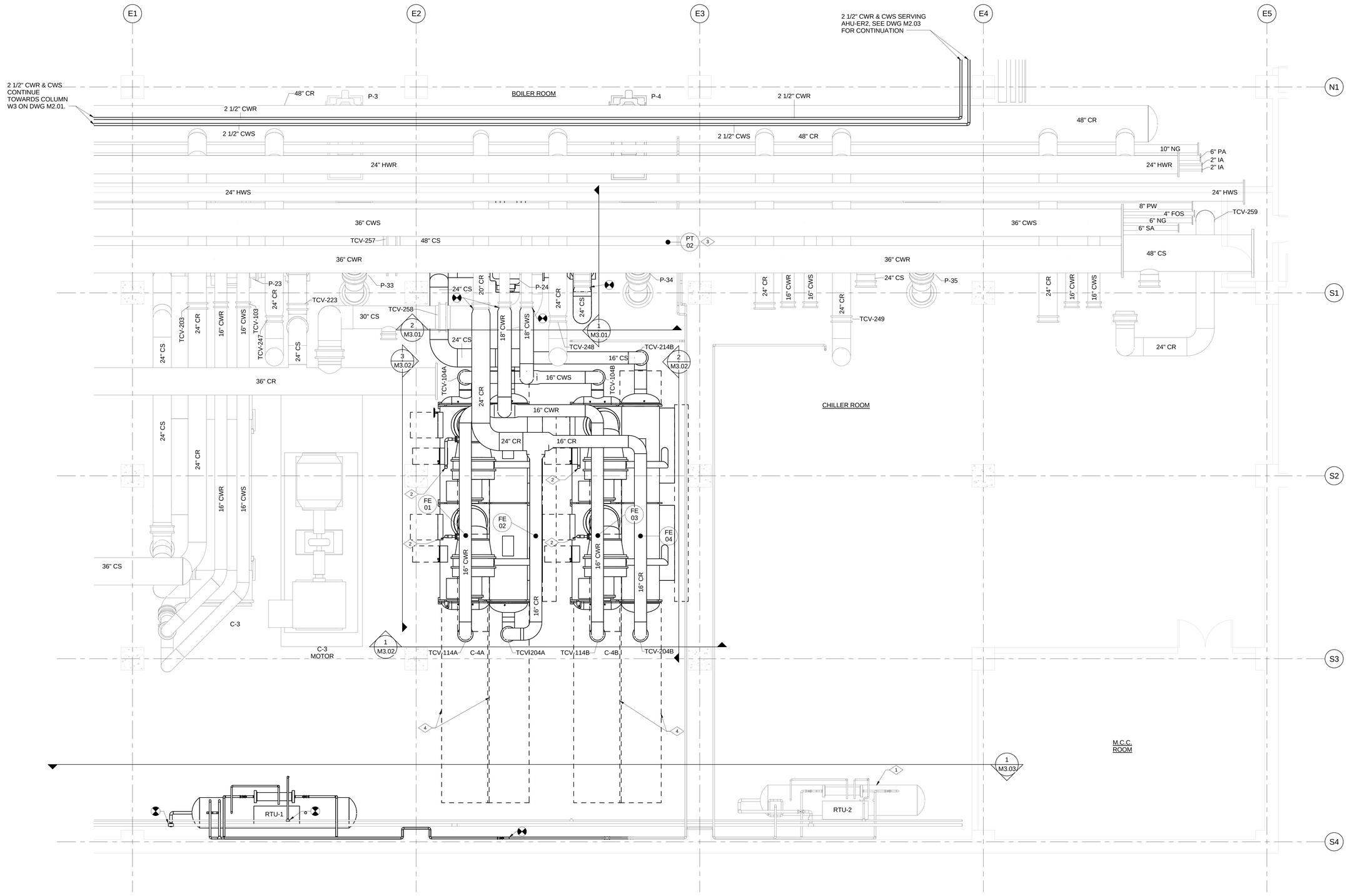
SHEET TITLE

LOWER LEVEL WEST MECHANICAL PLAN

SHEET NO.

M2.01

CADD FILE NO.



1 M2.02 LOWER LEVEL - CHILLER ROOM PLAN
1/4" = 1'-0"
SCALE IN FEET 0 2' 4' 8'

NOTES:

1. NEW CHILLERS (C-4A AND C-4B) SHOWN WITH MANUFACTURER CLEARANCES, CONTRACTOR IS RESPONSIBLE FOR COORDINATING WITH SUPPLIER TO MAINTAIN ALL REQUIRED CLEARANCES. CONTRACTOR SHALL TAKE THE TIME AND EFFORT NEEDED TO ACCURATELY PLACE THE NEW CHILLERS.
2. EXISTING DUCTWORK RUNS IN CHILLER ROOM ABOVE NEW CHILLERS AND ASSOCIATED NEW PIPING. DUCTWORK IS NOT SHOWN FOR CLARITY, HOWEVER, CONTRACTOR SHALL BE AWARE OF ALL EXISTING DUCTWORK FOR COORDINATION OF NEW EQUIPMENT, PIPING, VALVES, SUPPORTS, ETC.
3. SEE STRUCTURAL DRAWINGS FOR PIPE SUPPORT AND EQUIPMENT PAD DETAILS.

KEYED NOTES:

1. RTU-2 SHALL REMAIN IN OPERATION FOR THE DURATION OF CONSTRUCTION AND MAY ONLY BE SHUT DOWN ONCE RTU-1 HAS BEEN MOVED TO NEW LOCATION, ALL NEW PIPES HAVE BEEN ROUTED, AND IT IS TIME TO CONNECT RTU-1 BACK INTO THE MAIN PIPES. TEMPORARY SHUTDOWN OF RTU-2 MUST BE COORDINATED WITH CENTRAL UTILITY PLANT OPERATORS AND DIA PROJECT MANAGER.
2. 3" RUPTURE DISK (TYP OF 2 PER CHILLER). CONTRACTOR SHALL FIELD ROUTE PIPE THROUGH FLOOR ABOVE TO ATMOSPHERE. SEE STRUCTURAL DRAWINGS FOR FLOOR PENETRATION DETAILS.
3. INSTALL NEW PRESSURE TRANSMITTER IN THE SOUTH SIDE OF 48" CS PIPE.
4. TUBE PULL CLEARANCE.

KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MARION CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	AM	IFC	2\13\13	PMW

SCALE: 1/4" = 1'-0"

DATE: 10/23/12

DRAWN BY: A. MAHOBIAN

CHECKED BY: D. WHITNEY

FAA AIP NO.

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

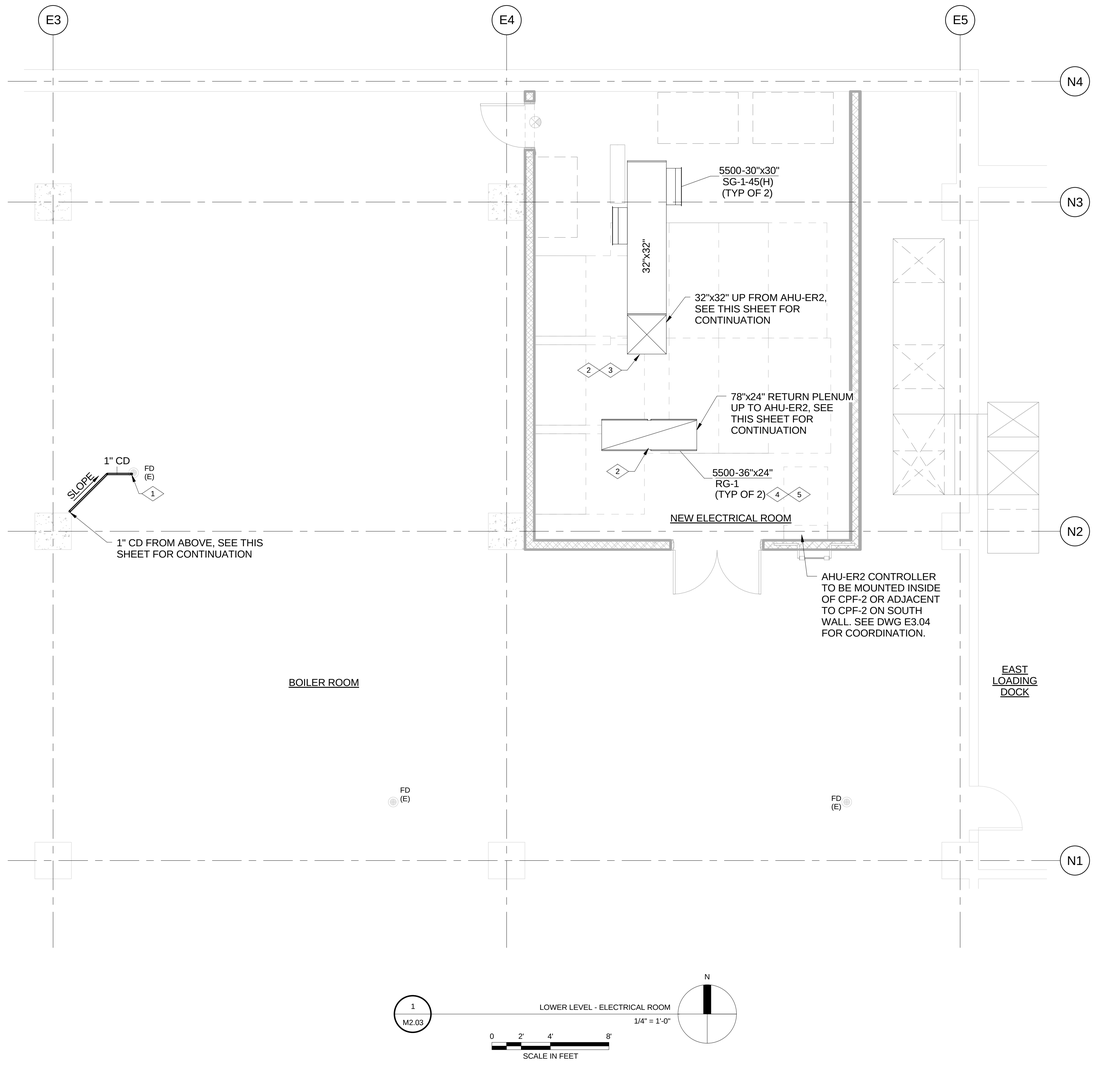
CONST. CONTRACT NO. 201310046-00

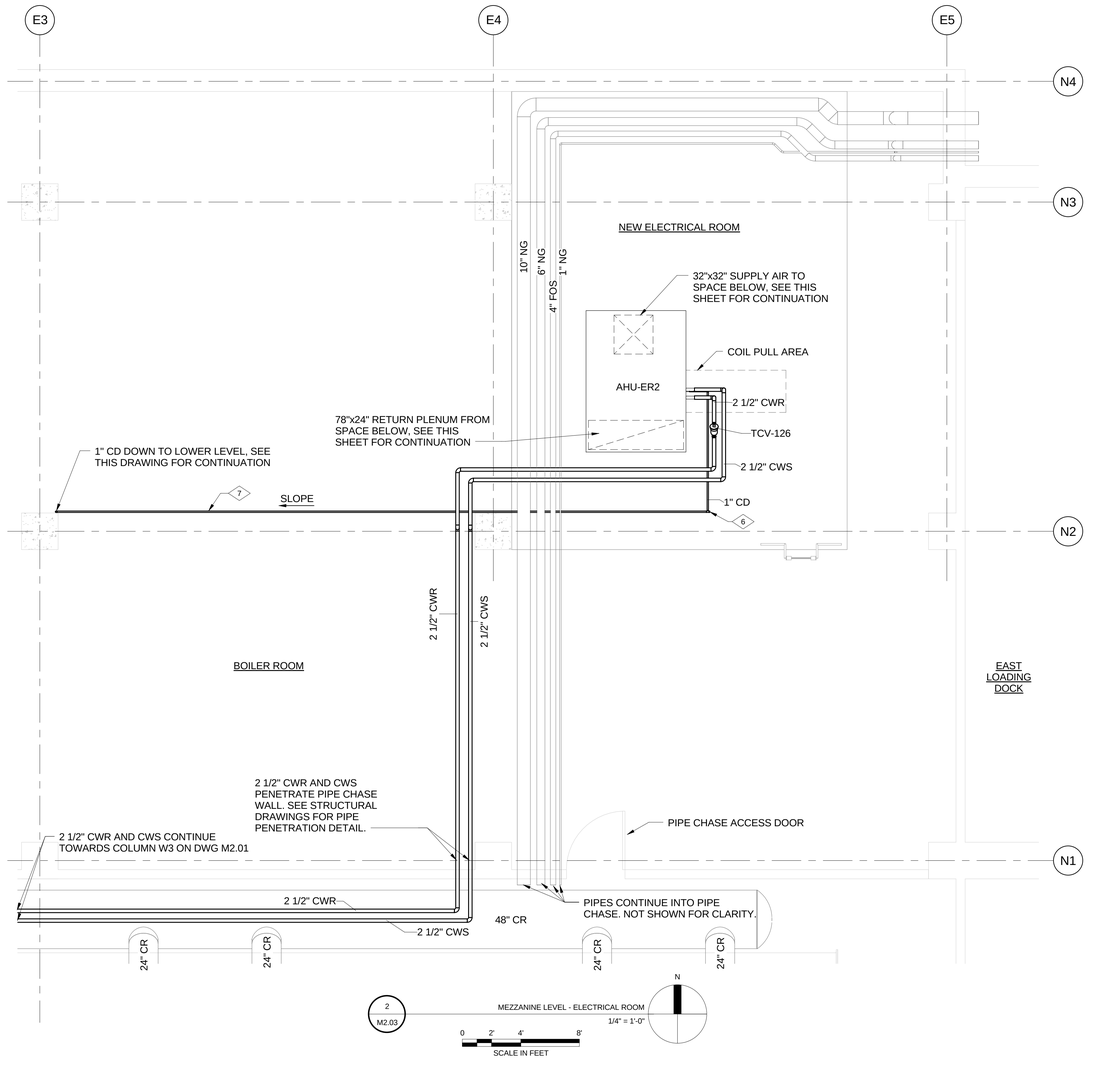
VOLUME NO. 01

SHEET TITLE
LOWER LEVEL EAST MECHANICAL PLAN

SHEET NO.
M2.02

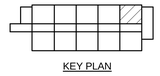
CADD FILE NO.





KEYED NOTES:

1. CONTRACTOR SHALL ROUTE PIPE ALONG FLOOR AND SLOPED TOWARDS THE FLOOR DRAIN. TERMINATE PIPE WITH A 90 DEGREE ELBOW LOCATED 1" ABOVE THE FLOOR.
2. INSTALL FIRE DAMPER IN VERTICAL DUCT AT FIRE-RATED PENETRATION. SEE DETAIL 11 ON M6.01.
3. INSTALL FIRE DAMPER ACCESS DOOR IN ELBOW DOWNSTREAM OF DAMPER.
4. FIRE DAMPER ACCESS THROUGH REMOVAL OF RETURN GRILLES.
5. RETURN GRILLE (TYP OF 2) ARE TO BE MOUNTED TO BOTTOM OF 78"x24" RETURN PLENUM.
6. INSTALL 1" TEE WITH PIPE PLUG FOR CLEANOUT.
7. 1" CD SHALL BE RUN ALONG OR ABOVE THE EXISTING BEAM RUNNING AT COLUMN N2 IN BETWEEN E3 & E4. MINIMUM SLOPE OF 1/4" PER FT MUST BE MAINTAINED PER CODE.



KEY PLAN

CITY & COUNTY
of DENVER

DENVER
INTERNATIONAL
AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MARIOON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell
SINCE 1898

ISSUE RECORD

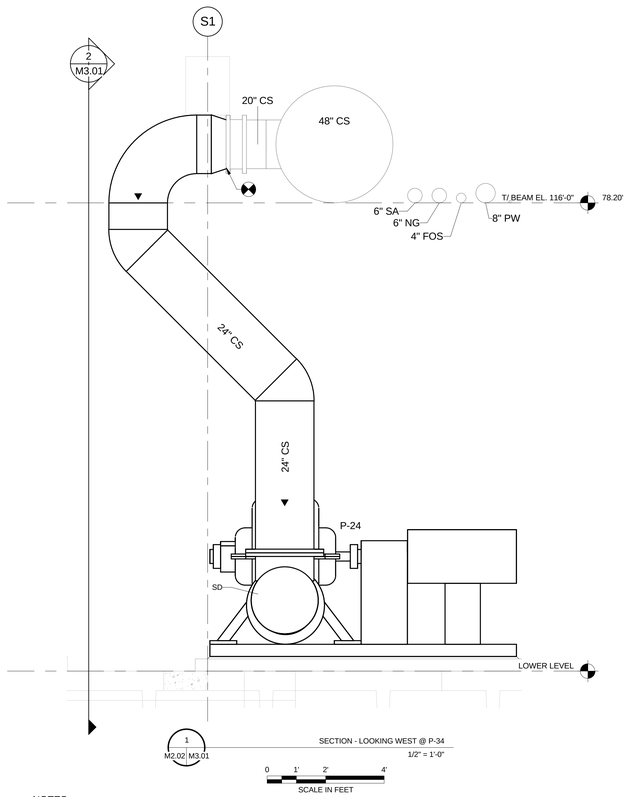
NO.	BY	PURPOSE	DATE	CKD
00	AM	IFC	2.13.13	DMW

SCALE: 1/4" = 1'-0"
DATE: 10/23/12
DRAWN BY: A. MAHOBIAN
CHECKED BY: D. WHITNEY
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01

SHEET TITLE
ELECTRICAL ROOM
HVAC PLANS

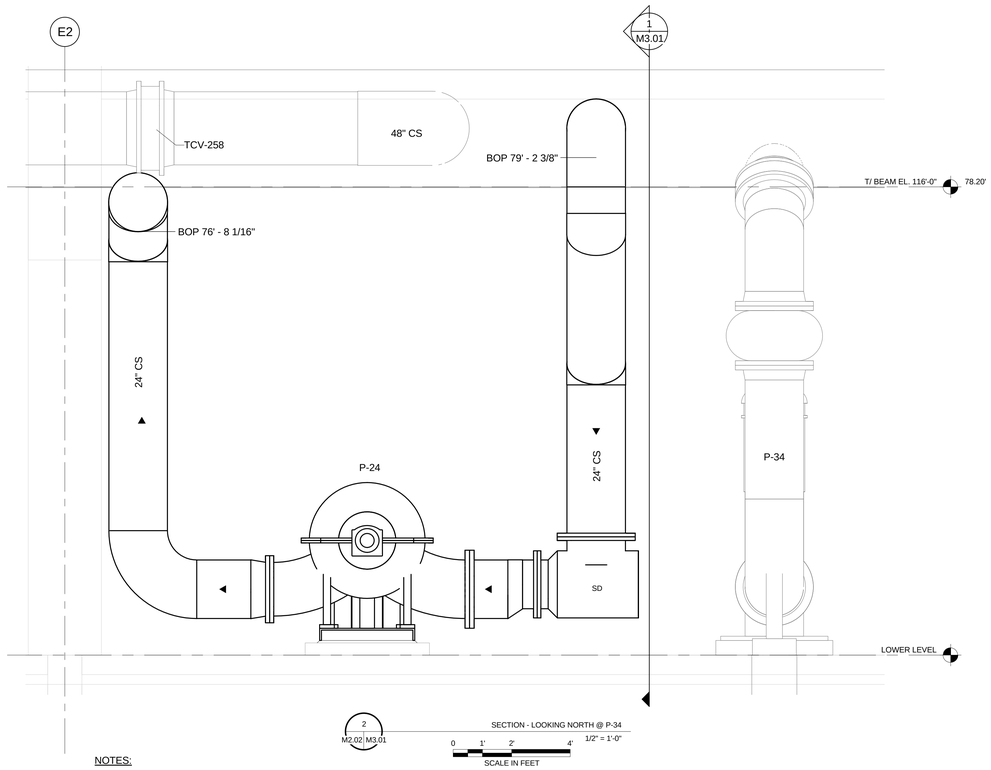
SHEET NO.
M2.03

CADD FILE NO.



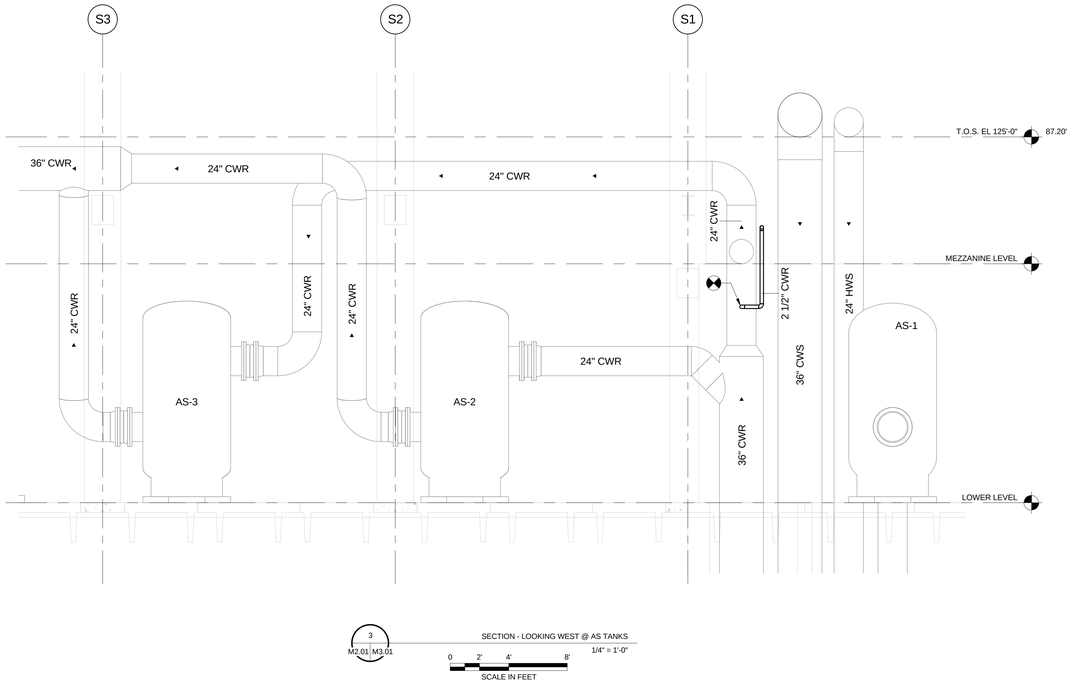
NOTES:

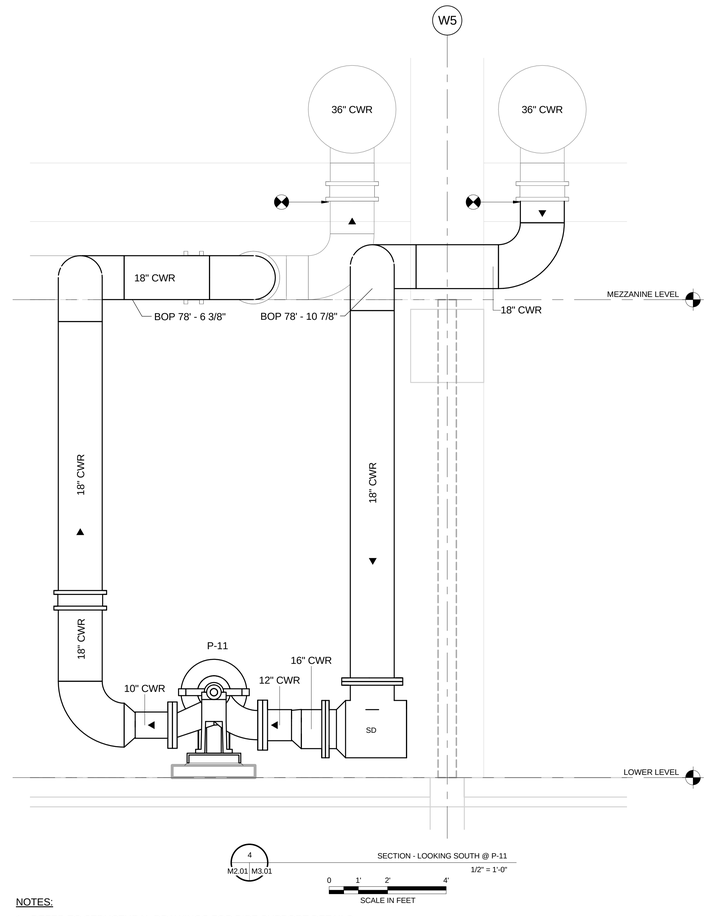
1. REFER TO STRUCTURAL DRAWINGS FOR PIPE SUPPORT DETAILS.
2. SOME VALVES, ACCESSORIES AND OTHER APPURTENANCES ARE NOT SHOWN IN THIS VIEW. REFER TO DETAIL 8 ON DWG M6.02 FOR ALL REQUIRED PUMP AND PIPING ACCESSORIES.
3. SEE DETAIL 5 ON DWG M6.02 FOR INERTIA BASE DETAILS.



NOTES:

1. REFER TO STRUCTURAL DRAWINGS FOR PIPE SUPPORT DETAILS.
2. SOME VALVES, ACCESSORIES AND OTHER APPURTENANCES ARE NOT SHOWN IN THIS VIEW. REFER TO DETAIL 8 ON DWG M6.02 FOR ALL REQUIRED PUMP AND PIPING ACCESSORIES.
3. SEE DETAIL 5 ON DWG M6.02 FOR INERTIA BASE DETAILS.





NOTES:

1. REFER TO STRUCTURAL DRAWINGS FOR PIPE SUPPORT DETAILS.
2. SOME VALVES, ACCESSORIES AND OTHER APPURTENANCES ARE NOT SHOWN IN THIS VIEW. REFER TO DETAIL 7 ON DWG M6.02 FOR ALL REQUIRED PUMP AND PIPING ACCESSORIES.
3. SEE DETAIL 5 ON DWG M6.02 FOR INERTIA BASE DETAILS.

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

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CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	AM	IFC	2.13.13	DWM

SCALE: As indicated

DATE: 10/23/12

DRAWN BY: A. MAHOBIAN

CHECKED BY: D. WHITNEY

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

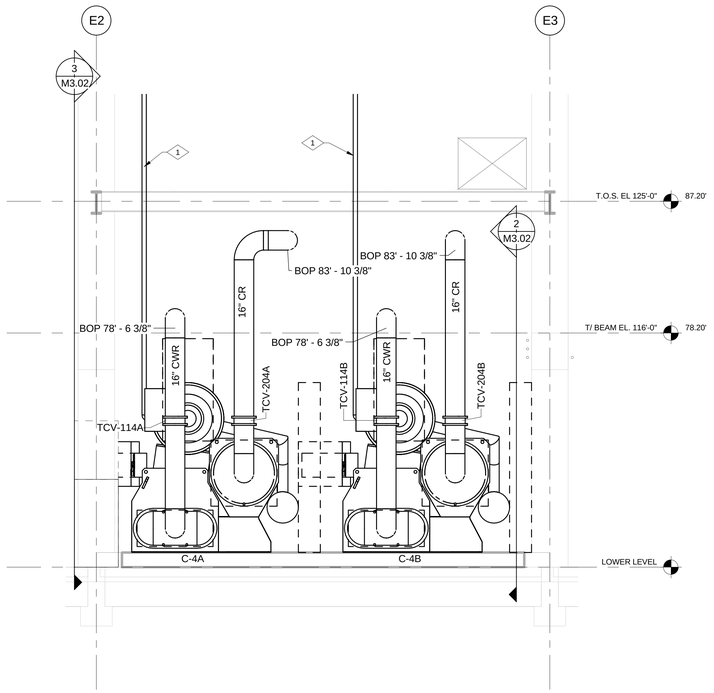
CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

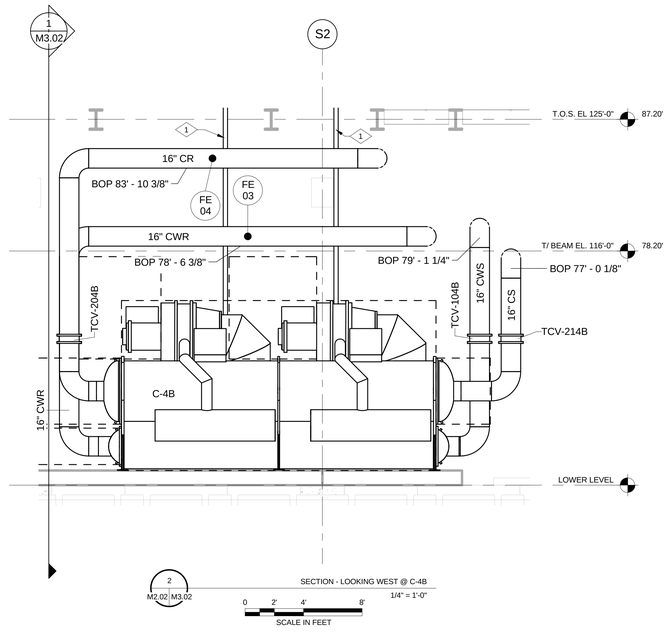
SHEET TITLE: MECHANICAL SECTIONS

SHEET NO. M3.01

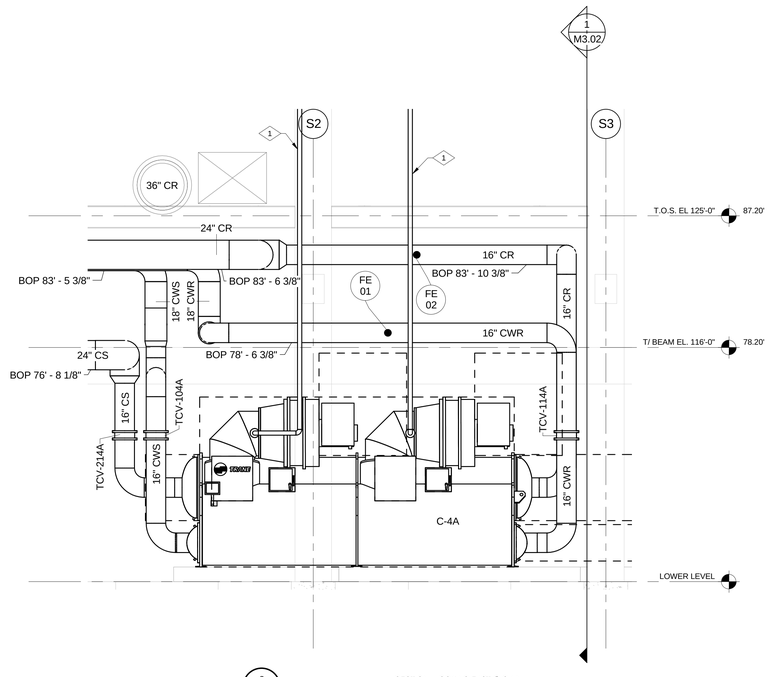
CADD FILE NO.



1 M2.02 M3.02 SECTION - LOOKING NORTH @ C-4A & C-4B
1/4" = 1'-0"
0 2' 4' 8'
SCALE IN FEET



2 M2.02 M3.02 SECTION - LOOKING WEST @ C-4B
1/4" = 1'-0"
0 2' 4' 8'
SCALE IN FEET



3 M2.02 M3.02 SECTION - LOOKING EAST @ C-4A
1/4" = 1'-0"
0 2' 4' 8'
SCALE IN FEET

KEYED NOTES:

1 3" RUPTURE DISK (TYP OF 2 PER CHILLER). CONTRACTOR SHALL FIELD ROUTE PIPE THROUGH FLOOR ABOVE TO ATMOSPHERE. SEE STRUCTURAL DRAWINGS FOR FLOOR PENETRATION DETAILS.

NOTES:

1. FLANGES FOR CHILLER PIPING CONNECTIONS AND ISOLATION VALVES ARE NOT SHOWN ON THIS DRAWING.
2. CHILLER ISOLATION VALVES SHALL BE FLANGED AND SHALL BE LOCATED AT A HEIGHT THAT WILL ALLOW FULL ACCESS TO THE CHILLER CONDENSER AND EVAPORATOR TUBES.

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

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CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

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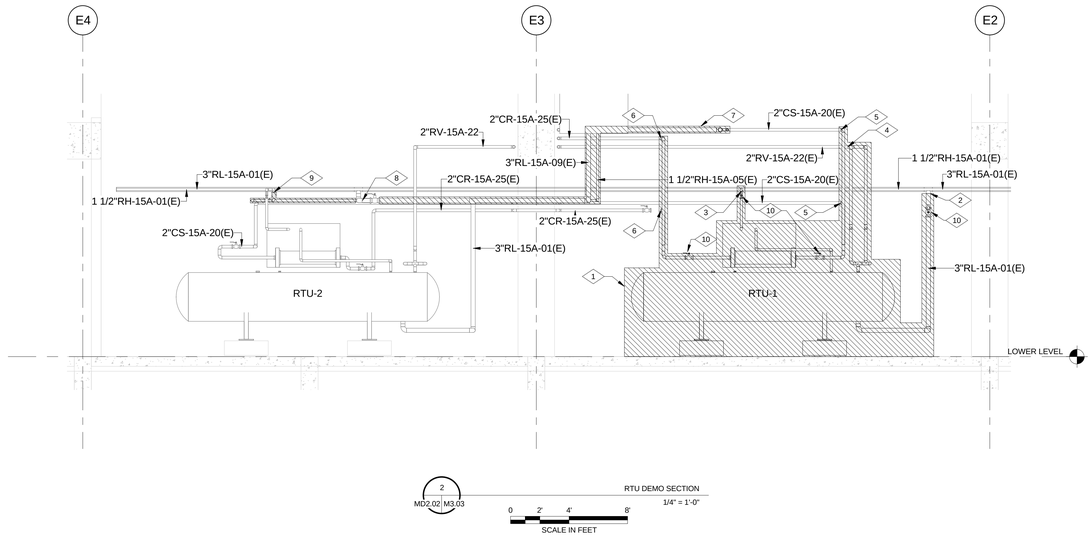
CHECKED BY: D. WHITNEY
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01

SHEET TITLE
MECHANICAL SECTIONS

SHEET NO.
M3.02

CADD FILE NO.



2 RTU DEMO SECTION
MD2.02 M3.03 1/4" = 1'-0"

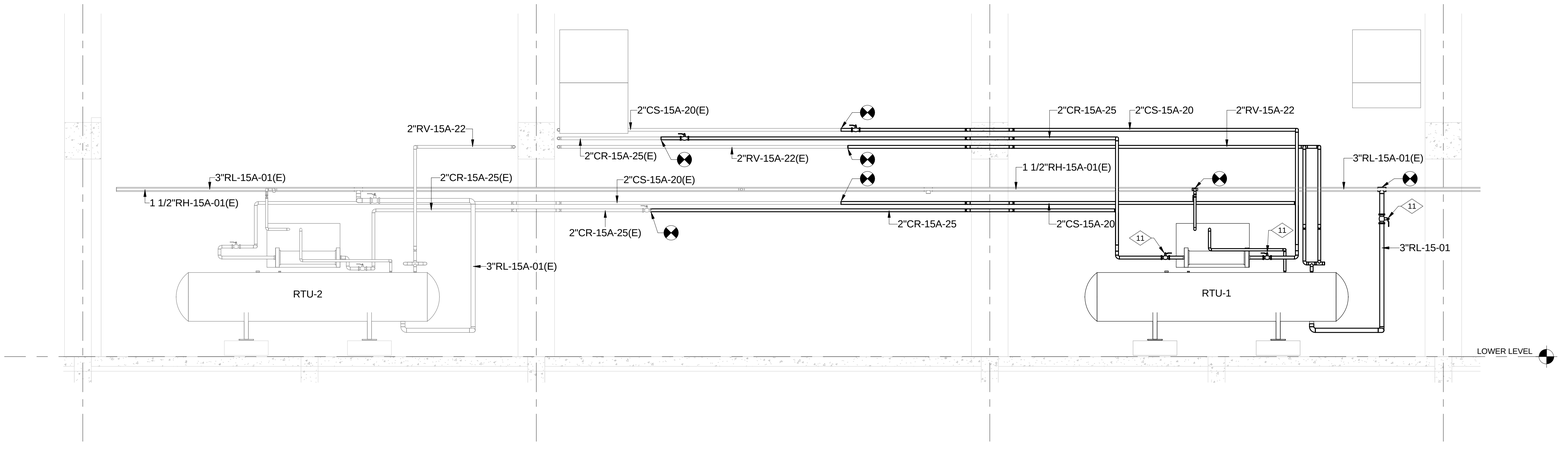
0 2' 4' 8'
SCALE IN FEET

KEYED NOTES:

1. CONTRACTOR SHALL RELOCATE RTU-1 AND ASSOCIATED PIPING TO POSITION SHOWN ON DWG M1.01. EXISTING PIPING WILL BE DISCONNECTED FROM MAINS AND RELOCATED WITH RTU-1 AS SHOWN BY BOUNDARIES OF DEMOLITION.
2. DISCONNECT 3" REFRIGERANT TRANSFER LINE FROM 3"RL-15A-01 MAIN AT TEE. CAP TEE BRANCH.
3. DISCONNECT 1 1/2" GAS EQUALIZATION LINE FROM 1 1/2"RH-15A-01 MAIN AT TEE. CAP TEE BRANCH.
4. DISCONNECT 2" RV-15A-22 AT ELBOW. EXTEND PIPING TO NEW LOCATION SHOWN IN DWG M2.02.
5. DISCONNECT 2"CS-15A-20 AT ELBOW. EXTEND PIPING TO NEW LOCATION SHOWN IN DWG M2.02.
6. DISCONNECT 2"CR-15A-25 AT ELBOW. EXTEND PIPING TO NEW LOCATION SHOWN IN DWG M2.02.
7. CONTRACTOR SHALL DEMOLISH PIPING SERVING C-4. DEMOLISH BRANCH PIPING FROM C-4 TO MAINS.
8. DEMOLISH 3"RL-15A-09 FROM C-4 TO TIE IN TO 3"RL-15A-01. CAP TEE BRANCH.
9. DEMOLISH 1 1/2"RH-15A-05 FROM C-4 TO TIE IN TO 1 1/2"RH-15A-01. CAP TEE BRANCH.
10. CLOSE SHUTOFF VALVE TO RTU-1.
11. NEW BALL VALVE.

NOTES:

1. DURING THE RELOCATION OF RTU-1, RTU-2 MUST REMAIN IN SERVICE.
2. CONTRACTOR SHALL CLOSE SHUTOFF VALVES TO AND FROM RTU-1. CONTRACTOR SHALL DISCONNET RTU-1 FROM SYSTEM AT SHUTOFF VALVES AND RELOCATE TO LOCATION SHOW ON DWG M2.02.
3. AFTER RTU-1 IS RELOCATED AND NEW PIPES ARE INSTALLED, CONTRACTOR SHALL TEMPORARILY SHUT DOWN THE REFRIGERANT COLLECTION SYSTEM TO MAKE FINAL CONNECTIONS. CONTRACTOR SHALL KEEP THE SHUT DOWN TIME OF THE REFRIGERANT COLLECTION SYSTEM TO A MINIMUM.
4. TEMPORARY SHUTDOWN OF REFRIGERANT COLLECTION SYSTEM MUST BE COORDINATED WITH AND APPROVED BY CENTRAL UTILITY PLANT OPERATORS AND DIA PROJECT MANAGER.



1 RTU NEW SECTION
M2.02 M3.03 1/4" = 1'-0"

0 2' 4' 8'
SCALE IN FEET

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

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9785 MARON CIRCLE, SUITE 400
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CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

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00	AM	IFC	2.13.13	DMW

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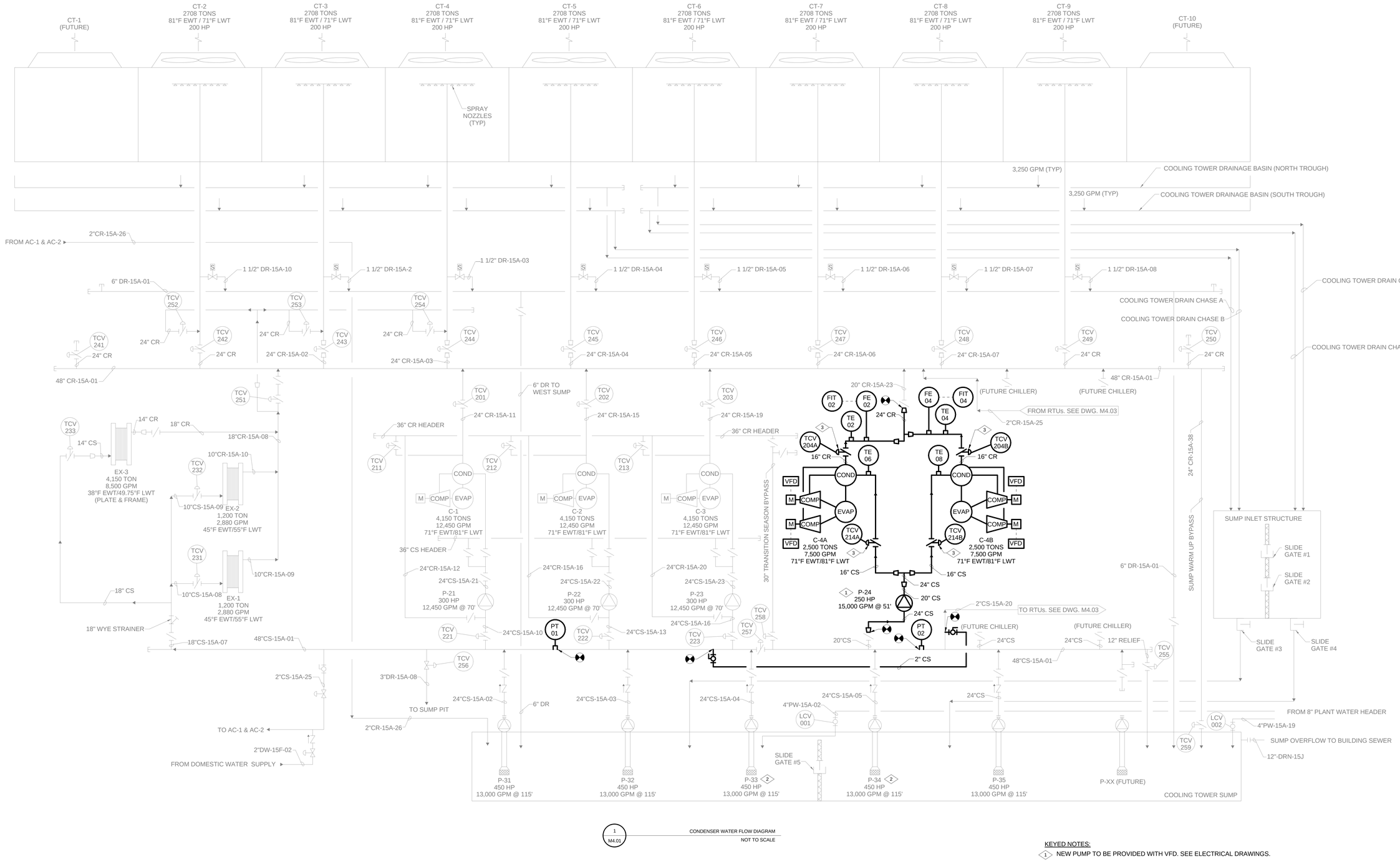
DATE: 10/23/12
DRAWN BY: A. MAHOBIAN
CHECKED BY: D. WHITNEY
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01

SHEET TITLE
RTU RELOCATION SECTIONS

SHEET NO.
M3.03

CADD FILE NO.



1 / M4.01 — CONDENSER WATER FLOW DIAGRAM
NOT TO SCALE

KEYED NOTES:

1. NEW PUMP TO BE PROVIDED WITH VFD. SEE ELECTRICAL DRAWINGS.
2. EXISTING PUMP TO BE PROVIDED WITH VFD. SEE ELECTRICAL DRAWINGS.
3. NEW CONTROL VALVE SHALL BE OPEN/CLOSE ONLY. SEE VALVE SCHEDULE ON M7.01 FOR DETAILS.

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

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9785 MAROON CIRCLE, SUITE 400
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CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

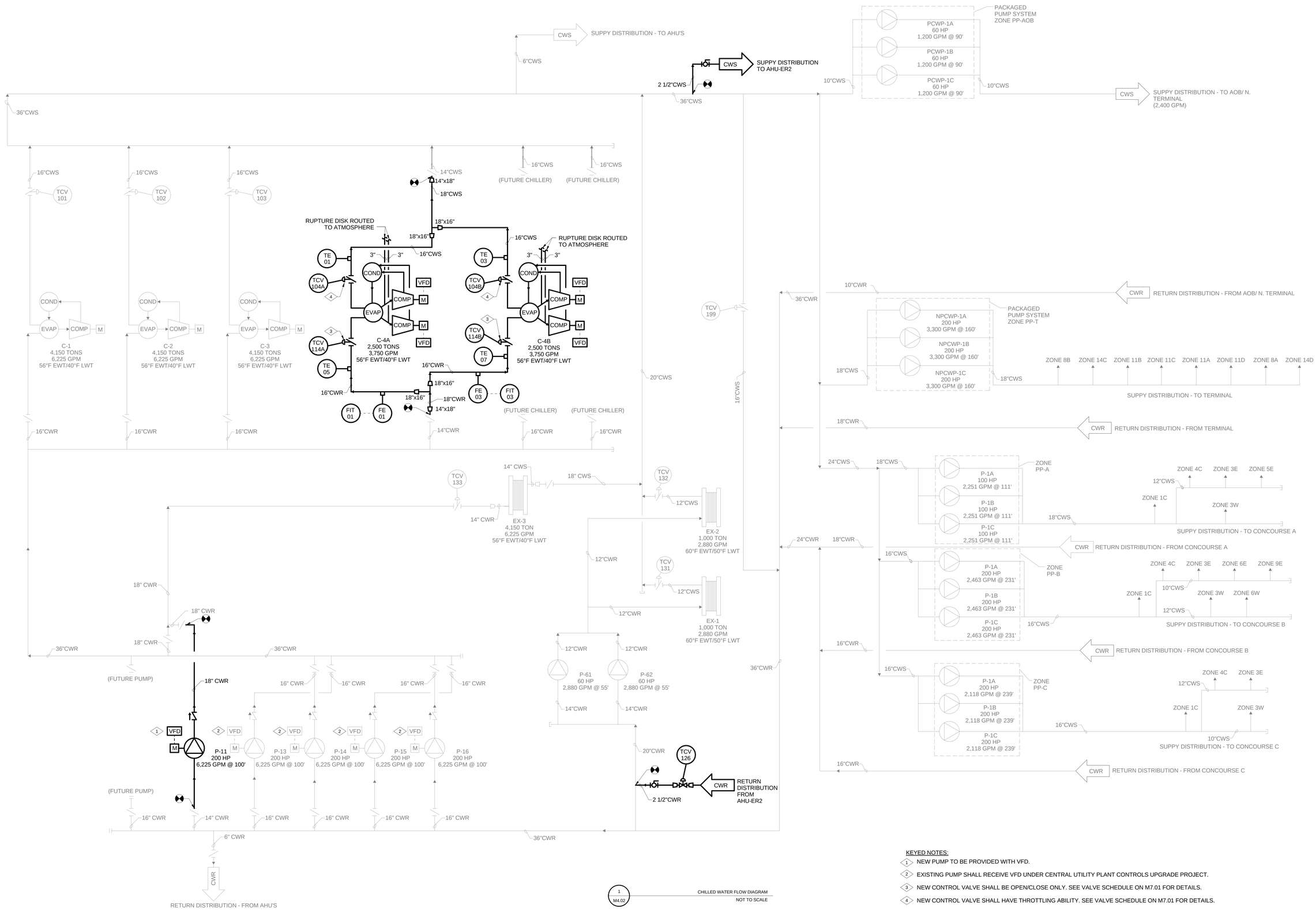
NO.	BY	PURPOSE	DATE	CKD
00	AM	#C	7/31/13	DWG

SCALE: NONE
DATE: 10/23/12
DRAWN BY: A. MAHOBIAN
CHECKED BY: D. WHITNEY
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01

SHEET TITLE
CONDENSER WATER FLOW DIAGRAM

SHEET NO.
M4.01

CADD FILE NO.



1 M4.02 CHILLED WATER FLOW DIAGRAM
NOT TO SCALE

KEYED NOTES:

1. NEW PUMP TO BE PROVIDED WITH VFD.
2. EXISTING PUMP SHALL RECEIVE VFD UNDER CENTRAL UTILITY PLANT CONTROLS UPGRADE PROJECT.
3. NEW CONTROL VALVE SHALL BE OPEN/CLOSE ONLY. SEE VALVE SCHEDULE ON M7.01 FOR DETAILS.
4. NEW CONTROL VALVE SHALL HAVE THROTTLING ABILITY. SEE VALVE SCHEDULE ON M7.01 FOR DETAILS.

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
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BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	AM	IFC	2.13.13	DMW

SCALE: NONE

DATE: 10/23/12

DRAWN BY: A. MAHOBIAN

CHECKED BY: D. WHITNEY

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 20131004 6-00

VOLUME NO. 01

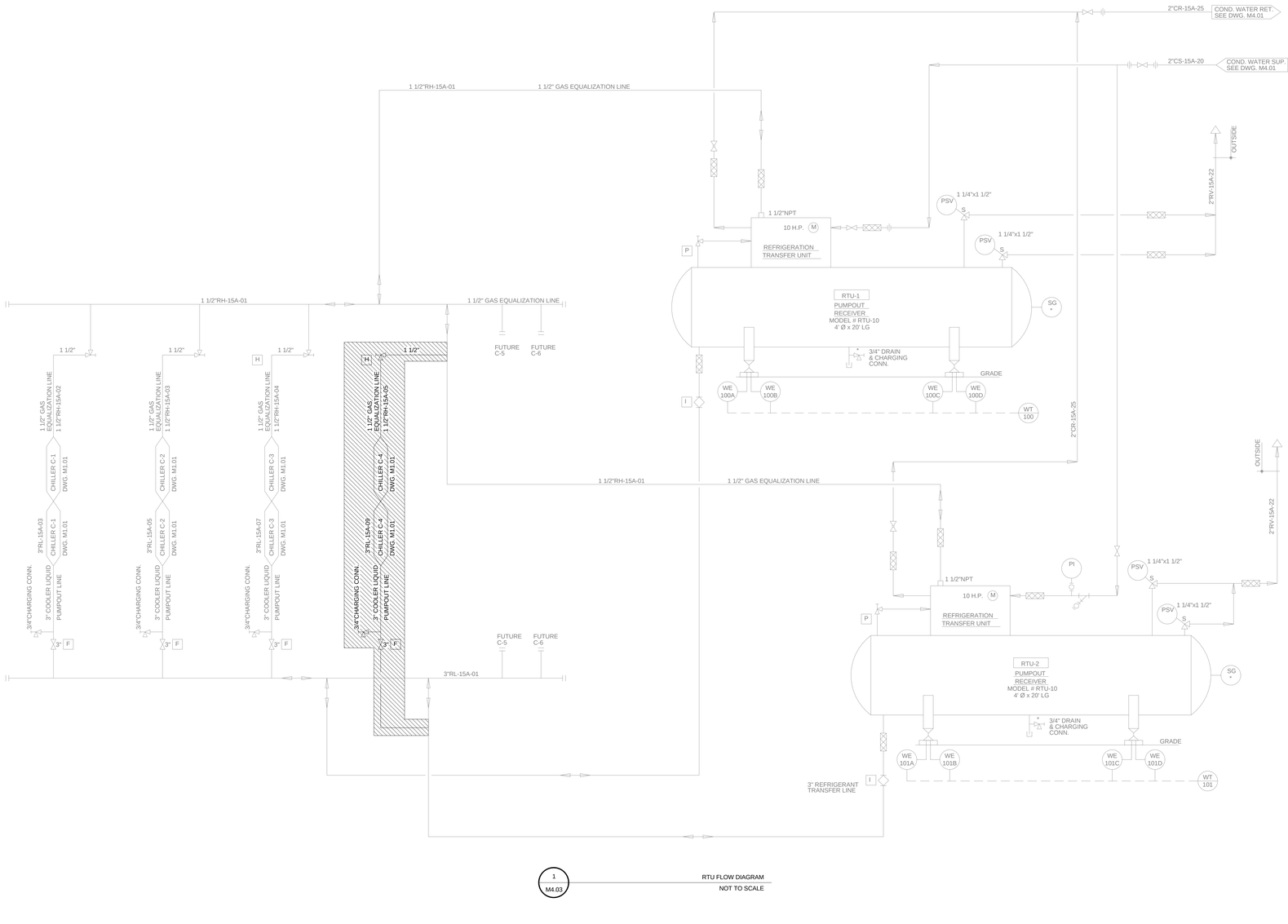
SHEET TITLE

CHILLED WATER FLOW DIAGRAM

SHEET NO.

M4.02

CADD FILE NO.



1
M4.03

RTU FLOW DIAGRAM
NOT TO SCALE

NOTES:

1. THE INTENT OF THIS FLOW DIAGRAM IS TO SHOW THE EXISTING ARRANGEMENT OF THE REFRIGERANT COLLECTION SYSTEM. DUE TO TUBE PULL CLEARANCES FOR THE NEW CHILLERS, RTU-1 MUST BE RELOCATED TO CHILLER BAY #3, HOWEVER, THE SYSTEM ARRANGEMENT IS TO REMAIN AS-IS.
2. DURING THE RELOCATION OF RTU-1, RTU-2 MUST REMAIN IN SERVICE.
3. CONTRACTOR SHALL CLOSE SHUTOFF VALVES TO AND FROM RTU-1. CONTRACTOR SHALL DISCONNET RTU-1 FROM SYSTEM AT SHUTOFF VALVES AND RELOCATE TO LOCATION SHOW ON DWG M2.02.
4. AFTER RTU-1 IS RELOCATED AND NEW PIPES ARE INSTALLED, CONTRACTOR SHALL TEMPORARILY SHUT DOWN THE REFRIGERANT COLLECTION SYSTEM TO MAKE FINAL CONNECTIONS. CONTRACTOR SHALL KEEP THE SHUT DOWN TIME OF THE REFRIGERANT COLLECTION SYSTEM TO A MINIMUM.
5. TEMPORARY SHUTDOWN OF REFRIGERANT COLLECTION SYSTEM MUST BE COORDINATED WITH AND APPROVED BY CENTRAL UTILITY PLANT OPERATORS AND DIA PROJECT MANAGER.
6. PRESSURE SETPOINTS OF ALL PSV'S SHALL BE SET BY CENTRAL UTILITY PLANT OPERATORS TO MATCH CURRENT OPERATIONS.

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BMCD PROJECT NUMBER: 67715

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Burns & McDonnell
SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	AM	IFC	23JL13	DMW

SCALE: NONE

DATE: 10/23/12

DRAWN BY: A. MAHOBIAN

CHECKED BY: D. WHITNEY

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

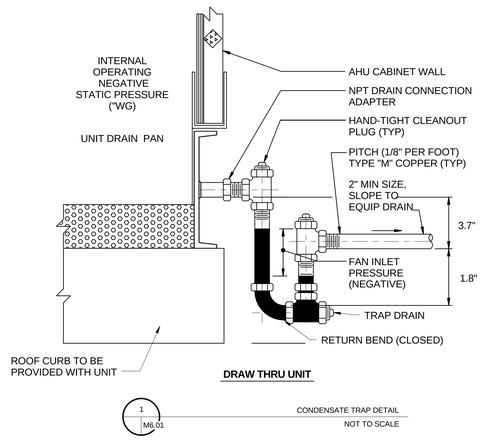
CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

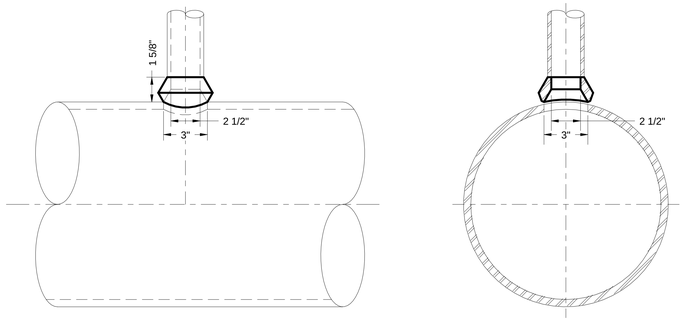
SHEET TITLE
RTU FLOW DIAGRAM

SHEET NO.
M4.03

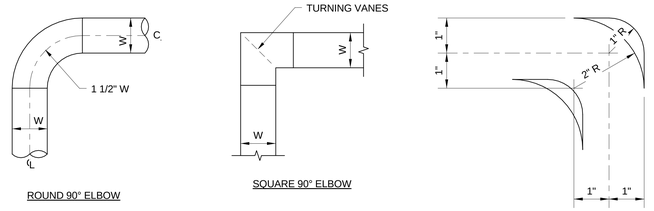
CADD FILE NO.



1 M6.01 CONDENSATE TRAP DETAIL NOT TO SCALE



5 M6.01 2 1/2" WELDOLET DETAIL (TYP FOR PIPE SIZES 20" TO 36") NOT TO SCALE

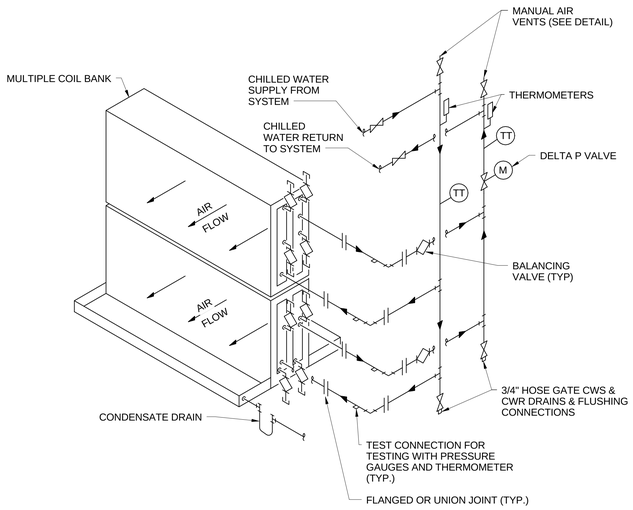


ROUND 90° ELBOW

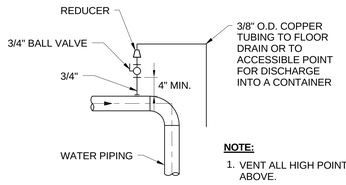
SQUARE 90° ELBOW

TURNING VANES DETAIL

NOTE:
USE THIS DESIGN WHERE SQUARE 90° ELBOWS ARE SHOWN ON DRAWINGS OR IF SPACE DOES NOT PERMIT ROUND 90° ELBOWS.

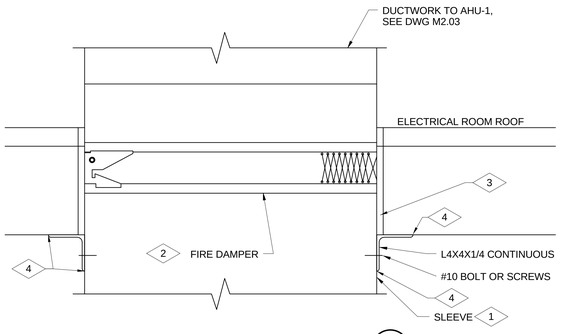


2 M6.01 CHILLED WATER COOLING COIL PIPING DETAIL NOT TO SCALE



NOTE:
1. VENT ALL HIGH POINTS AS INDICATED ABOVE.

6 M6.01 MANUAL AIR VENT DETAIL NOT TO SCALE



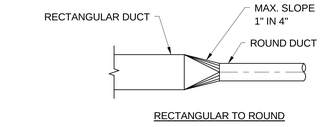
KEYED NOTES:

1. SLEEVE THICKNESS MUST BE EQUAL TO OR THICKER THAN THE DUCT CONNECTED TO IT.
2. FIRE DAMPER, SLEEVE AND ACCESS DOOR SHALL BE PROVIDED AS A COMPLETE UNIT. FIRE DAMPER SHALL BE A RUSKIN MODEL DIBD2 STYLE A OR APPROVED EQUAL WITH A 30" SLEEVE AND 12"x12" ACCESS DOOR, RUSKIN MODEL ADC24 OR APPROVED EQUAL, MOUNTED IN DUCT ELBOW DOWNSTREAM OF DAMPER.
3. PROVIDE 2HR FIRE PROOFING, REFER TO SPECIFICATIONS AND MANUFACTURER'S RECOMMENDATIONS.
4. HILTI FS-ONE FIRE CAULK ANGLE.

NOTES:

1. FOR ROOF PENETRATION DETAILS AND LOCATIONS SEE DRAWINGS S2.01 AND S5.01.

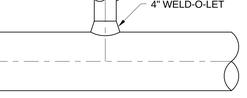
10 M6.01 FIRE DAMPER DETAIL NOT TO SCALE



RECTANGULAR TRANSITION

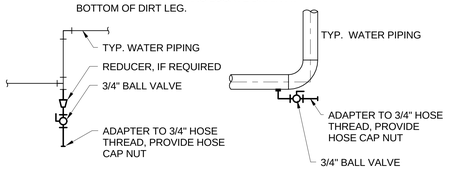
RECTANGULAR TO ROUND TRANSITION

9 M6.01 LOW VELOCITY DUCT LAYOUT NOT TO SCALE



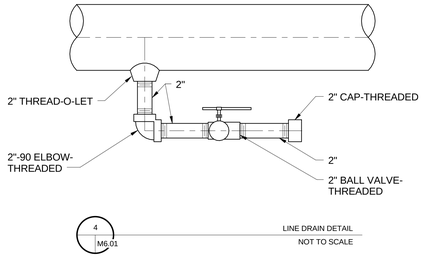
7 M6.01 LINE VENT DETAIL NOT TO SCALE

NOTES:
1. DRAIN ALL LOW POINTS AS INDICATED BELOW.
2. WHERE DIR LEGS ARE SHOWN ON PIPE RISER DIAGRAMS AND/OR PLANS LOCATE DRAIN AT BOTTOM OF DIRT LEG.

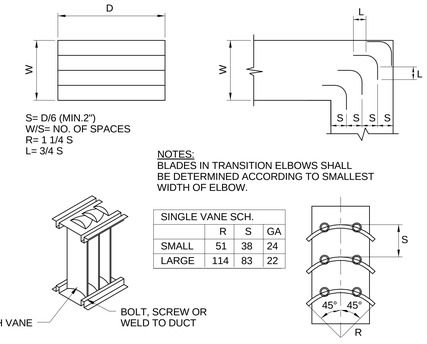


ELEVATION THREADED PIPING **ELEVATION WELDED PIPING**

3 M6.01 DRAIN VALVE CONNETION NOT TO SCALE



4 M6.01 LINE DRAIN DETAIL NOT TO SCALE



8 M6.01 RECTANGULAR AIR DUCT ELBOW TURNING VANES NOT TO SCALE

CITY & COUNTY of DENVER

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CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

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DESIGN CONTRACT NO. CE-03024-09
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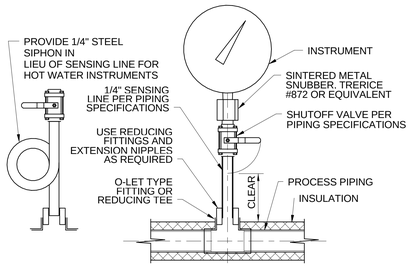
VOLUME NO. 01

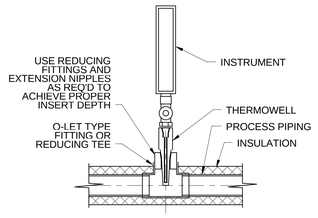
SHEET TITLE
MECHANICAL DETAILS

SHEET NO.
M6.01

CADD FILE NO.

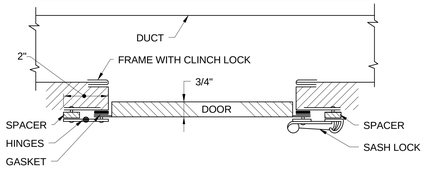


1 / M6.02 — LOCALLY MOUNTED PRESSURE INSTRUMENT DETAIL — NOT TO SCALE

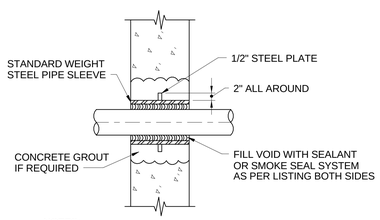


2 / M6.02 — LOCALLY MOUNTED TEMPERATURE INSTRUMENT — NOT TO SCALE

MAX DOOR SIZE	NO. OF HINGES	NO. OF HANDLES	SHEET METAL GAGE THICKNESS		
			DOOR	BACK	FRAME
12"x12"	2	1	26	26	24
16"x16"	2	2	24	26	22
24"x24"	3	2	22	26	22



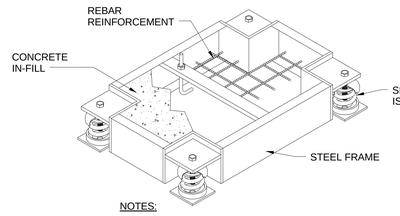
3 / M6.02 — ACCESS DOOR IN DUCT DETAIL — NOT TO SCALE

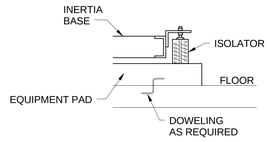


NOTES:

1. WHERE USED THROUGH FLOORS, EXTEND 3" ABOVE FLOOR. PROVIDE A COVER PLATE (TACK WELDED) ON TOP OF UNUSED SLEEVES.
2. FIRE/SMOKE SEAL AS REQUIRED. INSTALL PER MANUFACTURERS INSTRUCTIONS.

4 / M6.02 — PIPE PENETRATION DETAIL — NOT TO SCALE

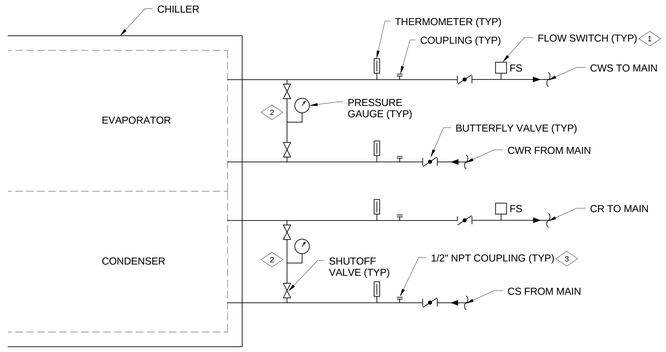




NOTES:

1. REFER TO SPEC. SECTION 15245 - VIBRATION ISOLATION FOR INERTIA BASE REQUIREMENTS.

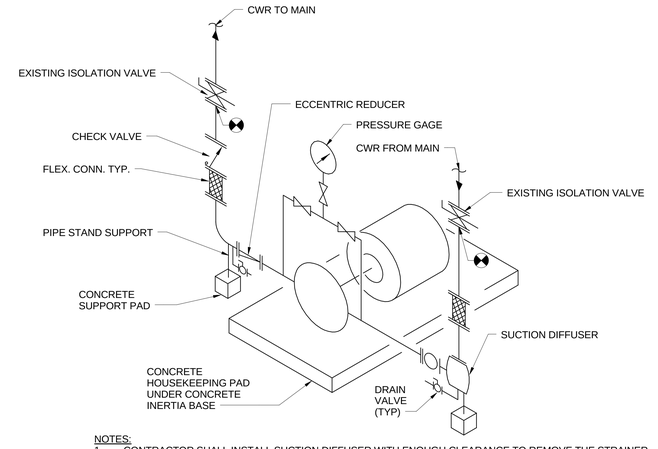
5 / M6.02 — INERTIA BASE DETAIL — NOT TO SCALE



KEYED NOTES:

1. FLOW SWITCH SHOULD BE INSTALLED IN LEAVING LEG OF THE CHILLED AND CONDENSER WATER CIRCUITS.
2. PIPE ONE GAUGE BETWEEN ENTERING AND LEAVING PIPES. A SHUTOFF VALVE ON EACH SIDE OF THE GAUGE ALLOWS THE OPERATOR TO READ EITHER ENTERING OR LEAVING WATER PRESSURE.
3. COUPLING IS TO ALLOW FIELD-SUPPLIED TEMPERATURE CONTROL DEVICE IF REQUIRED BY MANUFACTURER.

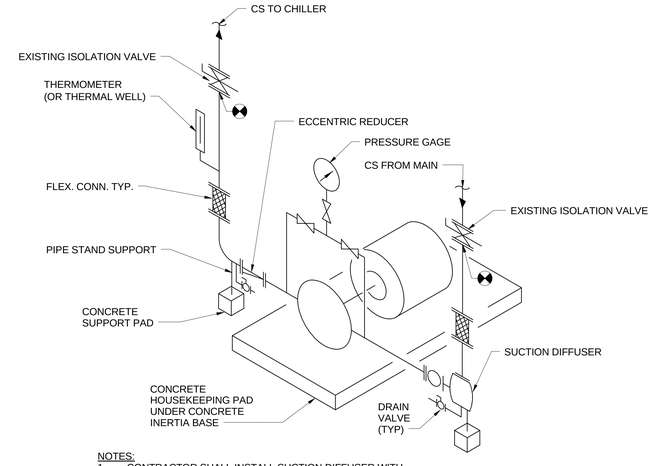
6 / M6.02 — CHILLER PIPING DETAIL — NOT TO SCALE



NOTES:

1. CONTRACTOR SHALL INSTALL SUCTION DIFFUSER WITH ENOUGH CLEARANCE TO REMOVE THE STRAINER.

7 / M6.02 — CHILLED WATER PUMP PIPING DETAIL - HSC — NOT TO SCALE



NOTES:

1. CONTRACTOR SHALL INSTALL SUCTION DIFFUSER WITH ENOUGH CLEARANCE TO REMOVE THE STRAINER.

8 / M6.02 — CONDENSER WATER PUMP PIPING DETAIL - HSC — NOT TO SCALE

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	AM	IFC	23JUL13	DMW

SCALE: NONE

DATE: 10/23/12

DRAWN BY: A. MAHOBIAN

CHECKED BY: D. WHITNEY

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE: MECHANICAL DETAILS

SHEET NO. M6.02

CADD FILE NO.

AIR HANDLING UNIT SCHEDULE

GENERAL			FAN					ELECTRICAL		COOLING COIL DATA										
TAG NO.	PLAN LOCATION	SMOKE CONTROL (Y/N)	UNIT ALTITUDE (FT)	CFM @ ALT. CONDITIONS	OUTSIDE AIR CFM @ ALT. CONDITIONS	EXT. STATIC PRESS (IN. WG.)	TOTAL STATIC PRESS (IN. WG.)	APPROX. MOTOR HP	ELECT. DATA	COIL TYPE	CFM @ ALT. CONDITIONS	GRAND TOTAL HEAT (MBH)	TOTAL SENSIBLE HEAT (MBH)	ENTERING AIR TEMP - DB (DEG F)	ENTERING AIR TEMP - WB (DEG F)	LEAVING AIR TEMP. - DB (DEG F)	LEAVING AIR TEMP. - WB (DEG F)	ENTERING WATER TEMP. (DEG F)	DESIGN CHILLED WATER FLOW (GPM)	DESIGN WATER TEMP. RISE (DEG F)	APPROX. WEIGHT (LBS)
AHU-ER2	M2.03	N	5,500	11,000	0	1.00	2.70	10	480/3/60	HYDRONIC	11,000	440.2	440.2	95.0	63.0	45.8	45.3	40.0	55.0	16	3,500

WATER CHILLER SCHEDULE

						EVAPORATOR				CONDENSER				ELECTRICAL				
TAG NO.	MANUFACTURER	MODEL NO.	TYPE	LOCATION	NOMINAL CAPACITY (TONS)	FLOW RATE (GPM)	EWT (°F)	LWT (°F)	PRESS DROP (PSI)	FLOW RATE (GPM)	EWT (°F)	LWT (°F)	PRESS DROP (PSI)	Hz	VOLTAGE	PHASE (Ø)	REFRIGERANT	OPER. WEIGHT (KIP)
C-4A	TRANE	CDHF2550	DUAL-COMPRESSOR, VFD	CHILLER ROOM - BAY 4	2,500	3,733	56	40	2.62	7,500	71	80	4.78	60	4,160	3	R-123	77.41
C-4B	TRANE	CDHF2550	DUAL-COMPRESSOR, VFD	CHILLER ROOM - BAY 4	2,500	3,733	56	40	2.62	7,500	71	80	4.78	60	4,160	3	R-123	77.41

NOTES

1. CHILLERS SHALL BE EQUIPED WITH BACNET IP COMMUNICATION CARDS AND CAPABLE OF INTERFACING WITH THE JCI SYSTEM.
2. CHILLERS SHALL BE PROVIDED WITH FLANGED PIPING CONNECTIONS.

PUMP SCHEDULE

TAG NO.	LOCATION	SERVICE	TYPE	FLUID	FLOW RATE (GPM)	HEAD (FT H2O)	OPERATING TEMP (°F)	MOTOR HP	Hz	VOLTAGE	PHASE (Ø)	NOTES
P-11	PUMP ROOM	CHILLED WATER	HORIZ. SPLIT CASE	WATER	6,225	100	40	200	60	480	3	1, 2, 3, 4
P-24	CHILLER ROOM	CONDENSER WATER	HORIZ. SPLIT CASE	WATER	15,000	51	71	250	60	4,160	3	1, 2, 3, 4, 5

NOTES

1. PUMP SHALL BE PROVIDED WITH PREMIUM EFFICIENCY, INVERTER-RATED MOTOR
2. PUMP SHALL BE PROVIDED WITH VARIABLE FREQUENCY DRIVE & BACNET COMMUNICATION CARD
3. PUMP SHALL BE PROVIDED WITH SUCTION DIFFUSER
4. PUMP ROTATION SHALL BE CCW (AS VIEWED FROM THE DRIVER END)
5. PUMP FLOW RATE AND HEAT ARE AT MAXIMUM OPERATING CONDITIONS. MOST OF THE TIME, THIS PUMP WILL BE OPERATING AT PART-LOAD (BETWEEN 5,000 - 10,000 GPM). THEREFORE THE PUMP SELECTED SHOULD HAVE ITS BEST EFFICIENCY POINT (BEP) SELECTED AT NON-MAXIMUM CONDITIONS. FINAL PUMP SELECTION MUST BE APPROVED BY ENGINEER.

CONTROL VALVE SCHEDULE

TAG NO.	FLUID TYPE	SERVICE	VALVE TYPE	ACTUATOR TYPE	FLOW RATE (GPM)	VALVE SIZE (IN.)	PIPE SIZE (IN.)	REFERENCE DWG	NOTES
TCV-114A	CHW	CHILLER C-4A ENTERING CHILLED WATER CV	BUTTERFLY	2-POSITION ELECTRIC	3,750	16	16	M4.02	1
TCV-114B	CHW	CHILLER C-4B ENTERING CHILLED WATER CV	BUTTERFLY	2-POSITION ELECTRIC	3,750	16	16	M4.02	1
TCV-104A	CHW	CHILLER C-4A LEAVING CHILLED WATER CV	BUTTERFLY	FULLY PROPORTIONING ELECTRIC	3,750	16	16	M4.02	1
TCV-104B	CHW	CHILLER C-4B LEAVING CHILLED WATER CV	BUTTERFLY	FULLY PROPORTIONING ELECTRIC	3,750	16	16	M4.02	1
TCV-204B	CW	CHILLER C-4A ENTERING CONDENSER WATER CV	BUTTERFLY	2-POSITION ELECTRIC	7,500	16	16	M4.01	1
TCV-204A	CW	CHILLER C-4B ENTERING CONDENSER WATER CV	BUTTERFLY	2-POSITION ELECTRIC	7,500	16	16	M4.01	1
TCV-214A	CW	CHILLER C-4A LEAVING CONDENSER WATER CV	BUTTERFLY	2-POSITION ELECTRIC	7,500	16	16	M4.01	1
TCV-214B	CW	CHILLER C-4B LEAVING CONDENSER WATER CV	BUTTERFLY	2-POSITION ELECTRIC	7,500	16	16	M4.01	1
TCV-126	CHW	AHU-ER2 CHILLED WATER CV	PRESSURE INDEPENDENT	FULLY PROPORTIONING ELECTRIC	55.0	2	2 1/2	M2.03	1, 2

NOTES

1. THE MAJOR CONTROL VALVES LISTED ABOVE ARE INTENDED FOR COORDINATION WITH JOHNSON CONTROLS, INC (JCI) INTERFACE. FOR AHU COIL AND EQUIPMENT FLOW CONTROL VALVES, FLOW METERING DEVICES AND OTHER ITEMS THAT ARE NOT LISTED ABOVE, REFER TO SYSTEM FLOW DIAGRAMS AND ASSOCIATED SYSTEM EQUIPMENT SPECIFICATION SECTIONS.
2. RECOMMENDED ACTUATOR IS JCI M9220-GGA-3.

DIFFUSER, REGISTER AND GRILLE SCHEDULE

TAG NO.	FACE TYPE	MOUNTING	PATTERN	DAMPER	ACCESSORIES	MATERIAL	FINISH	MAX NC	BASIS OF DESIGN MFR	BASIS OF DESIGN MODEL
RG-1	PR	S	FX	NA	NA	AL	A-E	45	TITUS	50F
SG-1	H-45	S	ADJ	O-B	NA	ST	A-E	45	TITUS	300FL

FACE TYPE:
RD - ROUND
H-R - HALF ROUND
RCT - RECTANGULAR
PR - PERFORATED
LR - LINEAR
H-S - HORIZ. STRAIGHT
V-S - VERT. STRAIGHT
H-22 - HORIZ. 22° FIXED
H-45 - HORIZ. 45° FIXED

ACCESSORIES:
E-D - EQUALIZING DEFLECTORS
S-R - SMUDGE RING
P-R - PLASTER RING
EXTR - EXTRACTOR
B-O-B - BLANK OFF BAFFLES
OP-KY- OPERATING KEYS

PATTERN:
FX - FIXED
2-P - 2 POSITION
ADJ - ADJUSTABLE
1-W - 1 WAY
2-W - 2 WAY
3-W - 3 WAY
4-W - 4 WAY
IND - INDUCTION
S-D - SINGLE DEFLECTION
D-D - DOUBLE DEFLECTION

PATTERN:
A-E - ALUMINUM ENAMEL
W-E - WHITE ENAMEL
A-A - ALUMINUM ANODIZED

MOUNTING:
S-M - SURFACE MOUNTED
FL - FLUSH
L-I - LAY IN
S-W - SIDE WALL
D - DUCT

MATERIALS:
ST - STEEL
AL - ALUMINUM

DAMPERS:
O-B - OPPOSED BLADE
BTFY - BUTTERFLY
ITGL - INTEGRAL

NOTES:
1. MANUFACTURER AND MODEL INDICATED ARE USED AS THE BASIS OF DESIGN. CONTRACTOR MAY PROVIDE EQUIVALENT PRODUCTS FROM THE FOLLOWING MANUFACTURERS: ANEMOSTAT, HART & COOLEY INC, KRUEGER, PRICE OR TUTTLE & BAILEY

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
			2/13,11	DWM

SCALE: NONE
DATE: 10/23/12
DRAWN BY: A. MAHOBIAN
CHECKED BY: D. WHITNEY
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01

SHEET TITLE
MECHANICAL SCHEDULES

SHEET NO.
M7.01

CADD FILE NO.

POWER SYMBOLS

- PUSH BUTTON
- JUNCTION BOX
- CONDUIT/WIRING DOWN
- CONDUIT/WIRING UP
- WIRE/CONDUIT CONTINUATION
- MOTOR
- SURFACE MOUNTED POWER PANELBOARD
- KEYED NOTE SYMBOL
- DUPLEX RECEPTACLE, NEMA 5-20R 18" AFF UON
- DISCONNECT SWITCH, SURFACE MOUNTED
- COMBINATION MOTOR STARTER
- PUSHBUTTON
- CONDUIT AND WIRING RUN EXPOSED, ARROWHEAD DENOTES HOMERUN. ALL POWER CONDUITS SHALL HAVE A GREEN EQUIPMENT GROUNDING CONDUCTOR.
- TRANSFORMER

GROUNDING SYMBOLS

- GROUND
- LIGHTNING ARRESTOR

LIGHTING SYMBOLS

- SINGLE FACE EXIT LIGHT WITHOUT DIRECTIONAL ARROW
- SURFACE OR PENDANT MOUNTED FLUORESCENT LIGHT FIXTURE - 1' X 4'
- EMERGENCY FLUORESCENT LIGHT FIXTURE - 1' X 4'
- THREE WAY SWITCH

ONE LINE/RISER SYMBOLS

- POWER TRANSFORMER
- POTENTIAL TRANSFORMER
- CURRENT TRANSFORMER
- CURRENT TRANSFORMER - ZERO SEQUENCE
- 120V CONTROL TRANSFORMER
- GROUNDING CONNECTION
- GROUNDING WYE WINDING CONNECTION
- DELTA WINDING CONNECTION
- RELAY CONTACTS - OPEN
- RELAY CONTACTS - CLOSED
- SEPARABLE CONNECTOR
- CONDUCTOR CONNECTION
- CIRCUIT BREAKER
- NON-FUSED DISCONNECT SWITCH
- FUSE
- VACUUM CONTACTOR
- CAPACITOR
- MOTOR THERMAL OVERLOAD PROTECTOR
- PROGRAMMABLE MOTOR PANEL
- MOTOR PROTECTION RELAY
- CONTACTOR COIL
- SOLID STATE REDUCED VOLTAGE MOTOR CONTROLLER
- START PUSHBUTTON
- STOP PUSHBUTTON
- HAND-AUTO PUSHBUTTON
- 2 SPEED PUSHBUTTON

COMMUNICATIONS SYMBOLS

- TELEPHONE OUTLET - SURFACE MOUNTED
- SOUND SYSTEM HORN

FIRE ALARM SYMBOLS

- FIRE ALARM SPEAKER W/ FLASHING LIGHT
- SMOKE DETECTOR, PHOTOELECTRIC
- REMOTE MOUNTED ANUNCIATOR LIGHT

INSTRUMENT AND CONTROL SYMBOLS

- INSTRUMENT OR CONTROL DEVICE
- DISCRETE INSTRUMENT, FIELD MOUNTED

EXPLANATION OF CIRCUIT DESIGNATIONS

L2A-12

- CIRCUIT NUMBER
- PANEL DESIGNATION
- PANEL LOCATION
  2 = LOWER LEVEL
  4 = GRADE LEVEL
- TYPE OF PANEL
  C - CRITICAL (UPS) POWER
  E - EMERGENCY POWER
  L - LIGHTING P - 480V POWER
  S - 208Y/120V POWER

NOTE:

DASHED SYMBOLS INDICATE FUTURE EQUIPMENT

INSTRUMENT IDENTIFICATION

LETTER	FIRST-LETTER		SUCCEEDING-LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	USER'S CHOICE			CONTROL	
D	USER'S CHOICE	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO			
G	USER'S CHOICE		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	USER'S CHOICE	MOMENTARY			MIDDLE INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

ELECTRICAL ABBREVIATIONS

A	AMPERE
AF	AMPERE FRAME
AFF	ABOVE FINISHED FLOOR
AIC	AMPERE INTERRUPTING CAPACITY (RMS SYMETRICAL)
APPROX	APPROXIMATELY
AS	AMPERE SWITCH
AT	AMPERE TRIP
ATS	AUTOMATIC TRANSFER SWITCH
BC	BARE COPPER
BKBD	BACKBOARD
BKR	BREAKER
BLDG	BUILDING
C	CONDUIT
CB	CIRCUIT BREAKER
CIRC	CIRCULAR
CKT	CIRCUIT
CL	CENTERLINE
CLG	CEILING
COMM	COMMUNICATIONS
CONT	CONTINUED
CT	CURRENT TRANSFORMER
CU	COPPER
DDC	DIRECT DIGITAL CONTROL
DIA	DIAMETER
DISC	DISCONNECT
DIST	DISTRIBUTION
DTC	DATA TERMINAL CABINET
DWG	DRAWING
E, EXIST	EXISTING
ELEC	ELECTRICAL
EQUIP	EQUIPMENT
FA	FIRE ALARM
FACP	FIRE ALARM CONTROL PANEL
FL, FLR	FLOOR
FLA	FULL LOAD AMPS
FLUOR	FLUORESCENT
FT	FEET
GFCI	GOVERNMENT FURNISHED, CONTRACTOR INSTALLED
GFI	GROUND FAULT INTERRUPTER
GND	GROUND
GRN	GREEN
HT	HEIGHT
HZ	HERTZ
IN	INCHES
J	JUMPER
J-BOX	JUNCTION BOX
kA	KILO AMPERE
kcmil	THOUSAND CIRCULAR MILS
kVA	KILOVOLT AMPERE
kW	KILOWATT
kWH	KILOWATT-HOUR
LTG	LIGHTING
MAX	MAXIMUM
MCA	MINIMUM CIRCUIT AMPACITY
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MDP	MAIN DISTRIBUTION PANELBOARD
MECH	MECHANICAL
MIN	MINIMUM
MLO	MAIN LUGS ONLY
MOCP	MAXIMUM OVERCURRENT PROTECTION
MTD	MOUNTED
MTG	MOUNTING
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN
NTS	NOT TO SCALE
OC	ON CENTER
PA	PUBLIC ADDRESS
PB	PULLBOX
PNL	PANEL
PT	POTENTIAL TRANSFORMER
PVC	POLYVINYL CHLORIDE
RECEPT	RECEPTACLE
REQD	REQUIRED
RGS	RIDIG GALVANIZED STEEL
RM	ROOM
RTD	RESISTANCE TEMPERATURE DETECTOR
SHD	SHIELDED
SHT	SHEET
SP	SPARE
SW	SWITCH
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SYM	SYMMETRICAL, SYMBOL
TB	TELEPHONE BACKBOARD
TBD	TO BE DETERMINED
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSION
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
V	VOLT, VOLTAGE
VFD	VARIABLE FREQUENCY DRIVE
W	WATT
W/	WITH
WP	WEATHERPROOF
XFMR	TRANSFORMER

GENERAL NOTES:

1. NEW ELECTRICAL EQUIPMENT, CONDUIT AND CONDUCTORS ARE INDICATED WITH A DARK LINE WEIGHT. EXISTING ELECTRICAL IS INDICATED WITH A LIGHT LINE WEIGHT.
2. FIRE ALARM CONTROL PANEL AND GRAPHIC ANNUNCIATOR LOCATED AT COLUMN LINES W1 AND N1 ON GRADE LEVEL, WEST ENTRANCE.

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2/28.13	GNP

SCALE: NONE

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

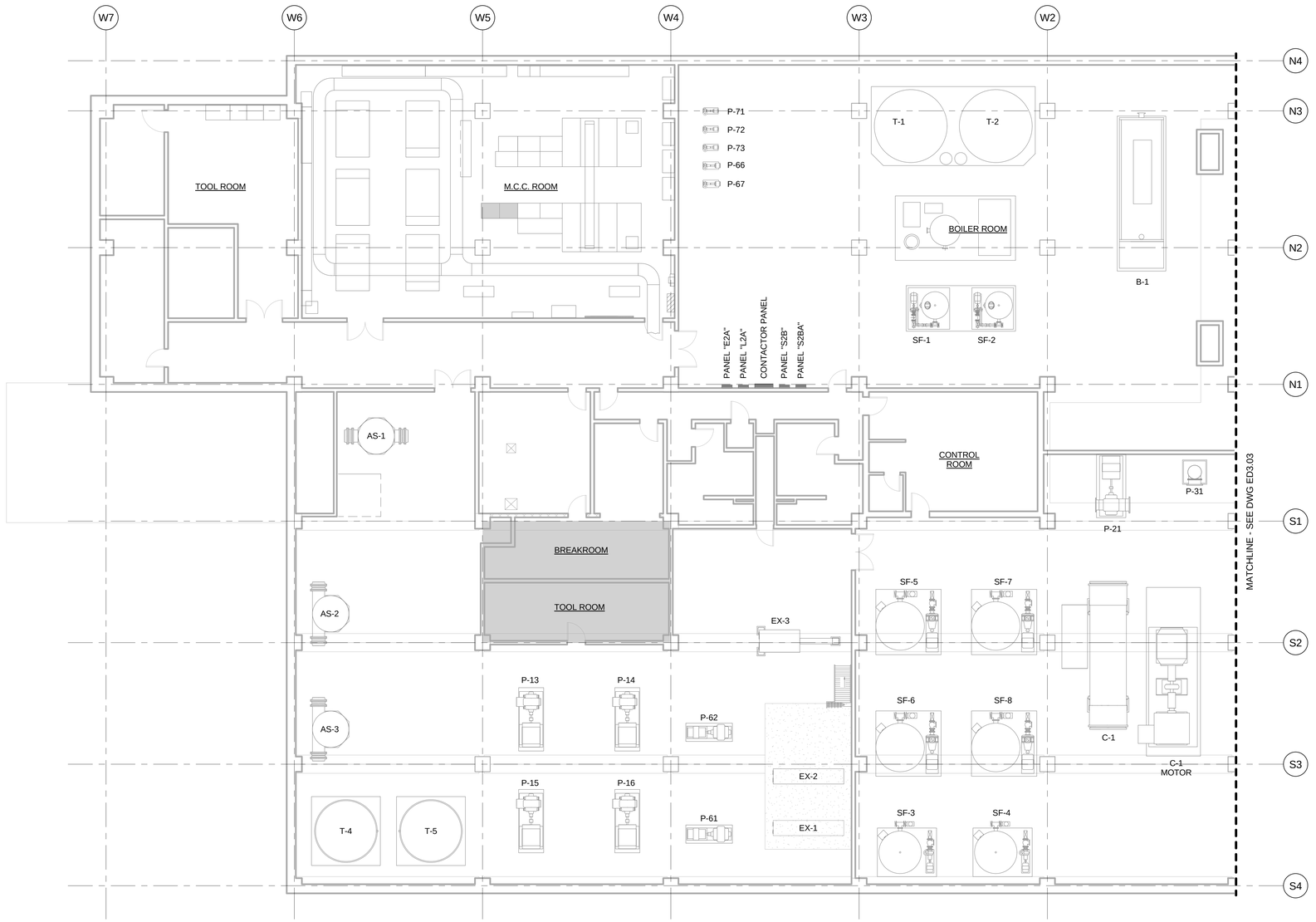
CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE: ELECTRICAL LEGEND

SHEET NO. E0.01

CADD FILE NO.



1 ED3.02 DEMO PLAN WEST LOWER LEVEL
1/8" = 1'-0"

0 4' 8' 16'
SCALE IN FEET

N

NOTES:

1. SHADED AREAS INDICATE GENERAL AREAS OF DEMOLITION.

KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MARION CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

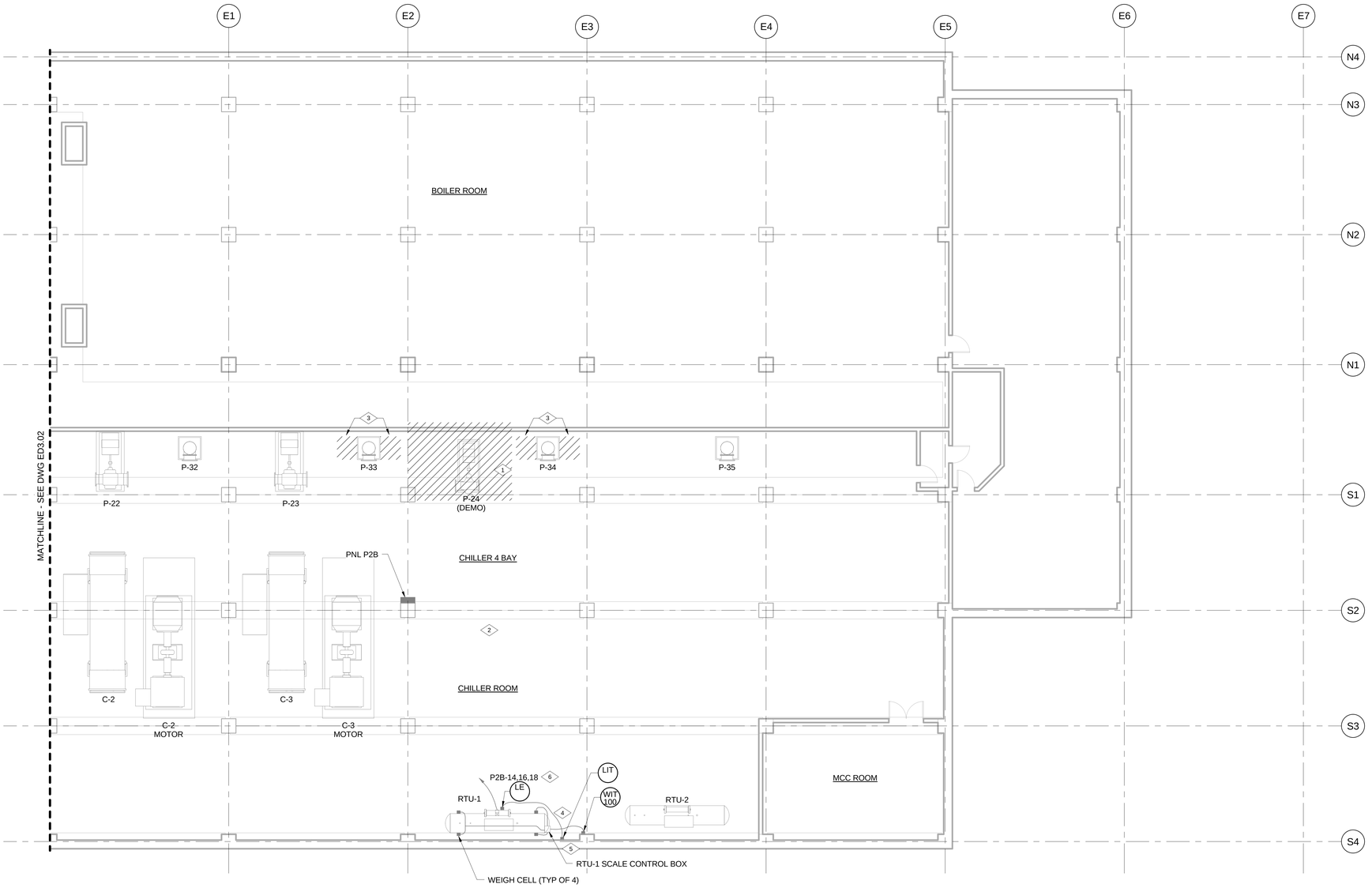
CENTRAL UTILITY PLANT CHILLER ADDITION

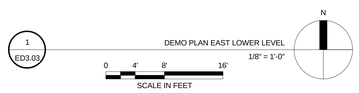
Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	23JUL13	DAP

SCALE: 1/8" = 1'-0"
DATE: 10/23/12
DRAWN BY: P. HEIMBURGER
CHECKED BY: R. KELEMEN
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01
SHEET TITLE: DEMO PLAN WEST LOWER LEVEL
SHEET NO. ED3.02
CADD FILE NO.



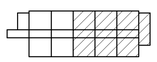


NOTES:

1. SEE SHEETS ED5.01 AND ED5.02 FOR DEMOLITION ONE-LINE DIAGRAMS.
2. SEE SHEET E3.03 FOR NEW WORK.

KEYED NOTES:

1. ELECTRICAL DEMOLITION FOR P-24 CONSISTS OF REMOVING MAIN 4160V FEEDER AND RTD CONDUCTORS AND CONDUIT BACK TO MCC. REMOVE EMERGENCY STOP/LOCKOUT PUSH BUTTON, CONDUIT AND CONDUCTORS BACK TO MCC.
2. ELECTRICAL DEMOLITION FOR CHILLER NO 4 CONSISTS OF REMOVING MAIN 4160V FEEDER AND RTD CONDUCTORS AND CONDUIT BACK TO MCC. DEMOLITION OF CHILLER AND ALL OTHER CHILLER ELECTRICAL EQUIPMENT AND WIRING IS UNDER A SEPARATE CONTRACT BY OTHERS.
3. REMOVE POWER CONDUIT AND WIRING FROM MOTOR BACK TO MCC. REMOVE RTD CONDUIT AND WIRING BACK TO MCC. REMOVE EMERGENCY STOP/LOCKOUT PUSH BUTTON, CONDUIT AND CONDUCTORS BACK TO MCC. NEW POWER CONDUIT AND WIRING TO BE INSTALLED.
4. REMOVE WEIGH CELLS, CONDUIT, UNISTRUT, WIRING, WEIGHT TRANSMITTER AND CONTROL BOX. SAVE ALL FOR REINSTALLATION AT RTU-1'S NEW LOCATION.
5. REMOVE LEVEL TRANSMITTER, LEVEL ELEMENT, AND WIRING. SAVE ALL FOR REINSTALLATION AT RTU-1'S NEW LOCATION.
6. REMOVE POWER FEEDER TO RTU-1 MOTOR STARTER. REMOVE CONDUIT BACK TO CONVENIENT POINT TO REROUTE NEW CONDUIT TO NEW MOTOR STARTER LOCATION. REMOVE CONDUCTORS BACK TO PANELBOARD.



KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2/18.13	GNP

SCALE: 1/8" = 1'-0"

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

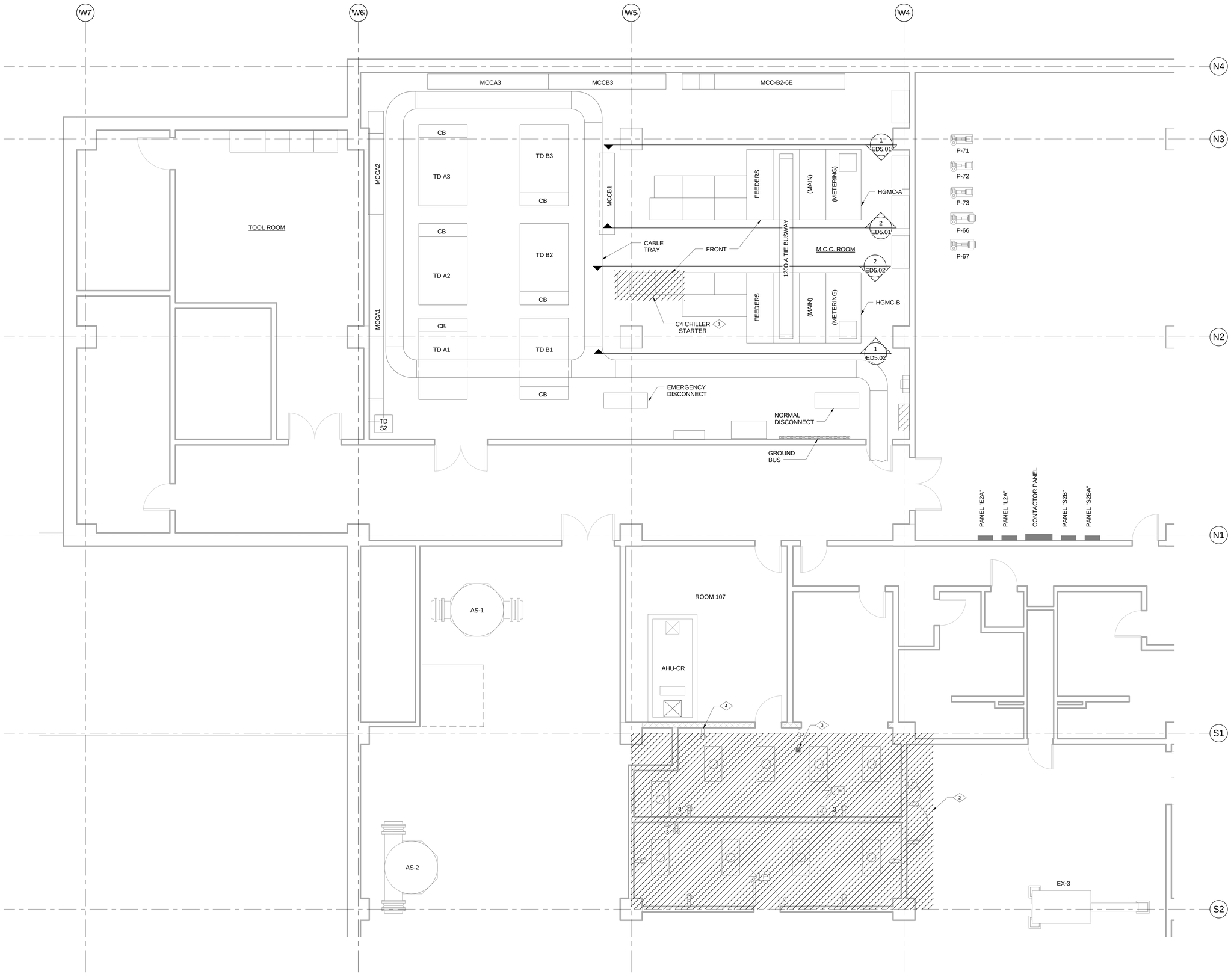
SHEET TITLE

DEMO PLAN EAST LOWER LEVEL

SHEET NO.

ED3.03

CADD FILE NO.



1 ED3.05 — MCC ROOM DEMO PLAN — 1/4" = 1'-0"

0 2' 4' 8'

SCALE IN FEET

N

KEYED NOTES:

1. COMPLETELY REMOVE CHILLER NO 4 REDUCED VOLTAGE STARTER AND FEEDER CONDUCTORS AND CONDUIT TO IT TO ALLOW FOR NEW MCC SECTIONS INSTALLATION.
2. DEMOLISH ALL ELECTRICAL, FIRE ALARM AND COMMUNICATION EQUIPMENT AND DEVICES INDICATED. DO NOT DISTURB ANY EQUIPMENT OR DEVICES NOT INDICATED ON THE DRAWING. REMOVE CONDUIT AND CONDUCTORS BACK TO CONVENIENT JBOX LOCATED OUTSIDE OF THE DEMOLITION LIMITS AND CAP AND ISOLATE CONDUCTORS. AREA IS BEING DEMOLISHED SO THAT PUMP P-11 CAN BE INSTALLED.
3. RELOCATE ANTENNA TO LOCATION INDICATED BY OWNER. EXTEND ANTENNA CABLE IF NECESSARY.
4. RECEPTACLE TO REMAIN.

KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2/13.13	CHK

SCALE: 1/4" = 1'-0"

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

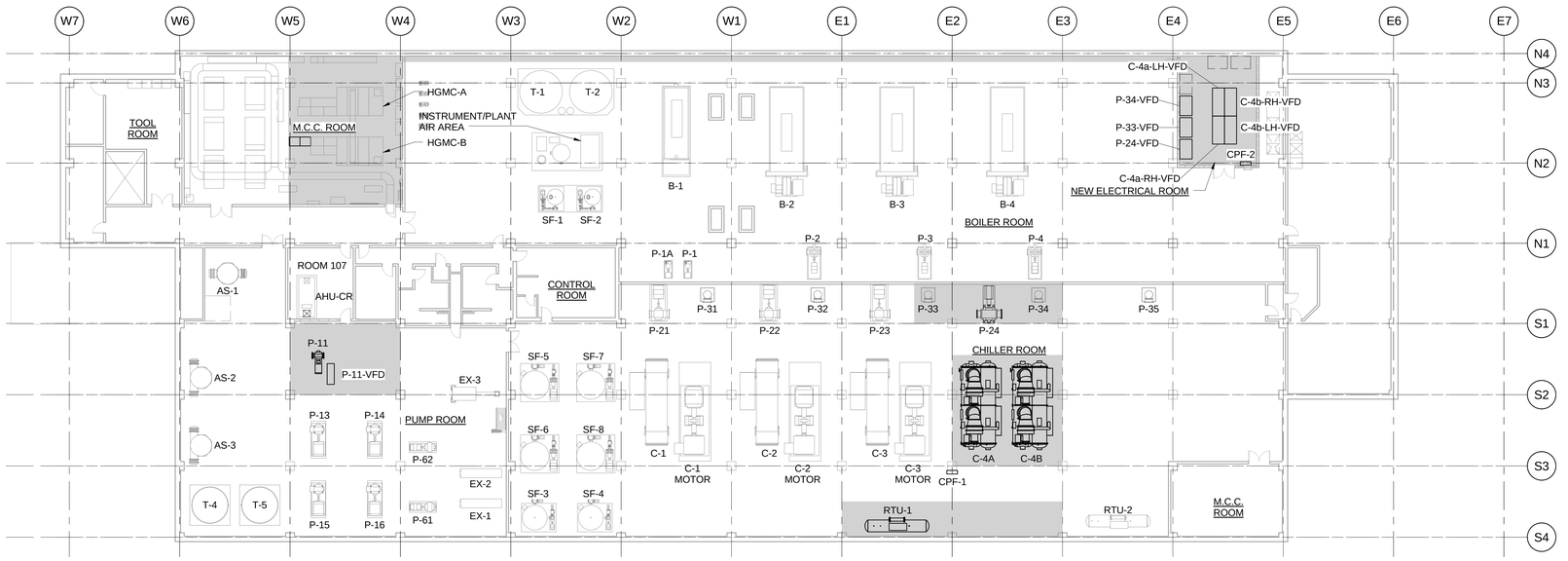
CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE: MCC ROOM DEMO PLAN

SHEET NO. ED3.05

CADD FILE NO.



1 E3.01 OVERALL LOWER LEVEL PLAN

1/16" = 1'-0"

0 8' 16' 32'

SCALE IN FEET

N

NOTES:

1. SHADED AREAS INDICATE GENERAL AREAS OF WORK.

KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MARIDON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2/18/13	GNF

SCALE: 1/16" = 1'-0"

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

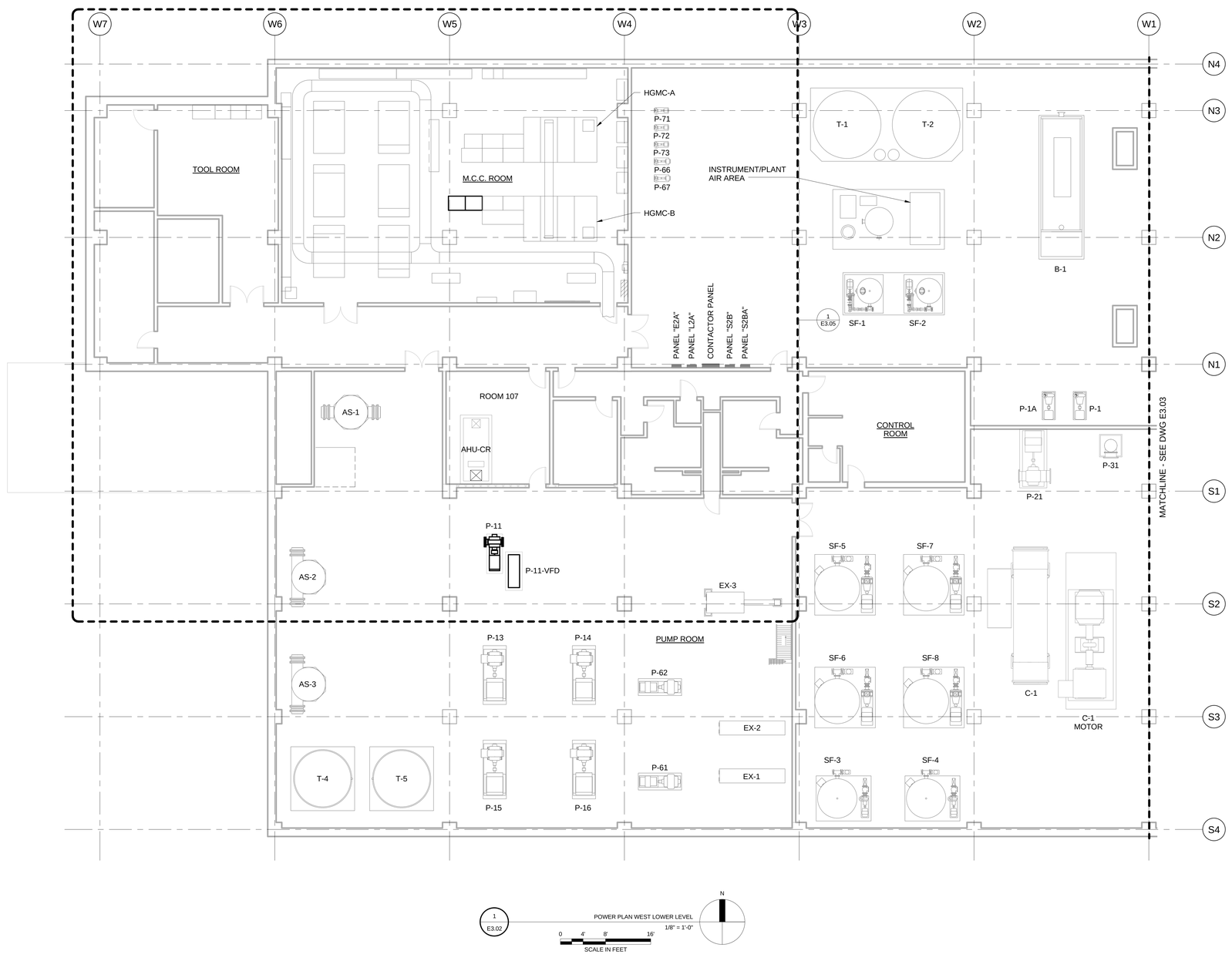
SHEET TITLE

OVERALL LOWER LEVEL PLAN

SHEET NO.

E3.01

CADD FILE NO.



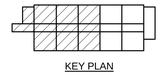
1 E3.02 POWER PLAN WEST LOWER LEVEL

1/8" = 1'-0"

0 4' 8' 16'

SCALE IN FEET

N



KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2.13.13	GMF

SCALE: 1/8" = 1'-0"

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

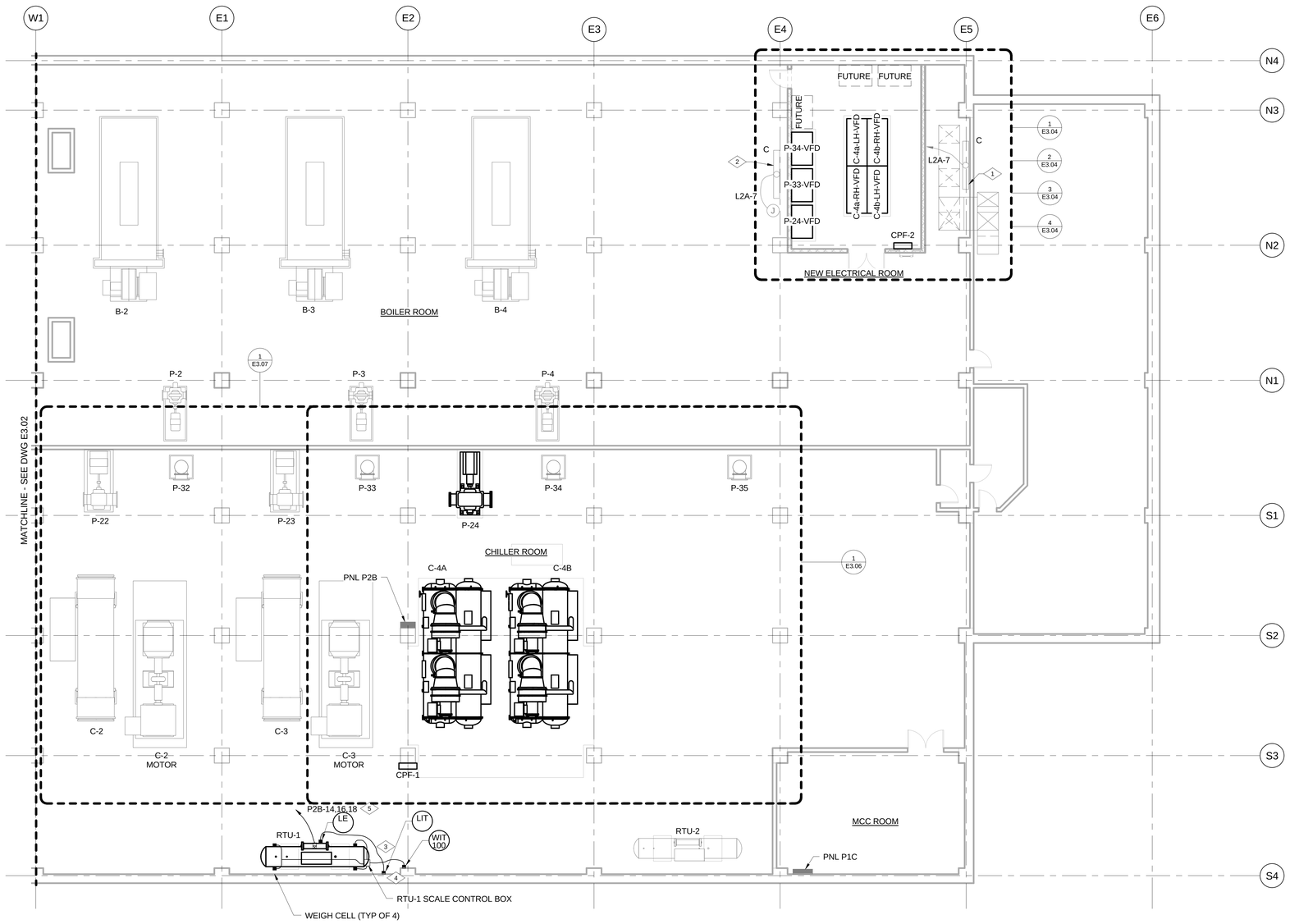
VOLUME NO. 01

SHEET TITLE

POWER PLAN WEST LOWER LEVEL

SHEET NO. E3.02

CADD FILE NO.



1 E3.03 — POWER PLAN EAST LOWER LEVEL — 1/8" = 1'-0"

0 4' 8' 16' SCALE IN FEET

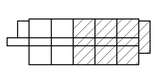
N

NOTES:

1. SEE SHEETS E5.01 - E5.03 FOR ONE-LINE DIAGRAMS AND CONDUIT AND CONDUCTOR SCHEDULES.
2. SEE SHEET E3.04 FOR VFD LOCATIONS ON ENLARGED ELECTRICAL ROOM PLAN.

KEYED NOTES:

1. LIGHT FIXTURE TO REMAIN UNCHANGED.
2. RELOCATE LIGHT AND JBOX 18" TO THE WEST. EXTEND CONDUIT AND UNISTRUT AS NECESSARY. REPLACE CONDUCTORS FROM NEAREST CONVENIENT JBOX TO NEW JBOX LOCATION.
3. REINSTALL WEIGH CELLS, CONDUIT, UNISTRUT, WIRING, WEIGHT TRANSMITTER AND CONTROL BOX REMOVED DURING DEMOLITION. MAKE RTU-1 FULLY FUNCTIONAL IN THE NEW LOCATION.
4. REINSTALL LEVEL TRANSMITTER, LEVEL ELEMENT, AND WIRING REMOVED DURING DEMOLITION.
5. EXTEND CONDUIT FROM EXISTING CONDUIT TO RTU-1'S NEW STARTER LOCATION. INSTALL NEW #10 WIRE FROM PANEL P2B TO MOTOR STARTER.



KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MARIPOSA CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2JUL13	CMP

SCALE: 1/8" = 1'-0"

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

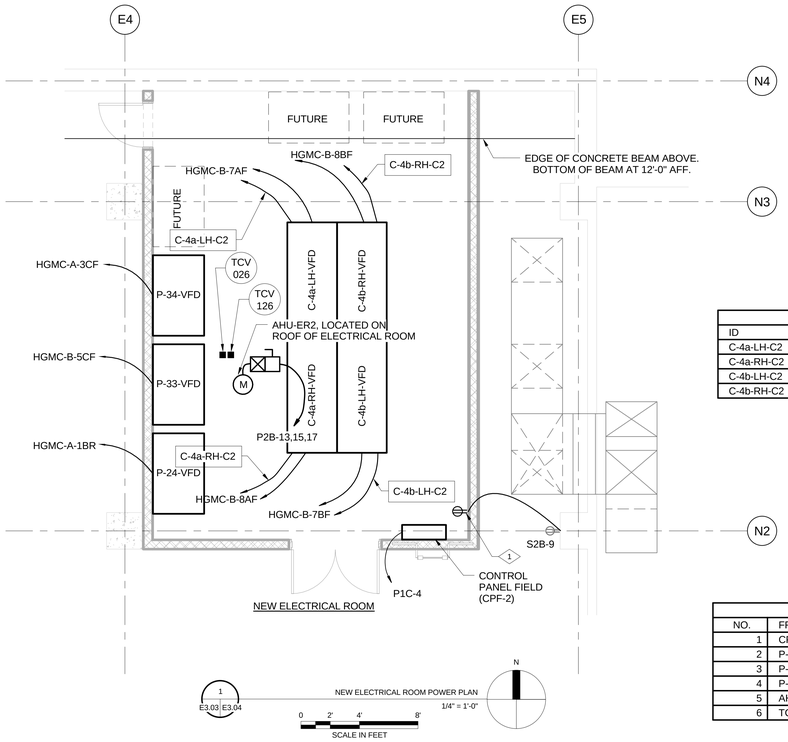
CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE
POWER PLAN EAST LOWER LEVEL

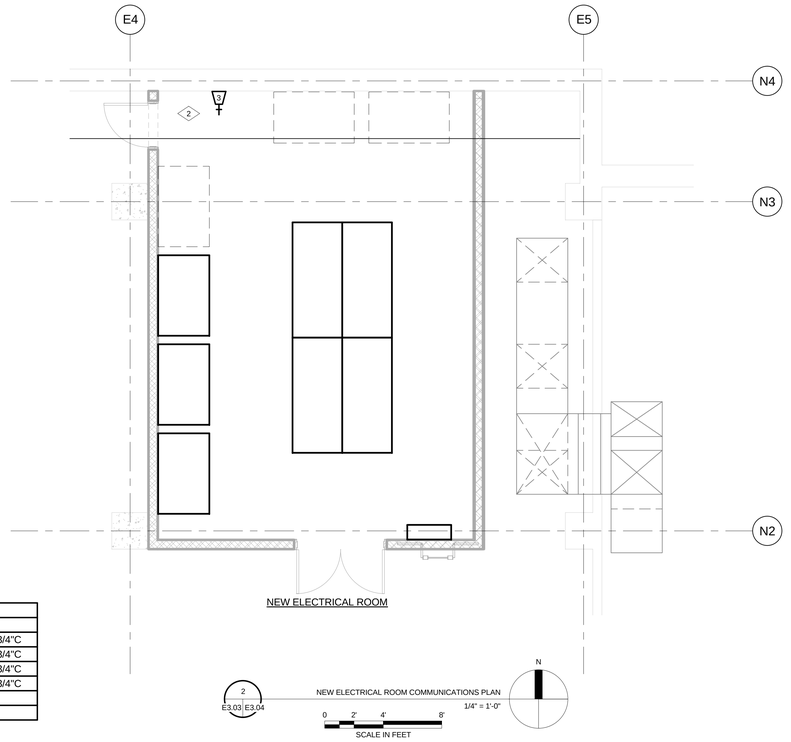
SHEET NO.
E3.03

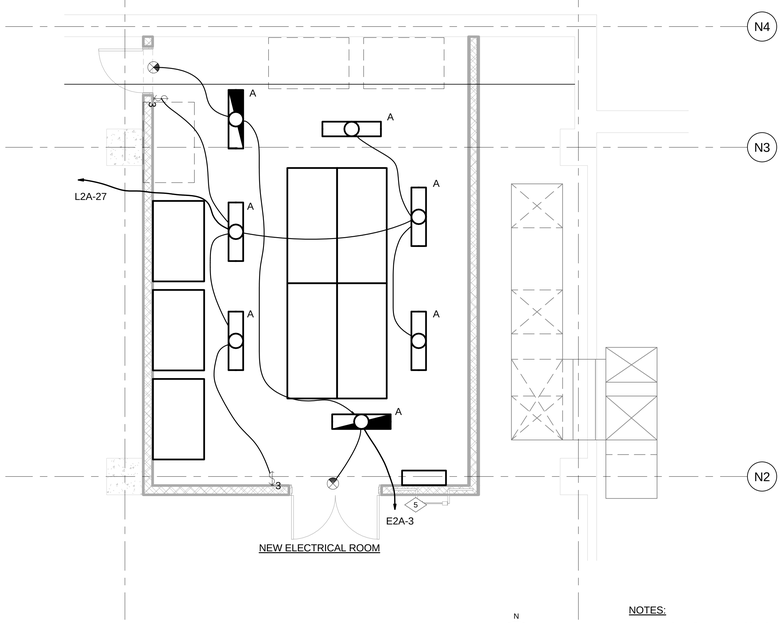
CADD FILE NO.

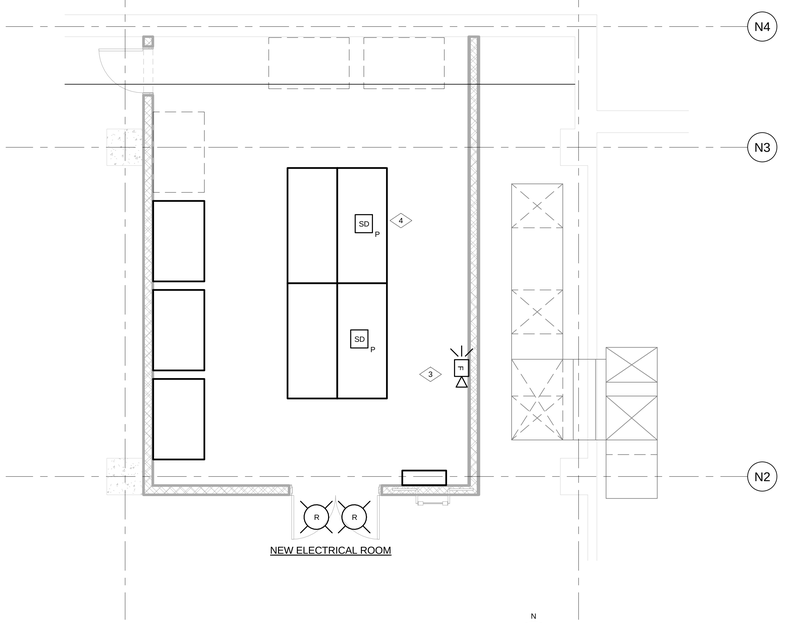


CONDUIT AND CONDUCTOR SCHEDULE		
ID	DESCRIPTION	SPARE
C-4a-LH-C2	3-#14, 3/4"C	1-#14
C-4a-RH-C2	3-#14, 3/4"C	1-#14
C-4b-LH-C2	3-#14, 3/4"C	1-#14
C-4b-RH-C2	3-#14, 3/4"C	1-#14

WIRING SCHEDULE				
NO.	FROM	TO	SIGNAL	WIRE TYPE
1	CPF-2	BACNET BUS	BACNET MS/TP	#22TSP, BELDEN #3106A, 3/4"C
2	P-24-VFD	P-33-VFD	BACNET MS/TP	#22TSP, BELDEN #3106A, 3/4"C
3	P-33-VFD	P-34-VFD	BACNET MS/TP	#22TSP, BELDEN #3106A, 3/4"C
4	P-34-VFD	CPF-2	BACNET MS/TP	#22TSP, BELDEN #3106A, 3/4"C
5	AHU-ER2	CPF-2	FIELD VERIFY	FIELD VERIFY
6	TCV-XXX	CPF-2	FIELD VERIFY	FIELD VERIFY





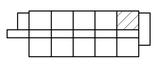


NOTES:

1. SEE SHEET E3.02 FOR RECEPTACLE AND LIGHTING PANELBOARD LOCATIONS.
2. SEE SHEETS E5.01 - E5.03 FOR ONE-LINE DIAGRAMS AND CONDUIT AND CONDUCTOR SCHEDULES.
3. SEE SHEET E3.05 AND E3.06 FOR EXISTING PANELBOARD LOCATIONS.
4. SEE SHEET E6.01 FOR LUMINAIRE SCHEDULE.
5. SEE SHEETS E6.01 AND E6.02 FOR PANELBOARD SCHEDULES.

KEYED NOTES:

1. CONNECT NEW RECEPTACLE TO EXISTING RECEPTACLE ON CIRCUIT S2B-9.
2. INSTALL 1" C AND CONDUCTORS FROM HORN TO EXISTING PAGING CIRCUIT CONDUIT SYSTEM. INTERCEPT CONDUIT SYSTEM AT COLUMN LINES S1 AND E5. VERIFY PAGING CIRCUIT NUMBER AND COORDINATE CONNECTION OF HORN TO SYSTEM WITH OWNER.
3. INSTALL 1" C AND CONDUCTORS FROM FA SPEAKER/STROBE TO EXISTING FA NOTIFICATION CIRCUIT. INTERCEPT CONDUIT SYSTEM AT COLUMN LINES N2 AND E4.
4. INSTALL 1"C AND CONDUCTORS FROM FA SMOKE DETECTORS TO EXISTING FA INITIATING CIRCUIT. INTERCEPT CONDUIT SYSTEM AT COLUMN LINES N1 AND E5.
5. ADD LIGHTS TO EXISTING EMERGENCY CIRCUIT E2A-3 LOCATED IN THE AREA OF COLUMNS E4 AND N1. LIGHTS ARE NON-SWITCHED.



KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MARIOON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	23.8.13	GRP

SCALE: 1/4" = 1'-0"

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

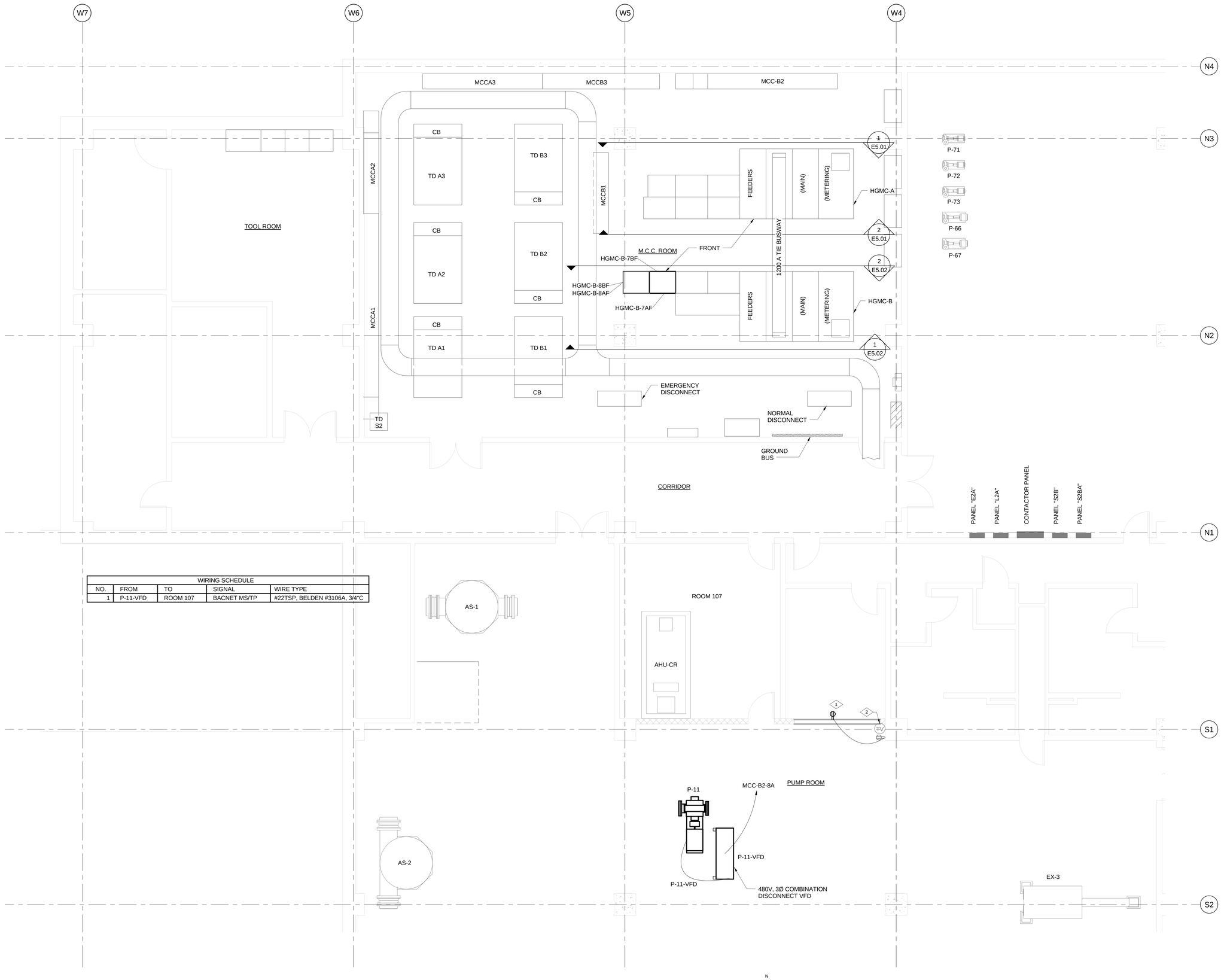
VOLUME NO. 01

SHEET TITLE

ELECTRICAL ROOM PLANS

SHEET NO. E3.04

CADD FILE NO.



WIRING SCHEDULE				
NO.	FROM	TO	SIGNAL	WIRE TYPE
1	P-11-VFD	ROOM 107	BACNET MS/TP	#22TSP, BELDEN #3106A, 3/4"C

1 E3.05 MCC ROOM PLAN 1/4" = 1'-0"

0 2' 4' 8'
SCALE IN FEET

N

NOTES:

1. SEE SHEETS E5.01 - E5.03 FOR ONE-LINE DIAGRAMS AND CONDUIT AND CONDUCTOR SCHEDULES.

KEYED NOTES:

1. INTERCEPT CIRCUIT S2B-35 IN CEILING AT JBOX. INSTALL NEW RECEPTACLE FOR TV AND CONNECT TO CIRCUIT. COORDINATE RECEPTACLE HEIGHT WITH NEW TV LOCATION.
2. OWNER TO RELOCATE CABLE TV OUTLET.

KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MARION CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

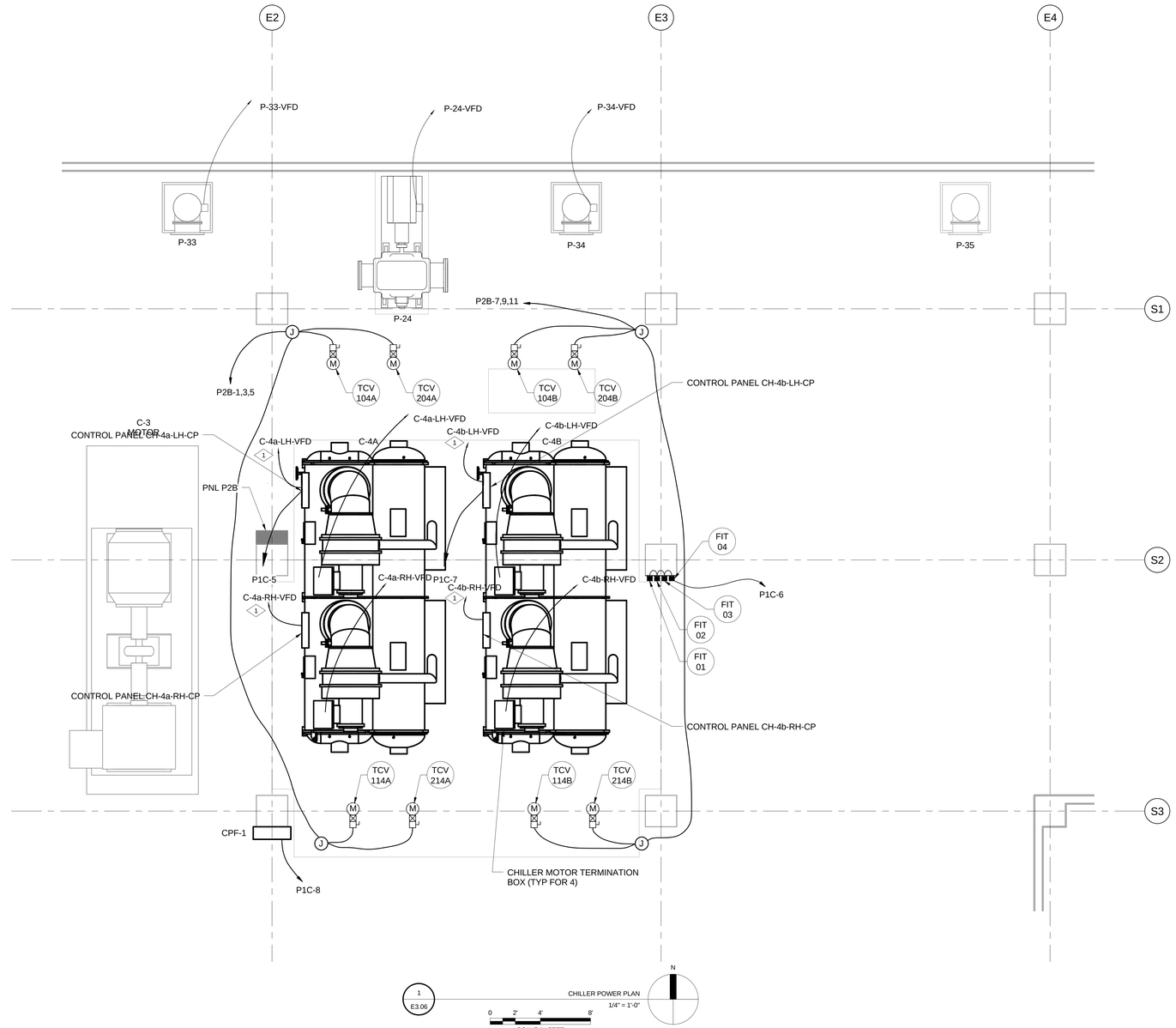
NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2.28.13	GRP

SCALE: 1/4" = 1'-0"
DATE: 10/23/12
DRAWN BY: P. HEIMBURGER
CHECKED BY: R. KELEMEN
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01

SHEET TITLE
MCC ROOM PLAN

SHEET NO.
E3.05

CADD FILE NO.



NOTES:

1. SEE SHEETS E5.01 - E5.03 FOR ONE-LINE DIAGRAMS AND CONDUIT AND CONDUCTOR SCHEDULES.
2. SEE SHEET E3.04 FOR VFD LOCATIONS ON ENLARGED ELECTRICAL ROOM PLAN.
3. ALL CONTROL VALVES SHOWN ARE 480V,3Ø,2HP.
4. SEE SHEET E3.03 FOR LOCATION OF EXISTING PANELBOARD P1C.

KEYED NOTES:

1 1-#8 GND, 3/4"C FROM CHILLER CONTROL PANEL TO CHILLER VFD.

KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MARIPOSA CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	23JL13	GNP

SCALE: 1/4" = 1'-0"

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

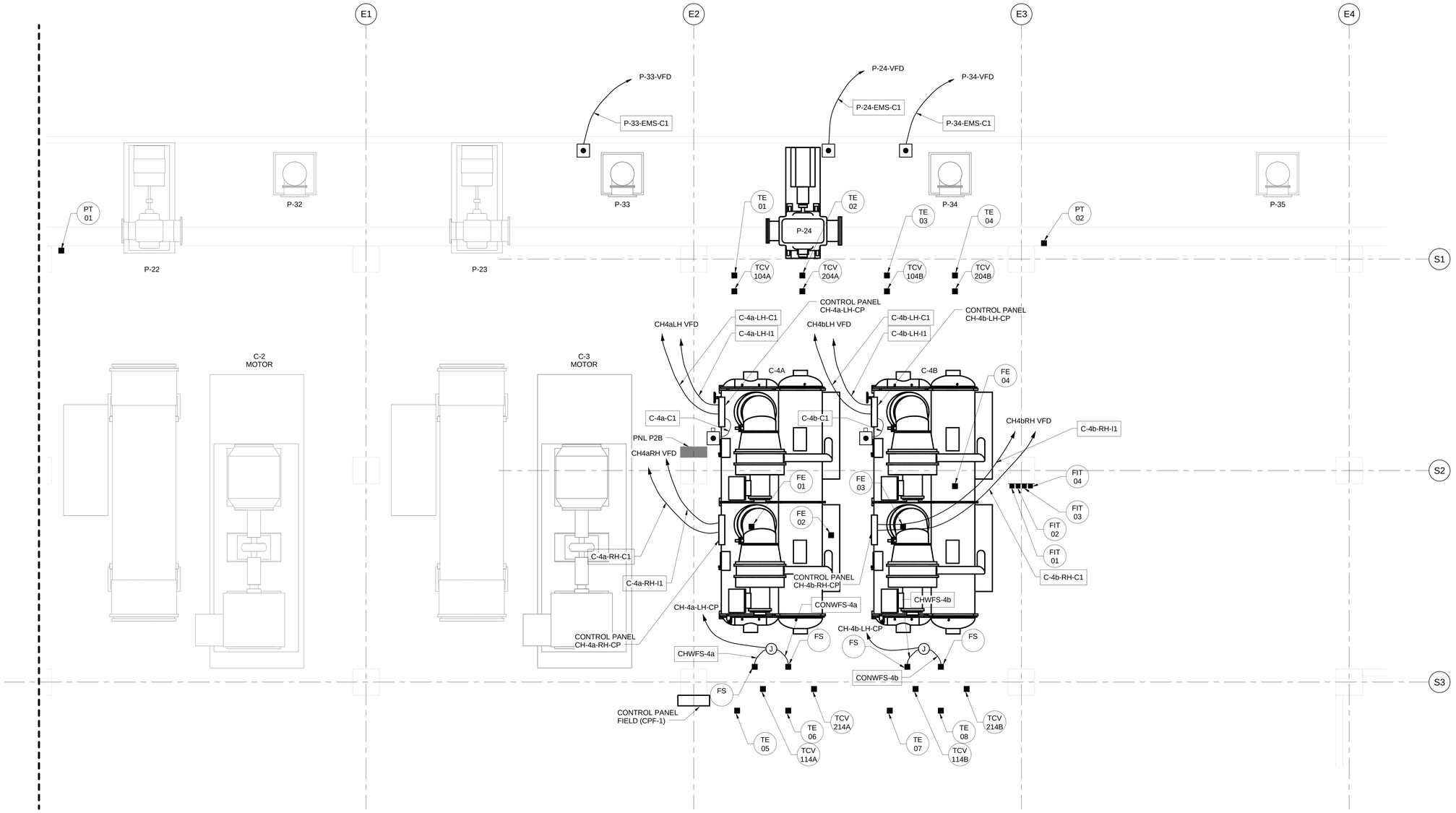
CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE: CHILLER POWER PLAN

SHEET NO. E3.06

CADD FILE NO.



1
E3.03 E3.07

INSTRUMENT AND CONTROLS PLAN
1/4" = 1'-0"

0 2' 4' 8'
SCALE IN FEET

N

CONDUIT AND CONDUCTOR SCHEDULE		
ID	DESCRIPTION	SPARE
C-4a-LH-C1	4-#14, 4-#10, 1-#10GND, 3/4"C	2-#14, 2-#10
C-4a-LH-I1	3-#16TSP, BELDEN #8719, 1"C	1 TSP
C-4a-RH-C1	4-#14, 4-#10, 1-#10GND, 3/4"C	2-#14, 2-#10
C-4a-RH-I1	3-#16TSP, BELDEN #8719, 1"C	1 TSP
C-4b-LH-C1	4-#14, 4-#10, 1-#10GND, 3/4"C	2-#14, 2-#10
C-4b-LH-I1	3-#16TSP, BELDEN #8719, 1"C	1 TSP
C-4b-RH-C1	4-#14, 4-#10, 1-#10GND, 3/4"C	2-#14, 2-#10
C-4b-RH-I1	3-#16TSP, BELDEN #8719, 1"C	1 TSP
C-4a-C1	3-#14, 3/4"C	1-#14
C-4b-C1	3-#14, 3/4"C	1-#14
CONWFS-4a	5/C JACKETED, VENDOR SUPPLIED, 1"C	-
CHWFS-4a	5/C JACKETED, VENDOR SUPPLIED, 1"C	-
CONWFS-4b	5/C JACKETED, VENDOR SUPPLIED, 1"C	-
CHWFS-4b	5/C JACKETED, VENDOR SUPPLIED, 1"C	-
P-33-EMS-C1	3-#14, 3/4"C	1-#14
P-34-EMS-C1	3-#14, 3/4"C	1-#14
P-24-EMS-C1	3-#14, 3/4"C	1-#14

WIRING SCHEDULE				
NO.	FROM	TO	SIGNAL	WIRE TYPE
1	TCV-104A	CPF-1	(2)-4-20mA	2-#16TSP,BELDEN #8719, 1"C
2	TCV-104B	CPF-1	(2)-4-20mA	2-#16TSP,BELDEN #8719, 1"C
3	TCV-114A	CPF-1	24Vdc	12-#14, 3/4"C, 2 SPARE
4	TCV-114B	CPF-1	24Vdc	12-#14, 3/4"C, 2 SPARE
5	TCV-204A	CPF-1	24Vdc	12-#14, 3/4"C, 2 SPARE
6	TCV-204B	CPF-1	24Vdc	12-#14, 3/4"C, 2 SPARE
7	TCV-214A	CPF-1	24Vdc	12-#14, 3/4"C, 2 SPARE
8	TCV-214B	CPF-1	24Vdc	12-#14, 3/4"C, 2 SPARE
9	FE-01	FIT-01	MANUFACTURER	VENDOR SUPPLIED, 3/4"C
10	FE-02	FIT-02	MANUFACTURER	VENDOR SUPPLIED, 3/4"C
11	FE-03	FIT-03	MANUFACTURER	VENDOR SUPPLIED, 3/4"C
12	FE-04	FIT-04	MANUFACTURER	VENDOR SUPPLIED, 3/4"C
13	FIT-01	CPF-1	4-20mA	#16TSP,BELDEN #8719, 3/4"C
14	FIT-02	CPF-1	4-20mA	#16TSP,BELDEN #8719, 3/4"C
15	FIT-03	CPF-1	4-20mA	#16TSP,BELDEN #8719, 3/4"C
16	FIT-04	CPF-1	4-20mA	#16TSP,BELDEN #8719, 3/4"C
17	FIT-01	CPF-1	10Vdc	4-#14, 3/4"C
18	FIT-02	CPF-1	10Vdc	4-#14, 3/4"C
19	FIT-03	CPF-1	10Vdc	4-#14, 3/4"C
20	FIT-04	CPF-1	10Vdc	4-#14, 3/4"C
21	TE-01	CPF-1	5Vdc	2-#24TP,BELDEN #9562, 3/4"C
22	TE-02	CPF-1	5Vdc	2-#24TP,BELDEN #9562, 3/4"C
23	TE-03	CPF-1	5Vdc	2-#24TP,BELDEN #9562, 3/4"C
24	TE-04	CPF-1	5Vdc	2-#24TP,BELDEN #9562, 3/4"C
25	TE-05	CPF-1	5Vdc	2-#24TP,BELDEN #9562, 3/4"C
26	TE-06	CPF-1	5Vdc	2-#24TP,BELDEN #9562, 3/4"C
27	TE-07	CPF-1	5Vdc	2-#24TP,BELDEN #9562, 3/4"C
28	TE-08	CPF-1	5Vdc	2-#24TP,BELDEN #9562, 3/4"C
29	PT-01	CPF-2	4-20mA	2-#16TSP,BELDEN #8719, 1"C
30	PT-02	CPF-2	4-20mA	2-#16TSP,BELDEN #8719, 1"C
31	CH-4a-LH-CP	ROOM 107	BACNET/IP	CATEGORY 6 CABLE, 3/4"C
32	CH-4b-LH-CP	ROOM 107	BACNET/IP	CATEGORY 6 CABLE, 3/4"C
33	CPF-1	BACNET BUS	BACNET MS/TP	#22TSP, BELDEN #3106A, 3/4"C

NOTES:

1. SEE SHEET E3.04 FOR VFD LOCATIONS.
2. MOUNT ALL PUSH BUTTON STATIONS AT 48" AFF TO CENTER.
3. PUMP AND CHILLER PUSH BUTTON STATIONS ARE EMERGENCY STOP ONE BUTTON STATIONS.
4. SEE SHEET E3.05 FOR ROOM 107 LOCATION.
5. SEE SHEET E3.04 FOR CONTROL PANEL FIELD (CPF-2) LOCATION.

KEY PLAN

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MARION CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	23JL13	GMP

SCALE: 1/4" = 1'-0"

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

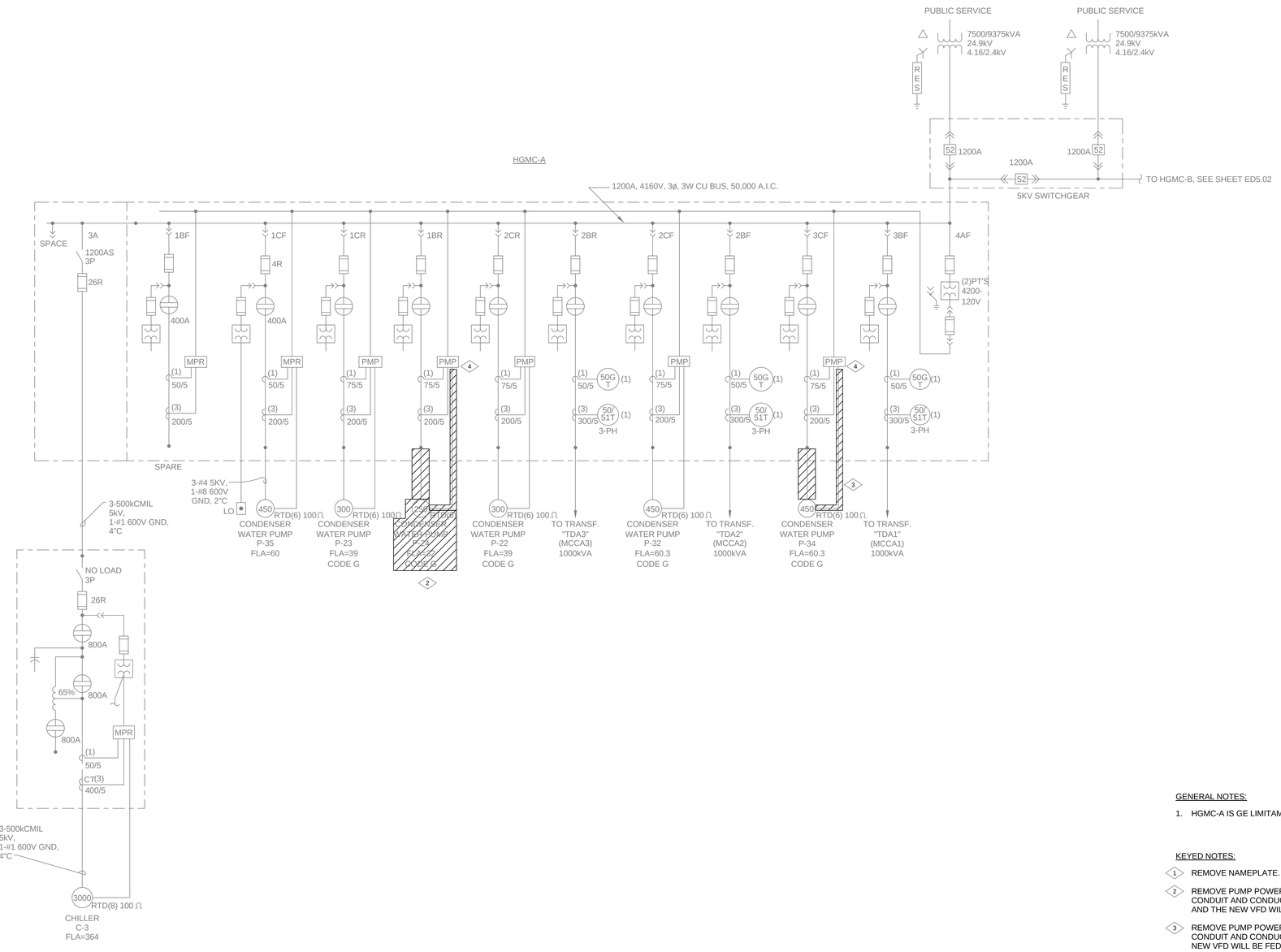
SHEET TITLE

INSTRUMENT AND CONTROLS PLAN

SHEET NO.

E3.07

CADD FILE NO.



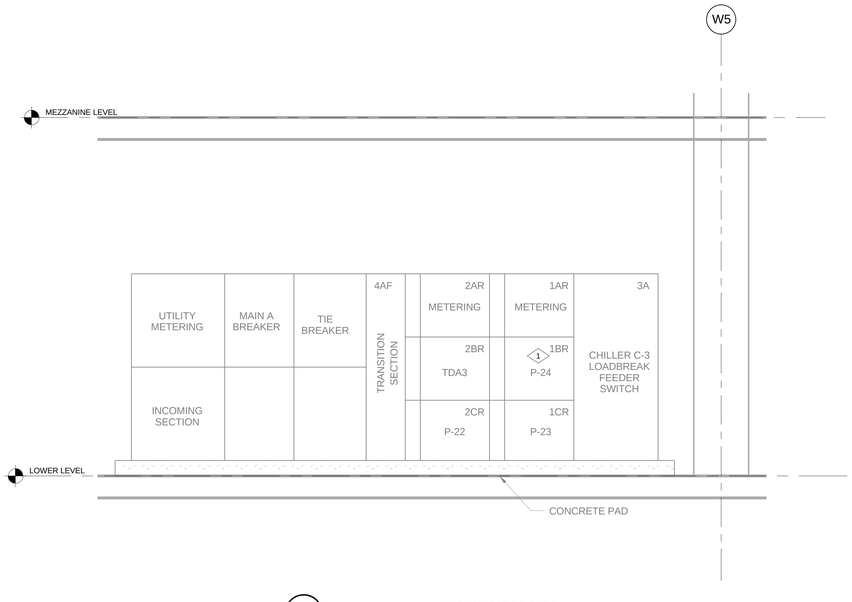
HGMC-A ONE LINE DIAGRAM

GENERAL NOTES:

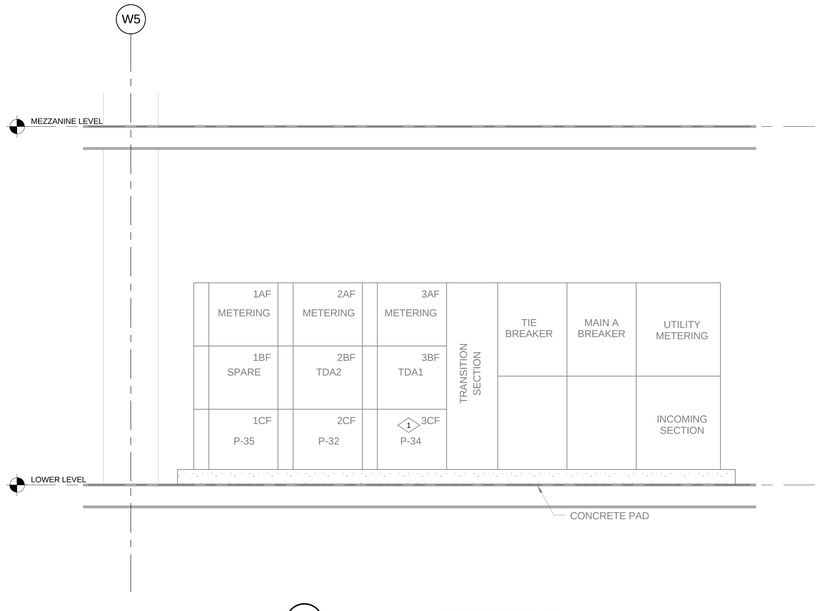
1. HGMC-A IS GE LIMITAMP 5kV.

KEYED NOTES:

1. REMOVE NAMEPLATE.
2. REMOVE PUMP POWER CONDUIT AND CONDUCTORS AND PUMP RTD CONDUIT AND CONDUCTORS. A NEW PUMP WILL REPLACE THE EXISTING AND THE NEW VFD WILL BE FED FROM THIS STARTER.
3. REMOVE PUMP POWER CONDUIT AND CONDUCTORS AND PUMP RTD CONDUIT AND CONDUCTORS. THE EXISTING PUMP WILL REMAIN AND THE NEW VFD WILL BE FED FROM THIS STARTER.
4. REPROGRAM PMP TO REMOVE MOTOR RTD'S FROM THE PROGRAMMING.



1 ED3.05 | ED5.01 — HGMC-A DEMO REAR ELEVATION — NOT TO SCALE



2 ED3.05 | ED5.01 — HGMC-A DEMO FRONT ELEVATION — NOT TO SCALE

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2/13.11	CWF

SCALE: As indicated

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

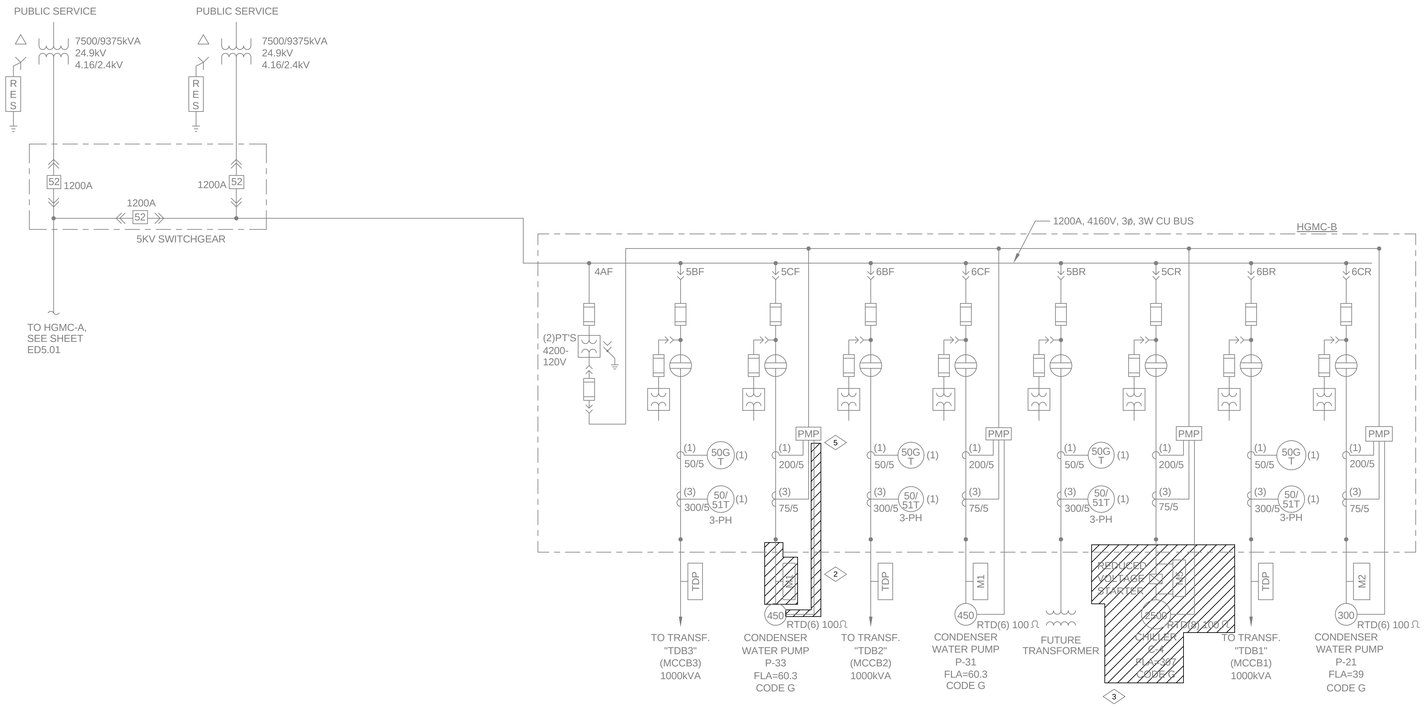
CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE: HGMC-A DEMO ONE-LINE DIAGRAM

SHEET NO. ED5.01

CADD FILE NO.



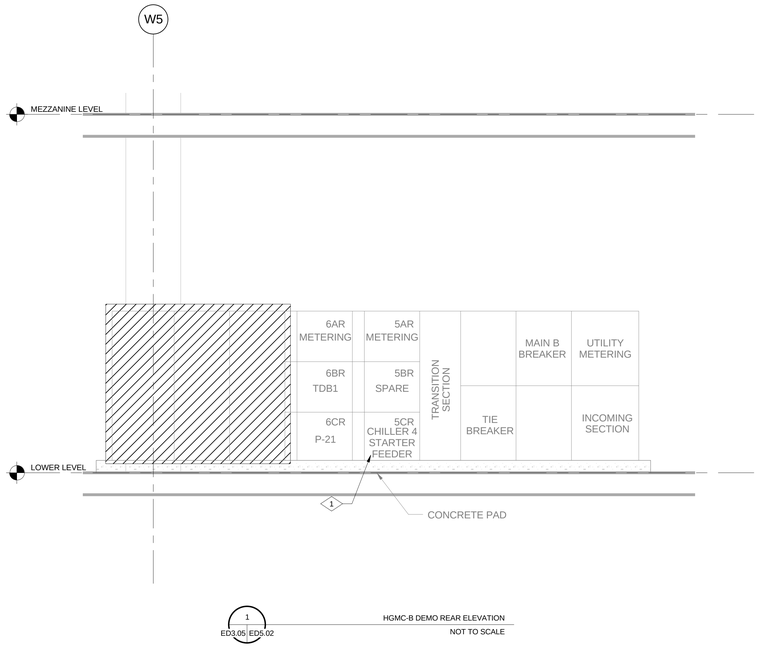
HGMC-B DEMO ONE LINE DIAGRAM

GENERAL NOTES:

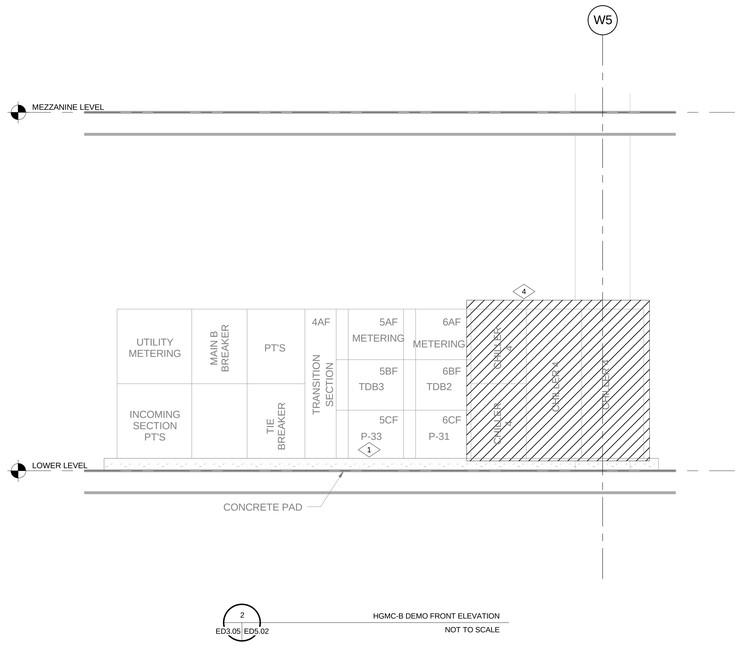
1. HGMC-B IS GE LIMITAMP 5kV.

KEYED NOTES:

1. REMOVE NAMEPLATE.
2. REMOVE PUMP POWER CONDUIT AND CONDUCTORS AND PUMP RTD CONDUIT AND CONDUCTORS. THE EXISTING PUMP WILL REMAIN AND THE NEW VFD WILL BE FED FROM THIS STARTER.
3. REMOVE CHILLER C-4 POWER CONDUIT AND CONDUCTORS AND CHILLER C-4 RTD CONDUIT AND CONDUCTORS FROM CHILLER C-4 TO C-4 REDUCED VOLTAGE STARTER AND HGMC-B. STARTER IN HGMC-B WILL BE SPARE.
4. REMOVE C-4 REDUCED VOLTAGE STARTER AND FEEDER TO IT FROM HGMC-B. THE SPACE ON THE PAD WILL BE UTILIZED TO ADD TWO NEW SECTIONS TO THE END OF HGMC-B. THESE NEW SECTIONS WILL FEED THE FOUR NEW CHILLER VFD'S.
5. REPROGRAM PMP TO REMOVE MOTOR RTD'S FROM THE PROGRAMMING.



1 ED3.05 | ED5.02 HGMC-B DEMO REAR ELEVATION
NOT TO SCALE



2 ED3.05 | ED5.02 HGMC-B DEMO FRONT ELEVATION
NOT TO SCALE

CITY & COUNTY
of DENVER

DENVER
INTERNATIONAL
AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

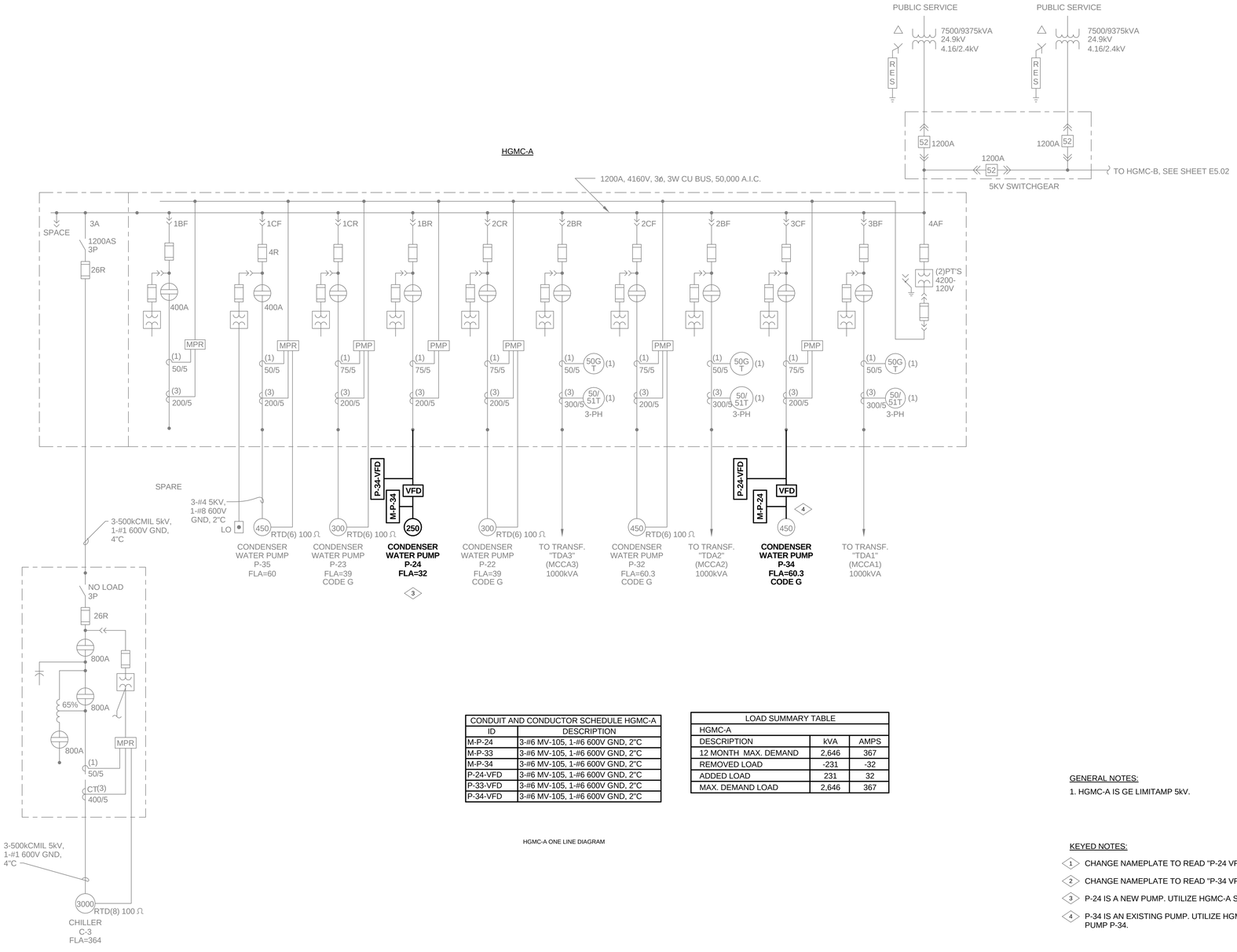
CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell
SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2|18|13	GNP

SCALE: As indicated
DATE: 10/23/12
DRAWN BY: P. HEIMBURGER
CHECKED BY: R. KELEMEN
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01
SHEET TITLE
HGMC-B DEMO
ONE-LINE DIAGRAM
SHEET NO.
ED5.02
CADD FILE NO.



CONDUIT AND CONDUCTOR SCHEDULE HGMC-A	
ID	DESCRIPTION
M-P-24	3-#6 MV-105, 1-#6 600V GND, 2"C
M-P-33	3-#6 MV-105, 1-#6 600V GND, 2"C
M-P-34	3-#6 MV-105, 1-#6 600V GND, 2"C
P-24-VFD	3-#6 MV-105, 1-#6 600V GND, 2"C
P-33-VFD	3-#6 MV-105, 1-#6 600V GND, 2"C
P-34-VFD	3-#6 MV-105, 1-#6 600V GND, 2"C

LOAD SUMMARY TABLE		
HGMC-A		
DESCRIPTION	kVA	AMPS
12 MONTH MAX. DEMAND	2,646	367
REMOVED LOAD	-231	-32
ADDED LOAD	231	32
MAX. DEMAND LOAD	2,646	367

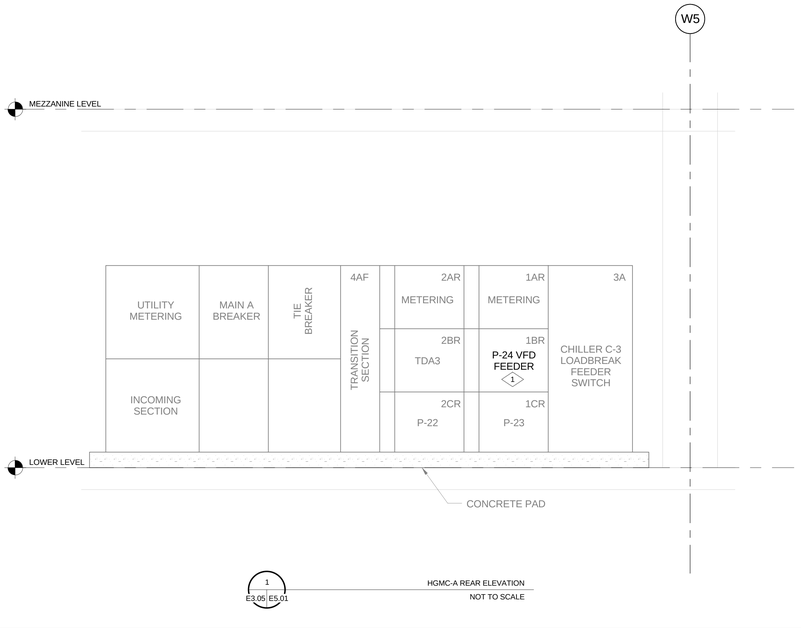
HGMC-A ONE LINE DIAGRAM

GENERAL NOTES:

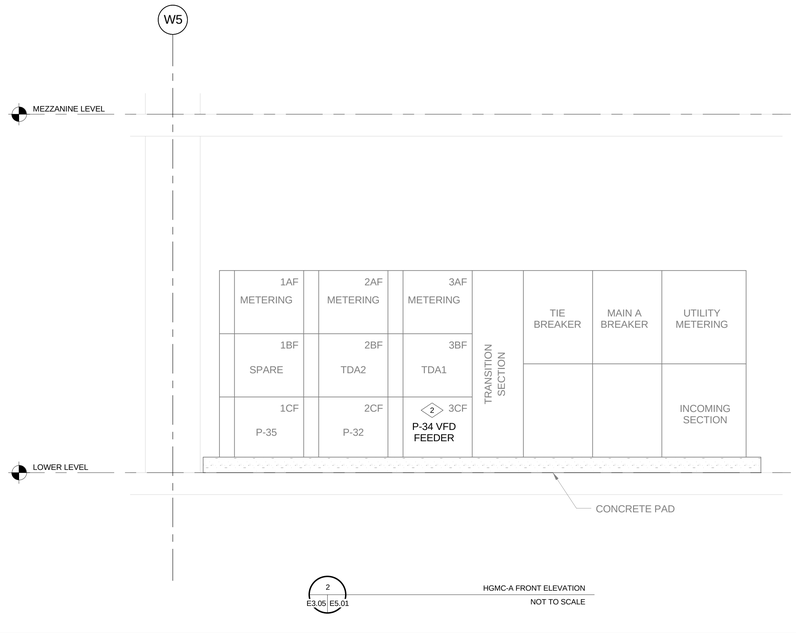
1. HGMC-A IS GE LIMITAMP 5kV.

KEYED NOTES:

1. CHANGE NAMEPLATE TO READ "P-24 VFD FEEDER".
2. CHANGE NAMEPLATE TO READ "P-34 VFD FEEDER".
3. P-24 IS A NEW PUMP. UTILIZE HGMC-A STARTER TO FEED NEW VFD FOR P-24.
4. P-34 IS AN EXISTING PUMP. UTILIZE HGMC-A STARTER TO FEED NEW VFD FOR PUMP P-34.



1 E3.05 E5.01 HGMC-A REAR ELEVATION
NOT TO SCALE



2 E3.05 E5.01 HGMC-A FRONT ELEVATION
NOT TO SCALE

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2/13.11	CAP

SCALE: As indicated

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

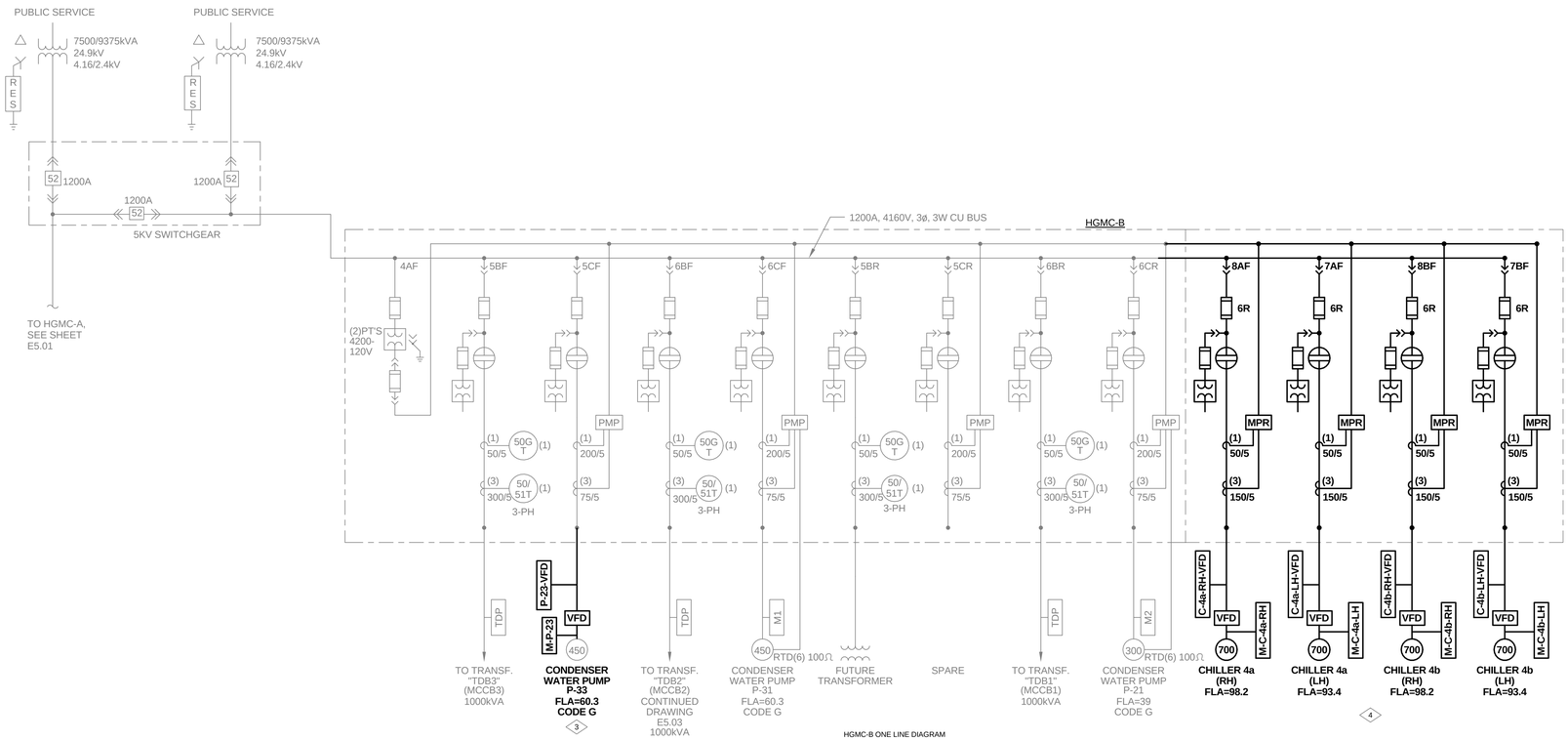
CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE: HGMC-A ONE-LINE DIAGRAM

SHEET NO. E5.01

CADD FILE NO.



HGMC-B ONE LINE DIAGRAM

CONDUIT AND CONDUCTOR SCHEDULE HGMC-B	
ID	DESCRIPTION
C-4a-LH-VFD	3-#2 MV-105, 1-#6 600V GND, 2.5"C
C-4a-RH-VFD	3-#2 MV-105, 1-#6 600V GND, 2.5"C
C-4b-LH-VFD	3-#2 MV-105, 1-#6 600V GND, 2.5"C
C-4b-RH-VFD	3-#2 MV-105, 1-#6 600V GND, 2.5"C
M-C-4a-LH	3-#2 MV-105, 1-#6 600V GND, 2.5"C
M-C-4a-RH	3-#2 MV-105, 1-#6 600V GND, 2.5"C
M-C-4b-LH	3-#2 MV-105, 1-#6 600V GND, 2.5"C
M-C-4b-RH	3-#2 MV-105, 1-#6 600V GND, 2.5"C
M-P-33	3-#6 MV-105, 1-#6 600V GND, 2"C
P-33-VFD	3-#6 MV-105, 1-#6 600V GND, 2"C

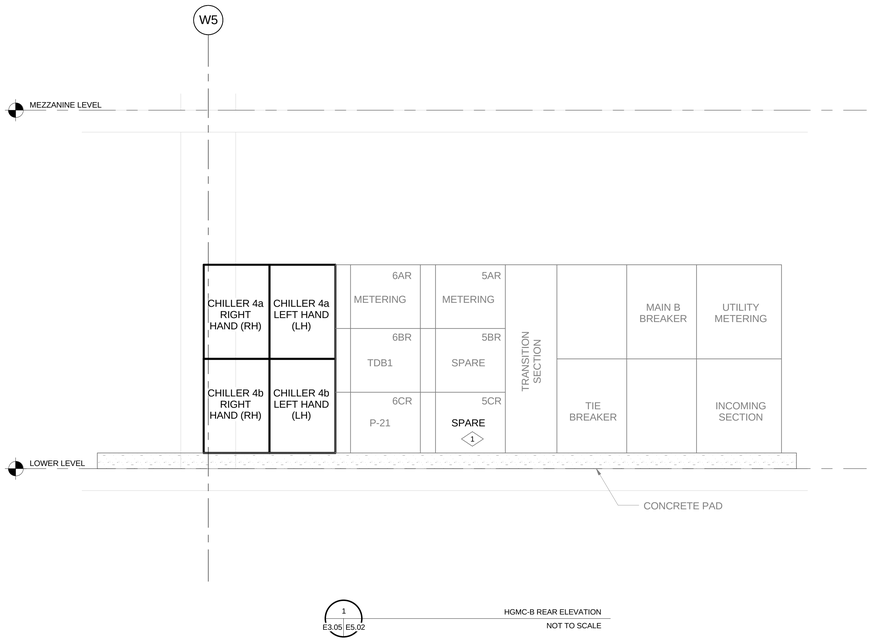
LOAD SUMMARY TABLE		
HGMC-B		
DESCRIPTION	kVA	AMPS
12 MONTH MAX. DEMAND	5,220	725
REMOVED LOAD	-2,212	-307
ADDED LOAD	3053	424
MAX. DEMAND LOAD	6,061	841

GENERAL NOTES:

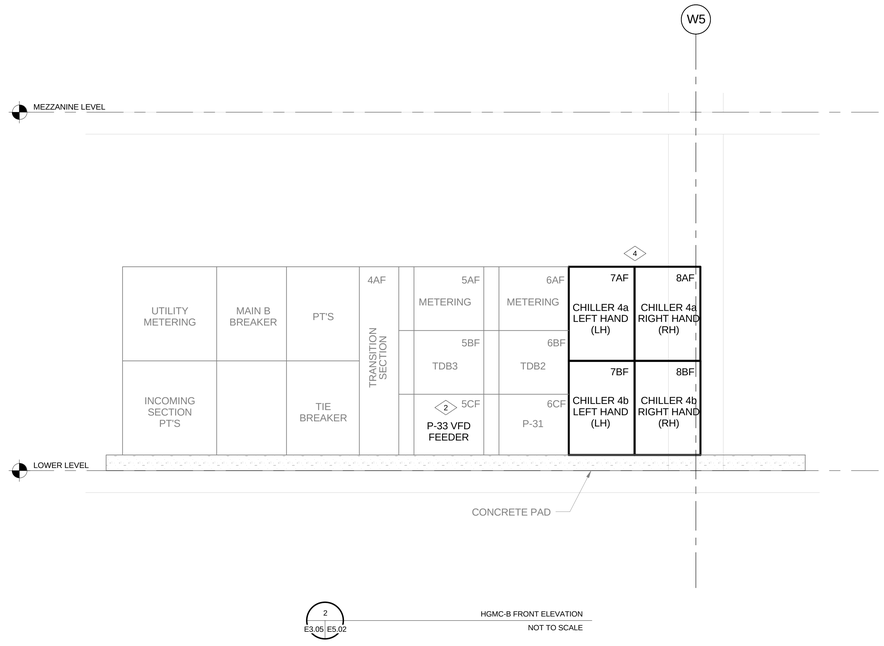
1. HGMC-B IS GE LIMITAMP 5kV.

KEYED NOTES:

1. CHANGE NAMEPLATE TO READ "SPARE".
2. CHANGE NAMEPLATE TO READ "P-33 VFD FEEDER".
3. P-33 IS AN EXISTING PUMP. UTILIZE HGMC-B STARTER TO FEED NEW VFD FOR PUMP P-33.
4. INSTALL TWO NEW MCC SECTIONS WITH TWO STARTERS EACH AND BUS CONNECT TO EXISTING HGMC-B. FEED FOUR NEW CHILLER VFD'S FROM NEW STARTERS.



1 E3.05 E5.02 HGMC-B REAR ELEVATION
NOT TO SCALE



2 E3.05 E5.02 HGMC-B FRONT ELEVATION
NOT TO SCALE

CITY & COUNTY
of DENVER

DENVER
INTERNATIONAL
AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MARIOON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell
SINCE 1898

ISSUE RECORD

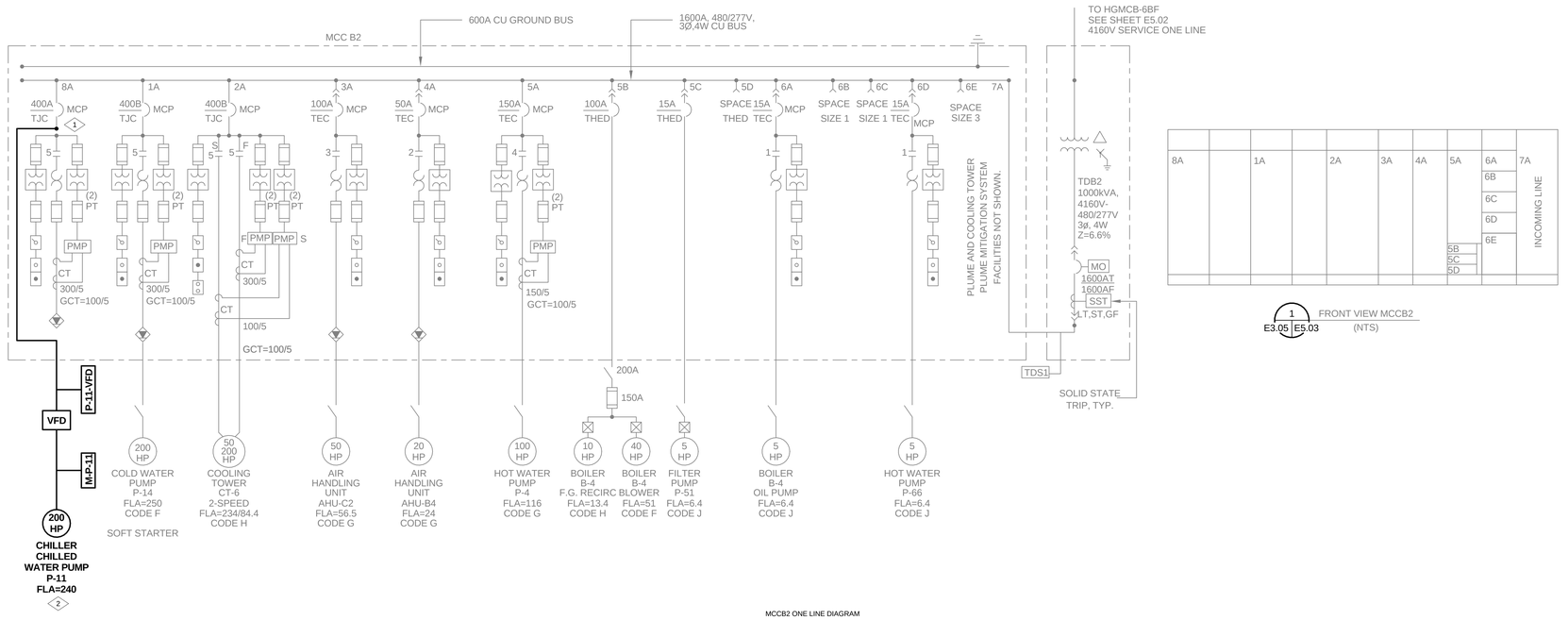
NO.	BY	PURPOSE	DATE	CKD
10	RSK	IFC	2/13/13	GRF

SCALE: As indicated
DATE: 10/23/12
DRAWN BY: P. HEIMBURGER
CHECKED BY: R. KELEMEN
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01

SHEET TITLE
HGMC-B ONE-LINE DIAGRAM

SHEET NO.
E5.02

CADD FILE NO.



MCCB2 ONE LINE DIAGRAM

1 E3.05 E5.03 FRONT VIEW MCCB2 (NTS)

CONDUIT AND CONDUCTOR SCHEDULE MCCB2	
ID	DESCRIPTION
P-11-VFD	3-350kCMIL, 1-#2GND, 3"C
M-P-11	3-350kCMIL, 1-#2GND, 3"C

GENERAL NOTES:

1. SEE SHEET E6.01 FOR MCC SCHEDULE.

KEYED NOTES:

1 DISCONNECT EXISTING SOLID STATE REDUCED VOLTAGE STARTER FROM THE INCOMING 400A MOTOR CIRCUIT PROTECTOR (MCP) RENDERING THE STARTER INOPERABLE. REUSE EXISTING 400A MCP TO FEED NEW CHILLED WATER PUMP.

2 P-11 IS A NEW PUMP. INSTALL NEW VFD AND FEEDERS.

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2/18.13	GRF

SCALE: 12" = 1'-0"

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE: MCCB2 ONE-LINE DIAGRAM

SHEET NO. E5.03

CADD FILE NO.

PANELBOARD S2B — 208/120 VOLTS — 3 PHASE — 4 WIRE — 225 AMP MAINS

MAIN BKR. TRIP: 225 — INCOMING FEEDER CKT. NO. T2B — MIN. RMS. SYM. 10,000 A.I.C. — LOCATION: DWG. E3.02 — MOUNTING: SURFACE

CKT. NO.	POLE NO.	TRIP AMPS	NO. POLES	WIRE AND CONDUIT	GND SIZE	LOAD SERVED	LOAD-AMPERES A	B	C	CKT. NO.	POLE NO.	TRIP AMPS	NO. POLES	WIRE AND CONDUIT	GND SIZE	LOAD SERVED
✳ 1	1	20	1			UNIT HTR-EAST DOCK	7.5			2	2	20	1	1/2"-2#10	10	LIGHTS-STAIR #3
3	3	25	1			UNIT HTRS-BOILER RM	5.0	13.8		4	4	20	1	1/2"-2#10	10	RECPT-TUNNEL LEVEL
5	5	20	1			UNIT HTRS-EAST VEST.		8.9	4.4	6	6	20	1	1/2"-2#10	10	O.H. DOOR-BOILER
7	7	20	1			RECPT-BOILER EAST	8.8		9.8	8	8	20	1	3/4"-2#8	8	O.H. DOOR-EAST
9	9	20	1			RECPT-BOILER EAST, EAST ELECTRICAL ROOM	9.8	6.0		10	10	20	1	3/4"-2#12	12	SECURITY-TUNNEL
11	11	20	1			RECPT-BOILER MID		2	9	12	12	20	1	3/4"-2#12	12	SECURITY-CONTROL
13	13	20	1			RECPT-BOILER MID	9		2	14	14	20	1	3/4"-2#12	12	SECURITY-WEST DOOR
15	15	20	1			RECPT-BOILER WEST		9		16	16	20	1	3/4"-2#12	12	SECURITY-EAST DOOR
17	17	20	1			RECPT-CHILLER EAST		2	9	18	18	20	1	3/4"-2#12	12	RECPT TOWER BASIN
19	19	20	1			RECPT-CHILLER EAST	7.5		1.5	20	20	20	1	3/4"-2#12	12	RECPT-CONTROL DESK
21	21	20	1			RECPT-CHILLER EAST	6	9		22	22	20	1	3/4"-2#12	12	RECPT-CONTROL DESK
23	23	20	1			RECPT-CHILLER EAST, NORTH		7.5	9	24	24	20	1	3/4"-2#12	12	RECPT-CONTROL DESK
25	25	20	1			RECPT-CHILLER MID	7.5		6	26	26	20	1	3/4"-2#12	12	RECPT-CONTROL ROOM
27	27	20	1			RECPT-CHILLER NORTH	10.5	7.5		28	28	20	1	3/4"-2#12	12	RECPT & WATER COOLER COFFEE MAKER
29	29	20	1			RECPT-PUMP RM, SOUTH EAST MEZZ		1.5	9	30	30	20	1	3/4"-2#12	12	RECPT-TRAINING, MECH
31	31	20	1			RECPT-PUMP RM, SOUTH EAST MEZZ EN 9,10,11	1.5		10	32	32	20	1	3/4"-2#12	12	RECPT-MC ROOM
33	33	20	1			RECPT-PUMP RM, MID	12	9		34	34	20	1	3/4"-2#12	12	RECPT-SHOP
35	35	20	1			RECPT-PUMP RM, WEST		10	9	36	36	20	1	3/4"-2#12	12	RECPT-SHOP
37	37	20	1	3/4"-2#10	10	RECPT-NORTH EAST MEZZ	9		12	38	38	20	1	3/4"-2#10	10	UNIT #6HTRS-WEST GRADE
39	39	20	1	3/4"-2#10	10	RECPT-NORTH WEST MEZZ	7.2	6		40	40	20	1	3/4"-2#10	10	RECPT-CATWALK
41	41	20	1	3/4"-2#12, #12G		FLOW ELEM- TUNNEL		10.5	2	42	42	20	1	3/4"-2#10	10	RECPT-ROOF
							103	103	9 102							

TOTAL CONNECTED LOAD IN AMPERES: (INCLUDES PANEL S2BA) — (RECEPTACLES OVER 10KVA AT 50%) — DEMAND FACTOR 55.8%
EXISTING PANEL 109 kVA — FEED THRU LUGS TO S2BA. — G.E. "A" SERIES PANEL — EST. DEMAND kVA 60.8

✳ #8 TO BOX, #12 FINAL CONNECTION TO DEVICE.

PANELBOARD S2BA (2) — 208/120 VOLTS — 3 PHASE — 4 WIRE — 225 AMP MAINS

MAIN BKR. TRIP: - — INCOMING FEEDER CKT. NO. - — MIN. RMS. SYM. 10,000 A.I.C. — LOCATION: DWG. E3.02 — MOUNTING: SURFACE

CKT. NO.	POLE NO.	TRIP AMPS	NO. POLES	WIRE AND CONDUIT	GND SIZE	LOAD SERVED	LOAD-AMPERES A	B	C	CKT. NO.	POLE NO.	TRIP AMPS	NO. POLES	WIRE AND CONDUIT	GND SIZE	LOAD SERVED
							30									
							30									
								30								
5	5	50	3	1"-3#6	6	WELDING RECPT-BOILER			30	6	6	50	3	1"-3#6	6	WELDING RECPT-SHOP
							30		30							
							30									
								30								
11	11	50	3	1"-3#6	6	WELDING RECPT-BOILER			30	12	12	50	3	1"-3#6	6	WELDING RECPT-MEZZ
							30			14	14	20	1			COOLING TOWR PLATFORM
							15									
								30		16	16	20	1			SOUND RACK MID RECPT
17	17	50	3	1"-3#6	6	WELDING RECPT-PUMP RM			2	18	18	20	1			SOUND RACK T&B RECPT
19	19	40	1			BOILER	20		30	20	20	20	1			LIBRARY COMP. TRAINING
21	21	20	1			CHEM FEED 227L-241M	4	1.5	2	22	22	20	1			RECEPTACLE
						OUTLET TO KITCHEN		1.5	25	24	24	20	1			OIL PMP FOR C. TOWER
25	25	40	2			JBOX	25		1.5	26						SPACE
27	27	20	1	3/4"-2#12	12	PUMP		9.8		28						SPACE
29	29	20	1	3/4"-2#10	10	O.H. DOOR - WEST			9.8	30						SPACE
							3.6			32						SPACE
								3.6		34						SPACE
35	35	15	3	3/4"-2#12	12	TUNNEL PUMP P-42			3.6	36						SPACE
37	37	20	1			SPARE				38						SPACE
39	39	20	1	3/4"C-2#12		CHEM FEED		7		40	40	20	1	3/4"C-2#12	12	P23
41	41	20	1	3/4"C-2#12		FLOW ELEMENT		7.2	2	42	42	20	1			SPARE
							218	183	207							

TOTAL CONNECTED LOAD IN AMPERES: — DEMAND FACTOR 49.9%
EXISTING PANEL 72.1 kVA — G.E. "A" SERIES PANEL — EST. DEMAND kVA 36.0

PANELBOARD L2A — 480/277 VOLTS — 3 PHASE — 4 WIRE — 225 AMP MAINS

MAIN BKR. TRIP: 100 A — INCOMING FEEDER CKT. NO. MCCA1.2 — MIN. RMS. SYM. 14,000 A.I.C. — LOCATION: DWG. E3.02 — MOUNTING: SURFACE

CKT. NO.	POLE NO.	TRIP AMPS	NO. POLES	WIRE AND CONDUIT	GND SIZE	LOAD SERVED	LOAD-AMPERES A	B	C	CKT. NO.	POLE NO.	TRIP AMPS	NO. POLES	WIRE AND CONDUIT	GND SIZE	LOAD SERVED
1	1	20	1	3/4"C-2#10	10	TUNNEL LEVEL VESTIBULE	3.3			2						
3	3	20	1	3/4"C-2#10	10	NW SHOPS, SWGR	16.2	10.3		4						
5	5	20	1	3/4"C-2#10	10	WEST BOILER		16.2	11.3	6	6	30	3	1"C-3#8	8	WATER HEATER NO.1 13.5KVA
7	7	20	1	3/4"C-2#10	10	EAST BOILER	12.6		16.2	8						SPACE
9	9	20	1	3/4"C-2#10	10	WEST CHILLER		4.7		10	10	20	1	3/4"C-2#10	10	EAST VESTIBULE LTG CONTROL POWER TO CONT
11	11	20	1	3/4"C-2#10	10	WEST CENTER CHILLER		6.1	13.0	12	12	20	1	3/4"C-2#10	10	TUNNEL
13	13	20	1	3/4"C-2#10	10	EAST CENTER CHILLER	12.0		3.7	14						HOBART UNIT, CLARK
15	15	20	1	3/4"C-2#10	10	EAST CHILLER	15	11.2		16						FORK LIFT BATTERY
17	17	20	1	3/4"C-2#10	10	CHILLER PUMP, FILTER		15	11.6	18	18	30	3			CHARGER
19	19	20	1	3/4"C-2#10	10	CORRIDOR	3.8		15	20						SPACE
21	21	20	1	3/4"C-2#10	10	CONTROL, CORRIDOR, REST ROOM AREA		7.5		22						SPACE
23	23	20	1	3/4"C-2#10	10	MECH. ROOM, TRAINING			3.1	24						SPACE
25	25	20	1	3/4"C-2#10	10	MEZZANINE	8.7			26						SPACE
(1) 27	27	20	1	3/4"C-2#10	10	EAST ELECTRICAL ROOM		1.3		28						SPACE
29						SPACE				30						SPACE
							71.6	72.3	73.9							

TOTAL CONNECTED LOAD IN AMPERES: — DEMAND FACTOR 100%
EXISTING PANEL 60.4 kVA — G.E. "A" SERIES PANEL — EST. DEMAND kVA 60.4

EXISTING M.C.C.

MOTOR CONTROL CENTER MCC B2 — 1600 AMPS — MAIN 65000 IAC RMS SYM
480 VOLTS — 3 PHASE — 3 WIRE — NEMA CLASS I — TYPE
- AMP NEUTRAL BUS — 1600 AMP GROUND BUS — HGMCB INCOMING CKT. NO.

CKT. NO.	NO. POLES	TRIP AMPS	MOTOR HP	CONN. kVA	NO. PH. WIRES & WIRE SIZE	GND SIZE	COND. SIZE	BKR. FR.	NEMA START	REMARKS	CAP KVAR
.1	3	50	20	22.4	3#8	10	.75	150	2	AHU-B4	-
.2	3	100	50	54	#4 TC	8	1.5	150	3	AHU-C2	-
.3	3	150	50	49.5	#4 TC	8	1.5	150	-	BOILER B4 BLOWER	15
.4	3	300	200	199	3#350MCM	2	3	400	5	COOL TWR CT-6	-
.5	3	200	100	103	#2/0 TC	6	2	400	4	HWPUMP P-4	30
.6	3	350	200	199	3#350MCM	3	3.0	400	5	CWPUMP P-14	-
.7	3	15	5	6.3	3#12	12	.75	150	-	FILTER PUMP P-51	-
.8	3	7	3	4.8	3#12	12	.75	150	1	HWPUMP P-66	-
.9	3	15	5	6.3	#12 TC	12	.75	150	-	BLR. B4 OIL PUMP	-
.10	**3**	**350**	**200**	**199**	**3-350kCMIL**	**2**	**3**	**400**	**-**	**CWS PUMP P-11 VFD**	**-**

LOAD DESCRIPTION	CONN. H.P.	CONN. kVA	DEMAND FACTOR	DEMAND kVA	FUTURE kVA	TOTAL kVA
HEATING MODE	158	**163.6**	0	-	-	-
COOLING MODE	600	**597**	1.0	**597**	-	**597**
CONTINUOUS	75	82.7	1.0	82.7	-	82.7
TOTAL	833	**843.3**	**.80**	**679.7**	-	**679.7**

PANELBOARD E2A — 480/277 VOLTS — 3 PHASE — 4 WIRE — 125 AMP MAINS

MAIN BKR. TRIP: 50 A — INCOMING FEEDER CKT. NO. EDP1.4 — MIN. RMS. SYM. 14,000 A.I.C. — LOCATION: DWG. E3.02 — MOUNTING: SURFACE

CKT. NO.	POLE NO.	TRIP AMPS	NO. POLES	WIRE AND CONDUIT	GND SIZE	LOAD SERVED	LOAD-AMPERES A	B	C	CKT. NO.	POLE NO.	TRIP AMPS	NO. POLES	WIRE AND CONDUIT	GND SIZE	LOAD SERVED
1	1	20	1	3/4"C-2#10	10	TUNNEL LVL VEST, LOWER NW AREA	7.6			2	2	20	1			SPARE
3	3	20	1	3/4"C-2#10	10	BOILER ROOM, **EAST ELECTRICAL ROOM**		**10.2**		4	4	20	1	3/4"C-2#10	10	REST ROOM, CONTROL ROOM AREA
5	5	20	1	3/4"C-2#10	10	CHILLER AND PUMP		1.6	13.6	6	6	20	1	3/4"C-2#10	10	EAST VESTIBULE
7						SPACE			1.7	8	8	20	1	3/4"C-2#10	10	PENTHOUSE
9	9	20	1	3/4"C-2#10	10	SOUTH STAIR NO. 2	4.4	2.1		10	10	20	1	3/4"C-2#10	10	MEZZANINE
11	11	20	1	3/4"C-2#10	10	NORTH STAIR NO. 1		3.7	2.4	12						SPACE
13	13	20	1	3/4"C-2#10	10	SOUTH STAIR NO. 1	2.7			14	14					SPACE
15						SPACE				16						SPACE
17						SPACE				18						SPACE
							14.7	**17.6**	**17.7**							

TOTAL CONNECTED LOAD IN AMPERES: — DEMAND FACTOR 100%
EXISTING PANEL 13.9 kVA — G.E. "A" SERIES PANEL — EST. DEMAND kVA 13.9

LUMINAIRE SCHEDULE

TYPE	LUMINAIRE	LAMP	VOLT	FINISH	DESCRIPTION	INPUT
◁	CRESCENT LIGHTING "LED ELIPSE SERIES" MODEL CSGW32E	LED	277	WHITE	EXIT LIGHT, WHITE, IMPACT-RESISTANT, SCRATCHPROOF, UV-STABLE THERMOPLASTIC. FACE SHALL BE STEEL STENCIL WITH 6" LETTERS AND UNIVERSAL CHEVRON DIRECTIONAL INDICATOR KNOCKOUTS, LED'S SHALL BE ENERGY EFFICIENT HIGH INTENSITY GREEN "GAN" LED'S, EQUIP WITH NICKEL CADMIUM BATTERIES AND WITH A BATTERY RECHARGE SYSTEM.	20 VA
A	LITHONIA AF10 2 32 MVOLT GEB10IS	(2) GE F32T8/SPX 35/ECO	277	WHITE	4' PENDANT-MOUNTED HEAVY DUTY INDUSTRIAL TURRET FLOURESCENT LUMINAIRE WITH (2) T8 CROSS-SECTION. 10% UPLIGHT. FURNISH LUMINAIRE WITH ELECTRONIC INSTANT START BALLAST.	70 VA

KEYED NOTES:

(1) PROVIDE AND INSTALL NEW 20A, 1 POLE CIRCUIT BREAKER MATCHING EXISTING CIRCUIT BREAKERS IN ALL ASPECTS INCLUDING AIC RATING. EXISTING CIRCUIT BREAKERS ARE G.E. TYPE TEY.

(2) PANELBOARD SCHEDULE PROVIDED FOR REFERENCE ONLY. NO CHANGES TO THIS PANEL.

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	23.8.13	GNP

SCALE: NONE
DATE: 10/23/12
DRAWN BY: P. HEIMBURGER
CHECKED BY: R. KELEMEN
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 201310046-00
VOLUME NO. 01

SHEET TITLE
MCC ROOM PANEL BOARD SCHEDULES 1

SHEET NO.
E6.01

CADD FILE NO.

PANELBOARD : P2B — 225A MAIN BUS — NONE MAIN BREAKER
VOLTS : 277Y/480V — 3Ø, 4 WIRE, SURFACE MOUNTED — 14,000 SYM. A.I.C. MINIMUM

	POLE NO.	TRIP AMPS	NO. POLE	WIRE	LOAD SERVED	LOAD-kVA A	LOAD-kVA B	LOAD-kVA C	POLE NO.	TRIP AMPS	NO. POLE	WIRE	LOAD SERVED
	1					**2.55** -			2				
3	**3**	**20**	**3**	**#12**	**TCV-104A,114A,204A,214A,C-4A**		**2.55** -		4	50	3		SPARE
	5							**2.55** -	6				
	7					**2.55** -			8				
3	**9**	**20**	**3**	**#12**	**TCV,104B,114B,204B,214B, C-4B**		**2.55** -		10	30	3	#12	SPARE TO JBOX NW WALL FOR FUTURE CCP #5
	11							**2.55** -	12				
	13					**3.88** 4.16			14				
4	**15**	**25**	**3**	**#10**	**AHU-ER2, NORTHEAST ELECTRICAL ROOM**		**3.88** 4.16		16	30	3	**#10**	RTU #1
	17							**3.88** 4.16	18				
	19					3.32 3.49			20				
	21	15	3	#12	RTU #2		3.32 3.49		22	20	3	#12	TCV-251,252,253,254
	23							3.32 3.49	24				
	25					- 3.49			26				
	27	100	3		SPARE		- 3.49		28	20	3	#12	SG-1 THRU 5, TCV-257
	29							- 3.49	30				
	31					- 3.77			32				
	33		3		SPACE		- 3.77		34	20	3	#12	TCV-221,222,223,258
	35							- 3.77	36				
	37					- -			38				
	39		3		SPACE		- -		40		3		SPACE
	41							- -	42				

TOTAL PER PH. LOAD = 27.2 27.2 27.2

TOTAL CONNECTED LOAD: 81.6 -kVA 98.2 -AMPS
DEMAND FACTOR 90.6% — EST DEMAND LOAD: 74.0 kVA 89.0 AMPS
LOCATION DWG, E3.03 — EXISTING PANEL

PANELBOARD P1C — 208/120 VOLTS — 3 PHASE — 4 WIRE — 225 AMP MAINS
MAIN BKR. TRIP: 200 A — INCOMING FEEDER CKT. NO. PP-1C — MIN. RMS. SYM. 22K A.I.C. — LOCATION: DWG. E3.03 — MOUNTING: SURFACE

	CKT. NO.	POLE NO.	TRIP AMPS	NO. POLES	WIRE AND CONDUIT	GND SIZE	LOAD SERVED	LOAD-AMPERES A	LOAD-AMPERES B	LOAD-AMPERES C	CKT. NO.	POLE NO.	TRIP AMPS	NO. POLES	WIRE AND CONDUIT	GND SIZE	LOAD SERVED
	1							3.3 1.5			2	2	20	1			RECEPT RM 119
	3	3	15	2	2-#10 THWN CU 3/4"C	10	ELEC RM CU-1		3.3 **5.0**		4	4	20	1			**CONTROL PANEL FIELD (CPF-2)**
2	**5**	**5**	**45**	**1**	**2-#8, 3/4"C**	**10**	**CHILLER 4A CONTROL PANEL**			**33.3 1.0**	6	6	20	1			**FIT-01,02,03,04**
2	**7**	**7**	**45**	**1**	**2-#8, 3/4"C**	**10**	**CHILLER 4B CONTROL PANEL**	**33.3 5.0**			8	8	20	1			**CONTROL PANEL FIELD (CPF-1)**
	9	9	20	1			SPARE				10	10	20	1			SPARE
	11	11	20	1			SPARE				12	12	20	1			SPARE
	13	13	20	1			SPARE				14	14	20	1			SPARE
	15	15	20	1			SPARE				16	16	20	1			SPARE
	17	17	20	1			SPARE				18	18	20	1			SPARE
	19	19	20	1			SPARE				20						
	21	21	20	1			SPARE				22						
	23	23	20	1			SPARE				24	24	30	3			SPARE
	25										26						
	27										28						
	29										30						
	31										32						
	33										34						
	35										36						
	37										38						
	39										40						
	41										42						
								43.1	8.3	34.3							

TOTAL CONNECTED LOAD IN AMPERES:
EXISTING PANEL 10.9 kVA
DEMAND FACTOR 100%
EST. DEMAND kVA 10.9

KEYED NOTES:

1. NOT USED.
2. REMOVE EXISTING 20A, 1 POLE CIRCUIT BREAKER AND RETURN TO OWNER. PROVIDE AND INSTALL NEW 45A, 1 POLE CIRCUIT BREAKER MATCHING EXISTING CIRCUIT BREAKERS IN ALL ASPECTS INCLUDING AIC RATING. EXISTING CIRCUIT BREAKERS ARE G.E. TYPE TEY.
3. REMOVE EXISTING SPARE G.E. TYPE TEY, 50A. 3P CIRCUIT BREAKER AND RETURN TO OWNER. PROVIDE AND INSTALL NEW 20A, 3P CIRCUIT BREAKER MATCHING EXISTING CIRCUIT BREAKER IN ALL ASPECTS INCLUDING AIC RATING.
4. REMOVE EXISTING SPARE G.E. TYPE TEY, 50A. 3P CIRCUIT BREAKER AND RETURN TO OWNER. PROVIDE AND INSTALL NEW 25A, 3P CIRCUIT BREAKER MATCHING EXISTING CIRCUIT BREAKER IN ALL ASPECTS INCLUDING AIC RATING.

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

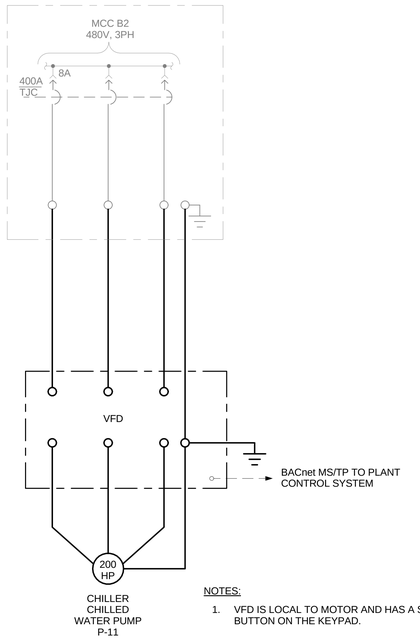
NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2/13,13	CHK

SCALE: NONE
DATE: 10/23/12
DRAWN BY: P. HEIMBURGER
CHECKED BY: R. KELEMEN
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 20131046-00
VOLUME NO. 01

SHEET TITLE
MCC ROOM PANEL BOARD SCHEDULES 2

SHEET NO.
E6.02

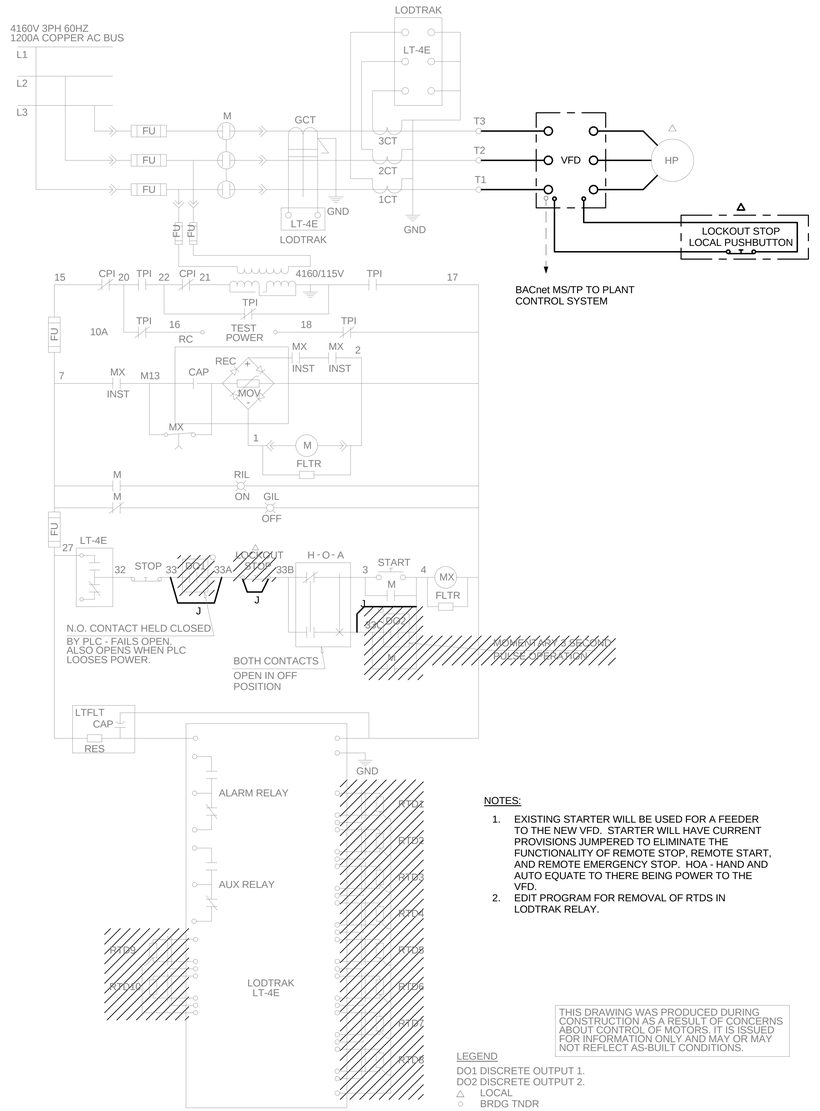
CADD FILE NO.



NOTES:

1. VFD IS LOCAL TO MOTOR AND HAS A STOP BUTTON ON THE KEYPAD.

CHILLER CHILLED WATER PUMP P-11
NOT TO SCALE



NOTES:

1. EXISTING STARTER WILL BE USED FOR A FEEDER TO THE NEW VFD. STARTER WILL HAVE CURRENT PROVISIONS JUMPERED TO ELIMINATE THE FUNCTIONALITY OF REMOTE STOP, REMOTE START, AND REMOTE EMERGENCY STOP. HOA - HAND AND AUTO EQUATE TO THERE BEING POWER TO THE VFD.
2. EDIT PROGRAM FOR REMOVAL OF RTDS IN LODTRAK RELAY.

LEGEND

DO1 DISCRETE OUTPUT 1.
DO2 DISCRETE OUTPUT 2.
△ LOCAL
○ BRDG TNDR

ITEM	SWGR	HP	AUTO CONTROL BY	DO1	DO2	MOTOR
CONDENSER WATER PUMP P-33	HGMC-B	450	BRDG TNDR	17		EXIST.
CONDENSER WATER PUMP P-34	HGMC-A	450	BRDG TNDR	18		EXIST.
CONDENSER WATER PUMP P-24	HGMC-A	250	BRDG TNDR	18		NEW

THIS DRAWING WAS PRODUCED DURING CONSTRUCTION AS A RESULT OF CONCERNS ABOUT CONTROL OF MOTORS. IT IS ISSUED FOR INFORMATION ONLY AND MAY OR MAY NOT REFLECT AS-BUILT CONDITIONS.

THIS DRAWING GENERATED AS A RESULT OF REVISIONS & QUESTIONS DURING CONSTRUCTION. IT IS INCLUDED FOR REFERENCE ONLY.

CONTROL DIAGRAM NO. 12

(DEVELOPED FROM G.E. DIAGRAM NO. 264B9992 SH. NO. 3 & BRDG TNDR DWG _____)
ALL DEVICES LOCATED IN SWGR EXCEPT AS NOTED.

CITY & COUNTY
of DENVER

DENVER
INTERNATIONAL
AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MAROON CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell
SINCE 1898

ISSUE RECORD

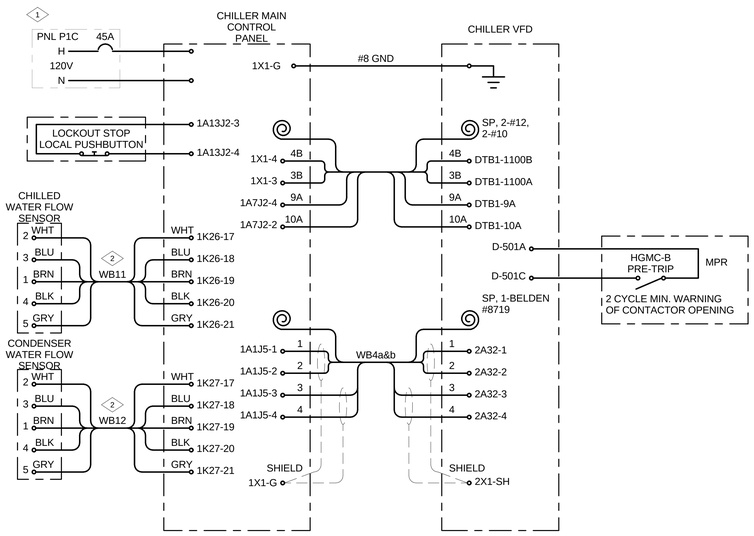
NO.	BY	PURPOSE	DATE	CKD
00	RDK	IFC	2/18.13	GRF

SCALE: NONE
DATE: 10/23/12
DRAWN BY: P. HEIMBURGER
CHECKED BY: R. KELEMEN
FAA AIP NO:
WORK BREAKDOWN NO.
DESIGN CONTRACT NO. CE-03024-09
CONST. CONTRACT NO. 20131004600
VOLUME NO. 01

SHEET TITLE
SCHEMATIC DIAGRAMS 1

SHEET NO.
E6.03

CADD FILE NO.



NOTES:

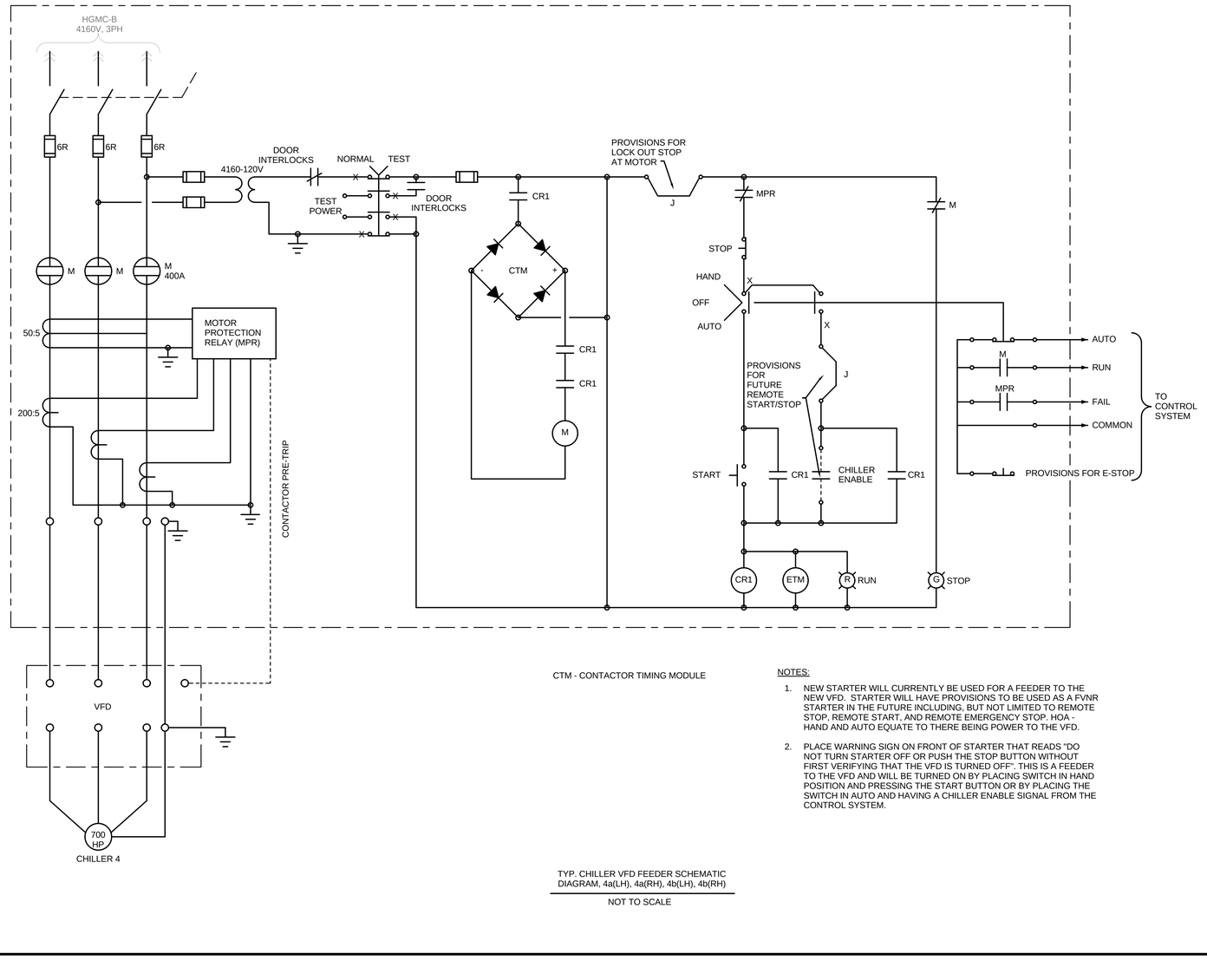
1. SEE SHEET E3.07 CONDUIT AND CONDUCTOR SCHEDULE.

KEYED NOTES:

1. 120V CIRCUIT REQIRED ON (LH) CHILLER CONTROL PANELS ONLY.
2. MANUFACTURER SUPPLIED CABLE.

TYP. CHILLER SCHEMATIC DIAGRAM, 4a(LH), 4a(RH), 4b(LH), 4b(RH)

NOT TO SCALE



CTM - CONTACTOR TIMING MODULE

NOTES:

1. NEW STARTER WILL CURRENTLY BE USED FOR A FEEDER TO THE NEW VFD. STARTER WILL HAVE PROVISIONS TO BE USED AS A FVNR STARTER IN THE FUTURE INCLUDING, BUT NOT LIMITED TO REMOTE STOP, REMOTE START, AND REMOTE EMERGENCY STOP. HOA - HAND AND AUTO EQUATE TO THERE BEING POWER TO THE VFD.
2. PLACE WARNING SIGN ON FRONT OF STARTER THAT READS "DO NOT TURN STARTER OFF OR PUSH THE STOP BUTTON WITHOUT FIRST VERIFYING THAT THE VFD IS TURNED OFF". THIS IS A FEEDER TO THE VFD AND WILL BE TURNED ON BY PLACING SWITCH IN HAND POSITION AND PRESSING THE START BUTTON OR BY PLACING THE SWITCH IN AUTO AND HAVING A CHILLER ENABLE SIGNAL FROM THE CONTROL SYSTEM.

TYP. CHILLER VFD FEEDER SCHEMATIC DIAGRAM, 4a(LH), 4a(RH), 4b(LH), 4b(RH)

NOT TO SCALE

CITY & COUNTY of DENVER

DENVER INTERNATIONAL AIRPORT

DESIGNER OF RECORD

BURNS & McDONNELL
9785 MARION CIRCLE, SUITE 400
CENTENNIAL, CO 80112
BMCD PROJECT NUMBER: 67715

CENTRAL UTILITY PLANT CHILLER ADDITION

Burns & McDonnell SINCE 1898

ISSUE RECORD

NO.	BY	PURPOSE	DATE	CKD
10	RDK	IFC	23JL13	GRF

SCALE: NONE

DATE: 10/23/12

DRAWN BY: P. HEIMBURGER

CHECKED BY: R. KELEMEN

FAA AIP NO:

WORK BREAKDOWN NO.

DESIGN CONTRACT NO. CE-03024-09

CONST. CONTRACT NO. 201310046-00

VOLUME NO. 01

SHEET TITLE: SCHEMATIC DIAGRAMS 2

SHEET NO. E6.04

CADD FILE NO.