A PROJECT OF THE
PEORIA PARK DISTRICT
PEORIA, ILLINOIS

CHILLER REPLACEMENT
NOBLE CENTER

1125 W LAKE AVENUE
PEORIA, ILLINOIS

PROJECT # 25-029

APRIL 7, 2026

PROJECT MANUAL

PACKAGE #_____

PROJECT MANUAL INCLUDING SPECIFICATIONS FOR:

CHILLER REPLACEMENT
NOBLE CENTER
1125 W LAKE AVENUE
PEORIA, ILLINOIS

OWNER:	PLEASURE DRIVEWAY AND PARK DISTRICT OF PEORIA, PEORIA, ILLINOIS
TRUSTEES:	ROBERT L. JOHNSON, SR., PRESIDENT RON SILVER STEVE MONTEZ MARK SLOVER JOYCE HARANT REAGAN LESLIE HILL ALEX SIERRA
PROJECT MANAGER:	DAVID VOORHEES PLANNING, DESIGN & CONSTRUCTION DIVISION BRADLEY PARK EQUIPMENT SERVICE 1314 N. PARK ROAD PEORIA, ILLINOIS 61604 TELEPHONE: (309) 678-0560
ADMINISTRATIVE STAFF:	EMILY CAHILL, EXECUTIVE DIRECTOR MATT FREEMAN, SUPERINTENDENT OF PARKS KARRIE ROSS, SUPERINTENDENT OF FINANCE AND ADMINISTRATIVE SERVICES BECKY FREDRICKSON, SUPERINTENDENT OF PLANNING, DESIGN AND CONSTRUCTION SHALESSE PIE, SUPERINTENDENT OF HUMAN RESOURCES SCOTT LOFTUS, SUPERINTENDENT OF RECREATION

****

Address all communications regarding this work to the PROJECT MANAGER listed above.

ADVERTISEMENT FOR BIDS

Sealed bids will be received by the Peoria Park District, Peoria, Illinois, hereinafter known as the Owner, for the following project:

CHILLER REPLACEMENT
NOBLE CENTER
1125 W LAKE AVENUE
PEORIA, ILLINOIS

It is the intent of the Owner to receive Base Bids for the project listed above.

Sealed bids will be received until TUESDAY, APRIL 21, 2026 AT 1:00 P.M. prevailing time, by the Owner, at the Peoria Park District Administrative Office, 1125 W. Lake Ave., Peoria, Illinois 61614. (The Board Room clock shall be the official time keeping device in respect to the bid submission deadline.)

An electronic file including Bid Documents is available at www.peoriaparks-planning.org at no charge. Bid Documents, including Plans, Specifications and Interpretations for this project may be obtained at the Planning, Design & Construction Department, Bradley Park Equipment Service, 1314 N. Park Road, Peoria, IL 61604. Telephone (309) 686-3386. A non-refundable plan deposit of THREE HUNDRED DOLLARS ($300.00) will be charged for each printed set of Bid Documents.

A list of planholders can be obtained upon request. This information will be available up to twenty-four (24) hours prior to the scheduled bid opening time. **After that deadline, no information pertaining to the project will be given.**

A 10% Bid Bond is required, and is to be included with the Bid Proposal. The successful Bidder will be required to furnish a 100% Performance Bond and a 100% Labor and Materials Payment Bond within ten (10) days of formal Award of Contract.

The general prevailing rate of wage for the Peoria area shall be paid for each craft or type of worker needed to execute this contract or perform this work as required by the State of Illinois Department of Labor. Additionally, it is required that provisions of the Illinois Preference Act, the Illinois Drug Free Workplace Act, and the Substance Abuse Prevention on Public Works Act must be adhered to. Bidders are also advised that contract documents for this project include the non-discrimination, equal opportunity and affirmative action provisions in the Human Rights Act and rules and regulations of the Department of Human Rights. The Peoria Park District is an AA/EEO organization and encourages participation by minority and female-owned firms.

The Peoria Park District reserves the right to reject any or all bids, waive technical deficiencies, informalities or irregularities or rebid any project.

PLEASURE DRIVEWAY AND PARK DISTRICT
OF PEORIA, ILLINOIS

BY: ROBERT L. JOHNSON, SR., President

BY: ALICIA WOODWORTH, Secretary

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SUPPLEMENTARY INSTRUCTIONS TO BIDDERS

1. INSTRUCTIONS TO BIDDERS

A. "Instructions to Bidders", AIA Document A701, 2018 Editions, published by the American Institute of Architects, including revisions adopted before date of this Project Manual, is hereby made part of these specifications with same force and effect as though set forth in full.

B. The following modifies, changes, deletes from or adds to the **Instructions to Bidders** (AIA Document A701, 2018 Edition). Where any Article of the Instructions to Bidders is modified or any Paragraph, Subparagraph or Clause thereof is modified or deleted by these Supplementary Conditions, the unaltered provisions of that Article, Paragraph, Subparagraph or Clause shall remain in effect.

C. Parenthesis ( ) indicates the appropriate section and Subparagraph of the Instructions to Bidders which each paragraph of the Supplementary Instructions to Bidders modifies or refers to.

2. PROJECT DESCRIPTION

A. The Project description generally is as follows:

1. BASE BID:

The project work includes all labor, materials and equipment necessary to upgrade all mechanical systems, instrumentation, components and finishes for the new chiller system at Noble Center, including but not limited to minor demolition and disposal of existing system, installation of all new mechanical pieces and hookups, and start up of system.

B. PRE-BID MEETING :

1. A pre-bid meeting will be held at the Noble Center on Tuesday, April 14th, 2026 at 10:00 a.m.

3. CODES AND PERMITS

A. COSTS ASSOCIATED WITH REGULATORY COMPLIANCE. All Work performed in connection with this Project shall be in compliance with the requirements of all applicable local, state, and federal laws, regulations, and rules, as well as the requirements of the Construction Documents. The Bid Price shall reflect all costs of compliance to those requirements, whether or not specifically stated in the Construction Documents or specific sections of the Project Manual.

B. PERMITS/FEES. Work shall not commence until all required building (and/or other) permits have been secured by the Contractor and copies of these permits submitted to the Owner's Representative. Cost of permits is to be included in the Bid Price.

4. BID GUARANTY

The bid must be accompanied by a Bid Guaranty which shall not be less than 10% of the amount of the Bid. At the option of the Bidder, the 10% Guaranty may be a Certified Check, Cashier's Check, or a Bid Bond. The Bid Bond shall be secured by a Guaranty or a Surety Company acceptable to the Owner. No bid will be considered unless it is accompanied by the required Guaranty. Funds must be made payable to the order of the Owner. Cash deposits will not be accepted. The Bid Guaranty shall ensure the execution of the Agreement and the furnishing of the Surety Bond or Bonds by the successful Bidder, all as required by the Contract Documents.

5. AWARD OF CONTRACT/REJECTION OF BIDS:

The Contracts will be awarded on the basis of Paragraph 5.3 of the Instructions to Bidders and Paragraph 16 of the Supplementary Instructions to Bidders. The Bidders to whom the awards are made will be notified at the earliest possible date. The Owner, however, reserves the right to reject any and all Bids, to accept any combination of base bids and alternates and to waive any technical deficiencies, informalities, or irregularities in Bids received whenever such rejection or waiver is in its interest.

No bid shall be withdrawn for a period of sixty (60) days after the opening of bids without the consent of the Owner. The failure of the Bidder to submit a Bid Bond, Certified Check or Cashier's Check in the full amount to cover all proposals bid upon shall be sufficient cause for rejection of his bid. The award will be made contingent upon submittal and evaluation of Contractor's Qualification Statement if requested, Bonds, Certificate of Insurance, Contractor Certifications, including Certification of Compliance of Listed Provisions and Laws, Peoria Park District Certificate of Equal Employment Opportunity Compliance for Contractors and Vendors, Workforce Profile, Company Ownership Certification, Minority/Women Owned Contact Sheet, Contractor/Subcontractor Workforce Plan, etc.

6. EXECUTION OF AGREEMENT:

Following the award and within ten (10) days after the prescribed forms are prepared and presented for signature by the Owner's Representative, the successful Bidder shall execute and return to the Owner's Representative the Agreement in the form included in the Contract Documents in such number of copies as the Owner may require. The Owner’s Representative will provide Notice to Proceed after all bonds and any other required documents have been received by the Park District.

7. PERFORMANCE BOND/LABOR AND MATERIAL PAYMENT BOND & INSURANCE

A. BONDS REQUIRED. Having satisfied all conditions of award as set forth elsewhere in these Documents, the successful Bidder shall, within ten (10) calendar days after award of contract, furnish Surety Bonds in penal sums, each not less than the amount of the Contract as awarded as security for the faithful performance of the Contract (Performance Bond), and for the payment (Labor and Materials Payment Bond) of all persons, firms or corporations to whom the Contractor may become legally indebted for labor, materials, tools, equipment or services employed or used by him in performing the work.

B. **FORM OF BONDS**. **Such bonds shall be in the same form as the samples included in the Project Manual** and shall bear the same date as or a date subsequent to that of the Agreement. The current Power of Attorney for the person who signs for any Surety Company shall be attached to such Bonds. Bonds shall be signed by a Guaranty or Surety Company acceptable to the Owner.

C. **COST OF PERFORMANCE BOND/LABOR AND MATERIAL PAYMENT BOND**. All costs for the Performance Bond/Labor and Material Payment Bond shall be included in the submitted Bid Price.

D. **INSURANCE.** Insurance requirements for this project are addressed both in the Supplementary General Conditions and in "Attachment A.6", in the "Exhibits" section of this Project Manual.

a) In respect to the property ("builders risk") insurance coverages referenced in the Supplementary General Conditions: the successful Bidder will be required to provide such coverages as the work of the Project will be accomplished by one general/prime contractor(s).

E. **TIME FRAMES.** The successful Bidder shall, within ten (10) days after award of contract by the Board of Trustees, submit Proof of Insurance coverages/Bonds in the form and amounts required to the Owner's Representative. Should the Bidder be unable to provide the required Proof of Insurance(s)/Bonds within the specified ten day period the Owner reserves the right, at its sole discretion, to withdraw its award of contract from that Bidder.

8. DEFAULT

A. The failure of the successful Bidders to execute the Agreement, supply the required Bonds or proof of required insurance coverage(s) within (ten) 10 days after award of contract, or within such extended period as the Owner may grant based upon reasons determined sufficient by the Owner, may constitute a default. In such case, award of contract will be transferred to the second lowest bidder.

9. CONTRACTOR'S QUALIFICATION STATEMENT

A. Contractor's Qualification Statement (AIA Document 305) shall be submitted by low bidder for evaluation prior to award of contract if so requested by the Owner or his representatives.

10. LIST OF SUBCONTRACTORS/PRODUCT & EQUIPMENT SUBSTITUTIONS

A. Each Bidder shall submit a "SUBCONTRACTORS LIST" proposed to be used in the execution of the Work. If there will be no subcontractors, the Bidder shall state "No Subcontractors" on this form. The completed form is due with the Bid Proposal.

1) Identify the trade name, address, telephone number, and category of work of each subcontractor.

2) Failure to submit the "Subcontractors List" with the Bid Proposal may result in the rejection of the Bid.

3) Delete Subparagraphs (6.3.1.1) from AIA A701.

B. The Bidder, by submission of a signed bid form, agrees to install all products and equipment by brand name or names specified in the Technical Specifications sections of this Project Manual. "Or equal" substitutions will be allowed only if approved in writing prior to the bid opening and listed in the "Substitutions" section of the Bid Form.

11. CONTRACT ADMINISTRATION FORMS/COSTS OF FORMS

A. **REQUIRED FORMS**. The following AIA forms will be used (AIA forms will be supplied by the Owner if requested, and charged to the Contractor at cost) in the administration of the project:

1) **AIA Document A310**: "Bid Bond", February 1970 edition

2) **AIA Document A305**: "Contractor's Qualification Statement", 1986 edition

3) **AIA Document G702**: "Application and Certificate of Payment", May 1992 edition

4) **AIA Document G703**: "Continuation Sheet", May 1992 edition

B. **OTHER FORMS**. Other contract administration forms (to be provided by the Owner unless otherwise noted) required for use in the Project are:

1) **Subcontractors List**

2) **Contractor's Affidavit**

3) **Performance Bond**

4) **Labor and Material Payment Bond**

5) **Lien Waiver Forms**

6) **Certified Payroll Form**

Please Note: Illinois State Law has changed. As a Contractor on a public works project, Contractor must submit certified payroll directly to the Illinois Department of Labor. See details at **https://www2.illinois.gov/idol/laws-rules/conmed/pages/prevailing-wage-portal.aspx**

The first time submitting certified payroll to this site requires additional set-up time and specialized forms that must be used.

After submitting certified payroll directly to the Illinois Department of Labor, Contractor will receive a PDF proof of submittal. A copy of this PDF proof of submittal is required with pay applications to Owner.

7) Insurance Forms: As required in Attachment A (at end of Project Manual) (will not be provided by Owner)

8) Agreement Between Owner and Contractor

Examples of these forms are included in the Project Manual.

12. CONSTRUCTION TIME AND LIQUIDATED DAMAGES CLAUSE:

PROJECT COMPLETION. The Agreement will include the following paragraph(s) or language substantially the same, regarding construction time and liquidated damages:

1) LIQUIDATED DAMAGES: Owner and Contractor recognize that time is of the essence of this Agreement and that Owner will suffer financial loss if the Work is not Substantially Complete within the time specified below, plus any extensions thereof allowed in accordance with Article 8 of the General Conditions. They also recognize the delays, expense and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time.

2) Accordingly, instead of requiring any such proof, Owner and Contractor agree that as Liquidated Damages for delay (but not as a penalty) Contractor shall pay Owner TWO HUNDRED AND FIFTY DOLLARS ($250.00) for each calendar day that expires after THREE HUNDRED AND FIFTY TWO (352) calendar days from Notice of Award until Substantial Completion is attained. The work is tentatively scheduled to begin on MAY 14, 2026 and be at Substantial Completion by APRIL 30, 2027. Actual work to begin on site starting October 2, 2026. Start up procedure for the new chiller system must be completed no later than APRIL 30, 2027.

3) After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work necessary to achieve Final Completion within FOURTEEN (14) calendar days or any proper extension thereof granted by Owner, Contractor shall pay Owner TWO HUNDRED AND FIFTY DOLLARS ($ 250.00) dollars for each day that expires after the time specified.

4) Owner and Contractor agree that the per day liquidated damage amounts set forth in subparagraphs "2" and "3" of this section constitute a reasonable forecast of the financial losses, actual costs and increased expenses the Owner may incur as a result of delayed Substantial or Final Completion of the Project.

13. PROJECT MANUAL/PLANS & SITE VISITATION

A. A set of Bid Documents may be examined, at no charge, at the office of the Owner's Representative.

B. **PLAN DEPOSIT**. An electronic file including Bid Documents is available at www.peoriaparks-planning.org at no charge. A printed set of Bid Documents, including Plans, Specifications and Interpretations for this project may be obtained at the Planning, Design & Construction Department, Bradley Park Equipment Service, 1314 N. Park Road, Peoria, IL 61604. Telephone (309)686-3386. A non-refundable plan deposit of THREE HUNDRED DOLLARS ($300.00) will be charged for each printed set of Bid Documents.

C. **FAMILIARITY WITH BID DOCUMENTS & SITE VISITATION**. Bidders, by submission of their Bids, represent that they have visited the site to acquaint themselves with the local conditions in which the Work is to occur, and that they are familiar with all the requirements of the Project, as defined in the Project Manual and the Plan(s).

14. OTHER MODIFICATIONS TO AIA-701/OTHER CONDITIONS

A. Add the following sentence to **(4.1.7)**: "Bidder shall submit two (2) completed copies of Bid Form and retain one (1) copy for his files."

B. Delete **(4.2.1)**

C. Delete Section **(6.2)** - "Owner's Financial Capability"

D. In reference to (**7.2.1**), the Peoria Park District reserves the right of final approval of bonding companies. Replace the first Sentence with "The Bidder shall deliver the required bonds to the Owner not later than ten days following the date of execution of the Contract."

E. Delete paragraph **(7.1.3).**

15. EQUAL EMPLOYMENT OPPORTUNITY/SEXUAL HARASSMENT

A. It is a goal of the Peoria Park District to encourage participation of minorities and women on Peoria Park District construction projects through contracts and workforce. Good Faith Effort must be made to encourage the use of minority and women owned businesses as sub-contractors and suppliers on the project.

On all bids $50,000.00 and over, see requirements listed in **Attachment B "Solicitation and Hiring for Qualifying Construction Contracts & Forms"**.

On all bids less than $50,000.00, complete and submit the following listed forms (provided in Attachment B) with the Bid.

Failure to submit the forms may result in rejection of the bid.

1. "**Peoria Park District Certificate of Equal Employment Opportunity Compliance for Contractors and Vendors**" Form

2. "**Workforce Profile**" Form

3. **"Company Ownership Certification"** Form

B. Effective July 1, 1993, every party to a public contract and every party bidding on public contracts is required to have a written **"Sexual Harassment Policy".** The Sexual Harassment Policy must contain:

1) A definition of sexual harassment under state law;

2) A description of sexual harassment utilizing examples;

3) A formalized complaint procedure;

4) A statement of victim's rights;

5) Directions on how to contact the Illinois Department of Human Rights **- Illinois companies**. Out-of-State companies must include directions on how to contact the enforcement agency within their state. Companies that issue a standard policy for all business locations must prepare an addendum providing directions on how to contact the appropriate enforcement agency.

6) A recitation that there cannot be any retaliation against employees who elect to file charges.

Recommendation: Your **"Sexual Harassment Policy"** should be drafted in language easy to understand and any revisions should be reviewed by legal counsel. A copy of your policy should be posted in a prominent and accessible location to assure all employees will be notified of the company's position.

In order to conduct business with the Peoria Park District, you must have a written "Sexual Harassment Policy" that conforms to the Act.

FAILURE TO DO SO WILL DISQUALIFY YOU AS AN ELIGIBLE VENDOR.

16. BID SUBMISSION

A. **DATE, TIME & PLACE OF RECEIVING BIDS**. Bids will be received until the date and time listed in the "Advertisement for Bids", at which time they will be publicly opened, read aloud and recorded. The Bid Opening will be held at the place listed in the "Advertisement for Bids".

B. **REQUIRED ITEMS**. The following items must be included as part of the "BID":

1) Two (2) signed copies of the **BID FORM**. (Retain the third copy for your files.)

2) The **SUBCONTRACTORS LIST**. (Submit form and state "No Subcontractors" on the form, if none will be used.)

3) The **PEORIA PARK DISTRICT CERTIFICATE OF EQUAL EMPLOYMENT OPPORTUNITY COMPLIANCE FOR CONTRACTORS AND VENDORS** form.

4) The **WORKFORCE PROFILE** form.

5) The **COMPANY OWNERSHIP CERTIFICATION** form.

6**)** The **CERTIFICATION OF COMPLIANCE OF THE LISTED PROVISIONS AND LAWS** form.

7**)** Completed **W-9.**

8**)** The **BID GUARANTY.**

9) If the bid is over $50,000.00, the **MINORITY/WOMEN OWNED CONTACT SHEET** form**.**

10**)** If the bid is over $50,000.00, the **CONTRACTOR/SUBCONTRACTOR WORKFORCE PLAN** form.

C. **BID SUBMISSION**. The "BID" shall be enclosed in envelopes (outer and inner), both of which shall be sealed and clearly labeled with the following information, in order to prevent premature opening of the bid:

- "PROPOSAL"
- NAME OF PROJECT
- NAME OF BIDDER
- DATE/TIME OF BID OPENING

END OF SUPPLEMENTARY INSTRUCTIONS TO BIDDERS

Bid From: _____

PROJECT NO. 25-029
BID FOR: CHILLER REPLACEMENT
LOCATION: NOBLE CENTER

BID FORM - REVISED

BID TO: PEORIA PARK DISTRICT

UNDERSIGNED:

1. Acknowledges receipt of:

   A. Project Manual and Drawings for:

   CHILLER REPLACEMENT
   NOBLE CENTER
   1125 W LAKE AVENUE
   PEORIA, ILLINOIS

   B. Addenda: No. _____ through No. _____

2. Has examined facility and the bid documents and shall be responsible for performing work specifically required of him by all parts of bidding documents including specifications for entire project, even though such work may be included as related requirements specified in other divisions or sections.

3. And agrees to enter into and execute Contract with Owner, if awarded on basis of this bid, and to:

   A. Furnish Bonds and Insurance required by the Bidding & Contract Documents.

   B. Accomplish work in accord with Contract.

   C. Complete work within specified Contract time.

4. **CONTRACT TIME**: Contractor agrees to Substantially Complete ALL WORK as required by the Contract Documents per the Supplementary General Conditions and Supplementary Instructions to Bidders.

5. **BASE BIDS**:
   A. Base Bid:
   Bidder agrees to perform all building and site work, as set forth in the Project Manual and Drawings for the sum of:

   _____ Dollars ($_____._____

6. **PROPOSED SUBSTITUTION LIST:**
   Base Bid(s) and Alternates are understood to include only those product brands, items, and elements which are specified in the Bid Documents. The following is a list of substitute products, equipment or methods of construction which the Bidder proposes to furnish on this project, with difference in price being added or deducted from Base Bid(s).

   Bidder understands that acceptance of any proposed substitution which has not been approved as an "equal" to the product brand, item, or element specified prior to bid opening is at Owner's option. Approval or rejection of any substitutions listed below will be indicated before executing Contract.

ITEM	ADD	DEDUCT
_____	$_____	$_____
_____	$_____	$_____
_____	$_____	$_____

7. **BIDDERS CHECKLIST:**

Did you visit the site?	Yes	No
Is Bid Security enclosed? (If applicable)	Yes	No
Is Peoria Park District Certificate of Equal Employment Opportunity Compliance for Contractors enclosed?	Yes	No
Is Workforce Profile enclosed?	Yes	No
Is Company Ownership Certification enclosed?	Yes	No
If the bid is $50,000.00 or over, the Minority/Women Owned Contact Sheet enclosed?	Yes	No
If the bid is $50,000.00 or over, the Contractor/Subcontractor Workforce Plan enclosed?	Yes	No
Is Subcontractors List enclosed?	Yes	No
Is Certification of Compliance of the Listed Provisions and Laws form enclosed?	Yes	No
Is a completed W-9 enclosed?	Yes	No

8. **BIDDER INFORMATION**:

NAME OF BIDDER:_____

ADDRESS: _____

CITY, STATE, ZIP: _____

TELEPHONE NO.: _____

BY: _____
(Signature of Authorized Official)

TITLE: _____

Bid From: _____

PROJECT NO. 25-029
BID FOR: CHILLER REPLACEMENT
LOCATION: NOBLE CENTER

BIDDER'S SEAL

WITNESS: _____

END OF BID FORM

SUBCONTRACTORS LIST

The following tabulation of Subcontractors shall be attached and made a condition of the Bid. The Bidder expressly understands and agrees to the following provisions:

A. If awarded a Contract as a result of this Bid, the subcontractors used in the prosecution of the work will be those listed below.
B. The following list includes all subcontractors, known at the time of the Bid, who will perform work on this project.
C. The subcontractors listed below are financially responsible and are qualified to perform the work required.
D. The subcontractors listed below comply with the requirements of the Contract Documents.
E. Any substitutions in the subcontractors listed below shall be requested in writing by the Contractor and must be approved in writing by the Owner. No sub-subcontractors will be allowed unless specifically stated on the form. All pertinent financial, performance, insurance and other applicable information shall be submitted with the request for substitution(s). Owner shall respond to such requests within 14 calendar days following the submission of all necessary information to the full satisfaction of the Owner.
F. Failure to submit the list of Subcontractors as stated herein shall constitute a material variation from the Invitation to Bid; and any such Bid may be rejected by the Owner.

Subcontractor Name	Telephone/Email	Area of Work	Minority/Women Owned Business (Yes/No)	Dollar Amount of Contract

BIDDER: _____

END OF SUBCONTRACTORS LIST

CERTIFICATION OF COMPLIANCE

OF THE LISTED PROVISIONS AND LAWS

1) **Illinois Drug Free Workplace Act of 1991**

2) **The Substance Abuse Prevention on Public Works Act Public Act 95-0635:**
Prohibits the use of drugs and alcohol while performing work on a public works project.

The Contractor/Subcontractor has signed collective bargaining agreement for all of its employees that deal with the subject matter or the Contractor/Subcontractor has a prevention program that meets or exceeds the requirements of the Public Act for all employees not covered by a collective bargaining agreement.

3) **Safety Compliance:**
Contractor/Subcontractors will comply with any and all prevailing occupational safety and health standards. Such compliance may include a training component or require a written program of compliance.

4) **Illinois Criminal Code, Illinois Compiled Statutes 720 ILCS 5/33E-3 and 5/33E-4:**
Contractor/Subcontractor has not been barred from bidding on public contract as a result of bid rigging or bid rotating.

The undersigned representative of the Contractor/Vendor hereby certifies to comply with the laws and provisions listed above.

_____
Contractor/Subcontractor

_____
Name of Authorized Representative (type or print)

_____
Signature of Authorized Representative

_____
Date

Form **W-9**
(Rev. March 2024)
Department of the Treasury
Internal Revenue Service

Request for Taxpayer Identification Number and Certification

Go to *www.irs.gov/FormW9* for instructions and the latest information.

Give form to the requester. Do not send to the IRS.

Before you begin. For guidance related to the purpose of Form W-9, see *Purpose of Form*, below.

Print or type. See ***Specific Instructions*** on page 3.

1 Name of entity/individual. An entry is required. (For a sole proprietor or disregarded entity, enter the owner's name on line 1, and enter the business/disregarded entity's name on line 2.)

2 Business name/disregarded entity name, if different from above.

3a Check the appropriate box for federal tax classification of the entity/individual whose name is entered on line 1. Check only **one** of the following seven boxes.

☐ Individual/sole proprietor ☐ C corporation ☐ S corporation ☐ Partnership ☐ Trust/estate

☐ LLC. Enter the tax classification (C = C corporation, S = S corporation, P = Partnership) . . . . .

Note: Check the "LLC" box above and, in the entry space, enter the appropriate code (C, S, or P) for the tax classification of the LLC, unless it is a disregarded entity. A disregarded entity should instead check the appropriate box for the tax classification of its owner.

☐ Other (see instructions)

3b If on line 3a you checked "Partnership" or "Trust/estate," or checked "LLC" and entered "P" as its tax classification, and you are providing this form to a partnership, trust, or estate in which you have an ownership interest, check this box if you have any foreign partners, owners, or beneficiaries. See instructions . . . . . ☐

4 Exemptions (codes apply only to certain entities, not individuals; see instructions on page 3):

Exempt payee code (if any)

Exemption from Foreign Account Tax Compliance Act (FATCA) reporting code (if any)

(Applies to accounts maintained outside the United States.)

5 Address (number, street, and apt. or suite no.). See instructions.

Requester's name and address (optional)

6 City, state, and ZIP code

7 List account number(s) here (optional)

Part I Taxpayer Identification Number (TIN)

Enter your TIN in the appropriate box. The TIN provided must match the name given on line 1 to avoid backup withholding. For individuals, this is generally your social security number (SSN). However, for a resident alien, sole proprietor, or disregarded entity, see the instructions for Part I, later. For other entities, it is your employer identification number (EIN). If you do not have a number, see *How to get a TIN*, later.

Note: If the account is in more than one name, see the instructions for line 1. See also *What Name and Number To Give the Requester* for guidelines on whose number to enter.

Social security number

			–		–				

or

Employer identification number

		–							

Part II Certification

Under penalties of perjury, I certify that:

1. The number shown on this form is my correct taxpayer identification number (or I am waiting for a number to be issued to me); and
2. I am not subject to backup withholding because (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Service (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or (c) the IRS has notified me that I am no longer subject to backup withholding; and
3. I am a U.S. citizen or other U.S. person (defined below); and
4. The FATCA code(s) entered on this form (if any) indicating that I am exempt from FATCA reporting is correct.

Certification instructions. You must cross out item 2 above if you have been notified by the IRS that you are currently subject to backup withholding because you have failed to report all interest and dividends on your tax return. For real estate transactions, item 2 does not apply. For mortgage interest paid, acquisition or abandonment of secured property, cancellation of debt, contributions to an individual retirement arrangement (IRA), and, generally, payments other than interest and dividends, you are not required to sign the certification, but you must provide your correct TIN. See the instructions for Part II, later.

Sign Here	**Signature of U.S. person**	**Date**

General Instructions

Section references are to the Internal Revenue Code unless otherwise noted.

Future developments. For the latest information about developments related to Form W-9 and its instructions, such as legislation enacted after they were published, go to *www.irs.gov/FormW9*.

What's New

Line 3a has been modified to clarify how a disregarded entity completes this line. An LLC that is a disregarded entity should check the appropriate box for the tax classification of its owner. Otherwise, it should check the "LLC" box and enter its appropriate tax classification.

New line 3b has been added to this form. A flow-through entity is required to complete this line to indicate that it has direct or indirect foreign partners, owners, or beneficiaries when it provides the Form W-9 to another flow-through entity in which it has an ownership interest. This change is intended to provide a flow-through entity with information regarding the status of its indirect foreign partners, owners, or beneficiaries, so that it can satisfy any applicable reporting requirements. For example, a partnership that has any indirect foreign partners may be required to complete Schedules K-2 and K-3. See the Partnership Instructions for Schedules K-2 and K-3 (Form 1065).

Purpose of Form

An individual or entity (Form W-9 requester) who is required to file an information return with the IRS is giving you this form because they

must obtain your correct taxpayer identification number (TIN), which may be your social security number (SSN), individual taxpayer identification number (ITIN), adoption taxpayer identification number (ATIN), or employer identification number (EIN), to report on an information return the amount paid to you, or other amount reportable on an information return. Examples of information returns include, but are not limited to, the following.

- Form 1099-INT (interest earned or paid).
- Form 1099-DIV (dividends, including those from stocks or mutual funds).
- Form 1099-MISC (various types of income, prizes, awards, or gross proceeds).
- Form 1099-NEC (nonemployee compensation).
- Form 1099-B (stock or mutual fund sales and certain other transactions by brokers).
- Form 1099-S (proceeds from real estate transactions).
- Form 1099-K (merchant card and third-party network transactions).
- Form 1098 (home mortgage interest), 1098-E (student loan interest), and 1098-T (tuition).
- Form 1099-C (canceled debt).
- Form 1099-A (acquisition or abandonment of secured property).

Use Form W-9 only if you are a U.S. person (including a resident alien), to provide your correct TIN.

Caution: If you don't return Form W-9 to the requester with a TIN, you might be subject to backup withholding. See *What is backup withholding*, later.

By signing the filled-out form, you:

1. Certify that the TIN you are giving is correct (or you are waiting for a number to be issued);

2. Certify that you are not subject to backup withholding; or

3. Claim exemption from backup withholding if you are a U.S. exempt payee; and

4. Certify to your non-foreign status for purposes of withholding under chapter 3 or 4 of the Code (if applicable); and

5. Certify that FATCA code(s) entered on this form (if any) indicating that you are exempt from the FATCA reporting is correct. See *What Is FATCA Reporting*, later, for further information.

Note: If you are a U.S. person and a requester gives you a form other than Form W-9 to request your TIN, you must use the requester's form if it is substantially similar to this Form W-9.

Definition of a U.S. person. For federal tax purposes, you are considered a U.S. person if you are:

- An individual who is a U.S. citizen or U.S. resident alien;
- A partnership, corporation, company, or association created or organized in the United States or under the laws of the United States;
- An estate (other than a foreign estate); or
- A domestic trust (as defined in Regulations section 301.7701-7).

Establishing U.S. status for purposes of chapter 3 and chapter 4 withholding. Payments made to foreign persons, including certain distributions, allocations of income, or transfers of sales proceeds, may be subject to withholding under chapter 3 or chapter 4 of the Code (sections 1441–1474). Under those rules, if a Form W-9 or other certification of non-foreign status has not been received, a withholding agent, transferee, or partnership (payor) generally applies presumption rules that may require the payor to withhold applicable tax from the recipient, owner, transferor, or partner (payee). See Pub. 515, Withholding of Tax on Nonresident Aliens and Foreign Entities.

The following persons must provide Form W-9 to the payor for purposes of establishing its non-foreign status.

- In the case of a disregarded entity with a U.S. owner, the U.S. owner of the disregarded entity and not the disregarded entity.
- In the case of a grantor trust with a U.S. grantor or other U.S. owner, generally, the U.S. grantor or other U.S. owner of the grantor trust and not the grantor trust.
- In the case of a U.S. trust (other than a grantor trust), the U.S. trust and not the beneficiaries of the trust.

See Pub. 515 for more information on providing a Form W-9 or a certification of non-foreign status to avoid withholding.

Foreign person. If you are a foreign person or the U.S. branch of a foreign bank that has elected to be treated as a U.S. person (under Regulations section 1.1441-1(b)(2)(iv) or other applicable section for chapter 3 or 4 purposes), do not use Form W-9. Instead, use the appropriate Form W-8 or Form 8233 (see Pub. 515). If you are a qualified foreign pension fund under Regulations section 1.897(l)-1(d), or a partnership that is wholly owned by qualified foreign pension funds, that is treated as a non-foreign person for purposes of section 1445 withholding, do not use Form W-9. Instead, use Form W-8EXP (or other certification of non-foreign status).

Nonresident alien who becomes a resident alien. Generally, only a nonresident alien individual may use the terms of a tax treaty to reduce or eliminate U.S. tax on certain types of income. However, most tax treaties contain a provision known as a saving clause. Exceptions specified in the saving clause may permit an exemption from tax to continue for certain types of income even after the payee has otherwise become a U.S. resident alien for tax purposes.

If you are a U.S. resident alien who is relying on an exception contained in the saving clause of a tax treaty to claim an exemption from U.S. tax on certain types of income, you must attach a statement to Form W-9 that specifies the following five items.

1. The treaty country. Generally, this must be the same treaty under which you claimed exemption from tax as a nonresident alien.

2. The treaty article addressing the income.

3. The article number (or location) in the tax treaty that contains the saving clause and its exceptions.

4. The type and amount of income that qualifies for the exemption from tax.

5. Sufficient facts to justify the exemption from tax under the terms of the treaty article.

Example. Article 20 of the U.S.-China income tax treaty allows an exemption from tax for scholarship income received by a Chinese student temporarily present in the United States. Under U.S. law, this student will become a resident alien for tax purposes if their stay in the United States exceeds 5 calendar years. However, paragraph 2 of the first Protocol to the U.S.-China treaty (dated April 30, 1984) allows the provisions of Article 20 to continue to apply even after the Chinese student becomes a resident alien of the United States. A Chinese student who qualifies for this exception (under paragraph 2 of the first Protocol) and is relying on this exception to claim an exemption from tax on their scholarship or fellowship income would attach to Form W-9 a statement that includes the information described above to support that exemption.

If you are a nonresident alien or a foreign entity, give the requester the appropriate completed Form W-8 or Form 8233.

Backup Withholding

What is backup withholding? Persons making certain payments to you must under certain conditions withhold and pay to the IRS 24% of such payments. This is called "backup withholding." Payments that may be subject to backup withholding include, but are not limited to, interest, tax-exempt interest, dividends, broker and barter exchange transactions, rents, royalties, nonemployee pay, payments made in settlement of payment card and third-party network transactions, and certain payments from fishing boat operators. Real estate transactions are not subject to backup withholding.

You will not be subject to backup withholding on payments you receive if you give the requester your correct TIN, make the proper certifications, and report all your taxable interest and dividends on your tax return.

Payments you receive will be subject to backup withholding if:

1. You do not furnish your TIN to the requester;

2. You do not certify your TIN when required (see the instructions for Part II for details);

3. The IRS tells the requester that you furnished an incorrect TIN;

4. The IRS tells you that you are subject to backup withholding because you did not report all your interest and dividends on your tax return (for reportable interest and dividends only); or

5. You do not certify to the requester that you are not subject to backup withholding, as described in item 4 under "*By signing the filled-out form*" above (for reportable interest and dividend accounts opened after 1983 only).

Certain payees and payments are exempt from backup withholding. See *Exempt payee code*, later, and the separate Instructions for the Requester of Form W-9 for more information.

See also *Establishing U.S. status for purposes of chapter 3 and chapter 4 withholding*, earlier.

What Is FATCA Reporting?

The Foreign Account Tax Compliance Act (FATCA) requires a participating foreign financial institution to report all U.S. account holders that are specified U.S. persons. Certain payees are exempt from FATCA reporting. See *Exemption from FATCA reporting code*, later, and the Instructions for the Requester of Form W-9 for more information.

Updating Your Information

You must provide updated information to any person to whom you claimed to be an exempt payee if you are no longer an exempt payee and anticipate receiving reportable payments in the future from this person. For example, you may need to provide updated information if you are a C corporation that elects to be an S corporation, or if you are no longer tax exempt. In addition, you must furnish a new Form W-9 if the name or TIN changes for the account, for example, if the grantor of a grantor trust dies.

Penalties

Failure to furnish TIN. If you fail to furnish your correct TIN to a requester, you are subject to a penalty of $50 for each such failure unless your failure is due to reasonable cause and not to willful neglect.

Civil penalty for false information with respect to withholding. If you make a false statement with no reasonable basis that results in no backup withholding, you are subject to a $500 penalty.

Criminal penalty for falsifying information. Willfully falsifying certifications or affirmations may subject you to criminal penalties including fines and/or imprisonment.

Misuse of TINs. If the requester discloses or uses TINs in violation of federal law, the requester may be subject to civil and criminal penalties.

Specific Instructions

Line 1

You must enter one of the following on this line; **do not** leave this line blank. The name should match the name on your tax return.

If this Form W-9 is for a joint account (other than an account maintained by a foreign financial institution (FFI)), list first, and then circle, the name of the person or entity whose number you entered in Part I of Form W-9. If you are providing Form W-9 to an FFI to document a joint account, each holder of the account that is a U.S. person must provide a Form W-9.

• **Individual.** Generally, enter the name shown on your tax return. If you have changed your last name without informing the Social Security Administration (SSA) of the name change, enter your first name, the last name as shown on your social security card, and your new last name.

Note for ITIN applicant: Enter your individual name as it was entered on your Form W-7 application, line 1a. This should also be the same as the name you entered on the Form 1040 you filed with your application.

• **Sole proprietor.** Enter your individual name as shown on your Form 1040 on line 1. Enter your business, trade, or "doing business as" (DBA) name on line 2.

• **Partnership, C corporation, S corporation, or LLC, other than a disregarded entity.** Enter the entity's name as shown on the entity's tax return on line 1 and any business, trade, or DBA name on line 2.

• **Other entities.** Enter your name as shown on required U.S. federal tax documents on line 1. This name should match the name shown on the charter or other legal document creating the entity. Enter any business, trade, or DBA name on line 2.

• **Disregarded entity.** In general, a business entity that has a single owner, including an LLC, and is not a corporation, is disregarded as an entity separate from its owner (a disregarded entity). See Regulations section 301.7701-2(c)(2). A disregarded entity should check the appropriate box for the tax classification of its owner. Enter the owner's name on line 1. The name of the owner entered on line 1 should never be a disregarded entity. The name on line 1 should be the name shown on the income tax return on which the income should be reported. For example, if a foreign LLC that is treated as a disregarded entity for U.S. federal tax purposes has a single owner that is a U.S. person, the U.S. owner's name is required to be provided on line 1. If the direct owner of the entity is also a disregarded entity, enter the first owner that is not disregarded for federal tax purposes. Enter the disregarded entity's name on line 2. If the owner of the disregarded entity is a foreign person, the owner must complete an appropriate Form W-8 instead of a Form W-9. This is the case even if the foreign person has a U.S. TIN.

Line 2

If you have a business name, trade name, DBA name, or disregarded entity name, enter it on line 2.

Line 3a

Check the appropriate box on line 3a for the U.S. federal tax classification of the person whose name is entered on line 1. Check only one box on line 3a.

IF the entity/individual on line 1 is a(n) . . .	THEN check the box for . . .
• Corporation	Corporation.
• Individual or • Sole proprietorship	Individual/sole proprietor.
• LLC classified as a partnership for U.S. federal tax purposes or • LLC that has filed Form 8832 or 2553 electing to be taxed as a corporation	Limited liability company and enter the appropriate tax classification: P = Partnership, C = C corporation, or S = S corporation.
• Partnership	Partnership.
• Trust/estate	Trust/estate.

Line 3b

Check this box if you are a partnership (including an LLC classified as a partnership for U.S. federal tax purposes), trust, or estate that has any foreign partners, owners, or beneficiaries, and you are providing this form to a partnership, trust, or estate, in which you have an ownership interest. You must check the box on line 3b if you receive a Form W-8 (or documentary evidence) from any partner, owner, or beneficiary establishing foreign status or if you receive a Form W-9 from any partner, owner, or beneficiary that has checked the box on line 3b.

Note: A partnership that provides a Form W-9 and checks box 3b may be required to complete Schedules K-2 and K-3 (Form 1065). For more information, see the Partnership Instructions for Schedules K-2 and K-3 (Form 1065).

If you are required to complete line 3b but fail to do so, you may not receive the information necessary to file a correct information return with the IRS or furnish a correct payee statement to your partners or beneficiaries. See, for example, sections 6698, 6722, and 6724 for penalties that may apply.

Line 4 Exemptions

If you are exempt from backup withholding and/or FATCA reporting, enter in the appropriate space on line 4 any code(s) that may apply to you.

Exempt payee code.

• Generally, individuals (including sole proprietors) are not exempt from backup withholding.

• Except as provided below, corporations are exempt from backup withholding for certain payments, including interest and dividends.

• Corporations are not exempt from backup withholding for payments made in settlement of payment card or third-party network transactions.

• Corporations are not exempt from backup withholding with respect to attorneys' fees or gross proceeds paid to attorneys, and corporations that provide medical or health care services are not exempt with respect to payments reportable on Form 1099-MISC.

The following codes identify payees that are exempt from backup withholding. Enter the appropriate code in the space on line 4.

1—An organization exempt from tax under section 501(a), any IRA, or a custodial account under section 403(b)(7) if the account satisfies the requirements of section 401(f)(2).

2—The United States or any of its agencies or instrumentalities.

3—A state, the District of Columbia, a U.S. commonwealth or territory, or any of their political subdivisions or instrumentalities.

4—A foreign government or any of its political subdivisions, agencies, or instrumentalities.

5—A corporation.

6—A dealer in securities or commodities required to register in the United States, the District of Columbia, or a U.S. commonwealth or territory.

7—A futures commission merchant registered with the Commodity Futures Trading Commission.

8—A real estate investment trust.

9—An entity registered at all times during the tax year under the Investment Company Act of 1940.

10—A common trust fund operated by a bank under section 584(a).

11—A financial institution as defined under section 581.

12—A middleman known in the investment community as a nominee or custodian.

13—A trust exempt from tax under section 664 or described in section 4947.

The following chart shows types of payments that may be exempt from backup withholding. The chart applies to the exempt payees listed above, 1 through 13.

IF the payment is for . . .	THEN the payment is exempt for . . .
• Interest and dividend payments	All exempt payees except for 7.
• Broker transactions	Exempt payees 1 through 4 and 6 through 11 and all C corporations. S corporations must not enter an exempt payee code because they are exempt only for sales of noncovered securities acquired prior to 2012.
• Barter exchange transactions and patronage dividends	Exempt payees 1 through 4.
• Payments over $600 required to be reported and direct sales over $5,000[1]	Generally, exempt payees 1 through 5.[2]
• Payments made in settlement of payment card or third-party network transactions	Exempt payees 1 through 4.

[1] See Form 1099-MISC, Miscellaneous Information, and its instructions.

[2] However, the following payments made to a corporation and reportable on Form 1099-MISC are not exempt from backup withholding: medical and health care payments, attorneys' fees, gross proceeds paid to an attorney reportable under section 6045(f), and payments for services paid by a federal executive agency.

Exemption from FATCA reporting code. The following codes identify payees that are exempt from reporting under FATCA. These codes apply to persons submitting this form for accounts maintained outside of the United States by certain foreign financial institutions. Therefore, if you are only submitting this form for an account you hold in the United States, you may leave this field blank. Consult with the person requesting this form if you are uncertain if the financial institution is subject to these requirements. A requester may indicate that a code is not required by providing you with a Form W-9 with "Not Applicable" (or any similar indication) entered on the line for a FATCA exemption code.

A—An organization exempt from tax under section 501(a) or any individual retirement plan as defined in section 7701(a)(37).

B—The United States or any of its agencies or instrumentalities.

C—A state, the District of Columbia, a U.S. commonwealth or territory, or any of their political subdivisions or instrumentalities.

D—A corporation the stock of which is regularly traded on one or more established securities markets, as described in Regulations section 1.1472-1(c)(1)(i).

E—A corporation that is a member of the same expanded affiliated group as a corporation described in Regulations section 1.1472-1(c)(1)(i).

F—A dealer in securities, commodities, or derivative financial instruments (including notional principal contracts, futures, forwards, and options) that is registered as such under the laws of the United States or any state.

G—A real estate investment trust.

H—A regulated investment company as defined in section 851 or an entity registered at all times during the tax year under the Investment Company Act of 1940.

I—A common trust fund as defined in section 584(a).

J—A bank as defined in section 581.

K—A broker.

L—A trust exempt from tax under section 664 or described in section 4947(a)(1).

M—A tax-exempt trust under a section 403(b) plan or section 457(g) plan.

Note: You may wish to consult with the financial institution requesting this form to determine whether the FATCA code and/or exempt payee code should be completed.

Line 5

Enter your address (number, street, and apartment or suite number). This is where the requester of this Form W-9 will mail your information returns. If this address differs from the one the requester already has on file, enter "NEW" at the top. If a new address is provided, there is still a chance the old address will be used until the payor changes your address in their records.

Line 6

Enter your city, state, and ZIP code.

Part I. Taxpayer Identification Number (TIN)

Enter your TIN in the appropriate box. If you are a resident alien and you do not have, and are not eligible to get, an SSN, your TIN is your IRS ITIN. Enter it in the entry space for the Social security number. If you do not have an ITIN, see *How to get a TIN* below.

If you are a sole proprietor and you have an EIN, you may enter either your SSN or EIN.

If you are a single-member LLC that is disregarded as an entity separate from its owner, enter the owner's SSN (or EIN, if the owner has one). If the LLC is classified as a corporation or partnership, enter the entity's EIN.

Note: See *What Name and Number To Give the Requester*, later, for further clarification of name and TIN combinations.

How to get a TIN. If you do not have a TIN, apply for one immediately. To apply for an SSN, get Form SS-5, Application for a Social Security Card, from your local SSA office or get this form online at *www.SSA.gov*. You may also get this form by calling 800-772-1213. Use Form W-7, Application for IRS Individual Taxpayer Identification Number, to apply for an ITIN, or Form SS-4, Application for Employer Identification Number, to apply for an EIN. You can apply for an EIN online by accessing the IRS website at *www.irs.gov/EIN*. Go to *www.irs.gov/Forms* to view, download, or print Form W-7 and/or Form SS-4. Or, you can go to *www.irs.gov/OrderForms* to place an order and have Form W-7 and/or Form SS-4 mailed to you within 15 business days.

If you are asked to complete Form W-9 but do not have a TIN, apply for a TIN and enter "Applied For" in the space for the TIN, sign and date the form, and give it to the requester. For interest and dividend payments, and certain payments made with respect to readily tradable instruments, you will generally have 60 days to get a TIN and give it to the requester before you are subject to backup withholding on payments. The 60-day rule does not apply to other types of payments. You will be subject to backup withholding on all such payments until you provide your TIN to the requester.

Note: Entering "Applied For" means that you have already applied for a TIN or that you intend to apply for one soon. See also *Establishing U.S. status for purposes of chapter 3 and chapter 4 withholding*, earlier, for when you may instead be subject to withholding under chapter 3 or 4 of the Code.

Caution: A disregarded U.S. entity that has a foreign owner must use the appropriate Form W-8.

Part II. Certification

To establish to the withholding agent that you are a U.S. person, or resident alien, sign Form W-9. You may be requested to sign by the withholding agent even if item 1, 4, or 5 below indicates otherwise.

For a joint account, only the person whose TIN is shown in Part I should sign (when required). In the case of a disregarded entity, the person identified on line 1 must sign. Exempt payees, see *Exempt payee code*, earlier.

Signature requirements. Complete the certification as indicated in items 1 through 5 below.

1. Interest, dividend, and barter exchange accounts opened before 1984 and broker accounts considered active during 1983. You must give your correct TIN, but you do not have to sign the certification.

2. Interest, dividend, broker, and barter exchange accounts opened after 1983 and broker accounts considered inactive during 1983. You must sign the certification or backup withholding will apply. If you are subject to backup withholding and you are merely providing your correct TIN to the requester, you must cross out item 2 in the certification before signing the form.

3. Real estate transactions. You must sign the certification. You may cross out item 2 of the certification.

4. Other payments. You must give your correct TIN, but you do not have to sign the certification unless you have been notified that you have previously given an incorrect TIN. "Other payments" include payments made in the course of the requester's trade or business for rents, royalties, goods (other than bills for merchandise), medical and health care services (including payments to corporations), payments to a nonemployee for services, payments made in settlement of payment card and third-party network transactions, payments to certain fishing boat crew members and fishermen, and gross proceeds paid to attorneys (including payments to corporations).

5. Mortgage interest paid by you, acquisition or abandonment of secured property, cancellation of debt, qualified tuition program payments (under section 529), ABLE accounts (under section 529A), IRA, Coverdell ESA, Archer MSA or HSA contributions or distributions, and pension distributions. You must give your correct TIN, but you do not have to sign the certification.

What Name and Number To Give the Requester

For this type of account:	Give name and SSN of:
1. Individual	The individual
2. Two or more individuals (joint account) other than an account maintained by an FFI	The actual owner of the account or, if combined funds, the first individual on the account[1]
3. Two or more U.S. persons (joint account maintained by an FFI)	Each holder of the account
4. Custodial account of a minor (Uniform Gift to Minors Act)	The minor[2]
5. a. The usual revocable savings trust (grantor is also trustee)	The grantor-trustee[1]
b. So-called trust account that is not a legal or valid trust under state law	The actual owner[1]
6. Sole proprietorship or disregarded entity owned by an individual	The owner[3]
7. Grantor trust filing under Optional Filing Method 1 (see Regulations section 1.671-4(b)(2)(i)(A))**	The grantor*
8. Disregarded entity not owned by an individual	The owner
9. A valid trust, estate, or pension trust	Legal entity[4]
10. Corporation or LLC electing corporate status on Form 8832 or Form 2553	The corporation
11. Association, club, religious, charitable, educational, or other tax-exempt organization	The organization
12. Partnership or multi-member LLC	The partnership
13. A broker or registered nominee	The broker or nominee
14. Account with the Department of Agriculture in the name of a public entity (such as a state or local government, school district, or prison) that receives agricultural program payments	The public entity
15. Grantor trust filing Form 1041 or under the Optional Filing Method 2, requiring Form 1099 (see Regulations section 1.671-4(b)(2)(i)(B))**	The trust

[1] List first and circle the name of the person whose number you furnish. If only one person on a joint account has an SSN, that person's number must be furnished.

[2] Circle the minor's name and furnish the minor's SSN.

[3] You must show your individual name on line 1, and enter your business or DBA name, if any, on line 2. You may use either your SSN or EIN (if you have one), but the IRS encourages you to use your SSN.

[4] List first and circle the name of the trust, estate, or pension trust. (Do not furnish the TIN of the personal representative or trustee unless the legal entity itself is not designated in the account title.)

* **Note:** The grantor must also provide a Form W-9 to the trustee of the trust.

** For more information on optional filing methods for grantor trusts, see the Instructions for Form 1041.

Note: If no name is circled when more than one name is listed, the number will be considered to be that of the first name listed.

Secure Your Tax Records From Identity Theft

Identity theft occurs when someone uses your personal information, such as your name, SSN, or other identifying information, without your permission to commit fraud or other crimes. An identity thief may use your SSN to get a job or may file a tax return using your SSN to receive a refund.

To reduce your risk:

- Protect your SSN,
- Ensure your employer is protecting your SSN, and
- Be careful when choosing a tax return preparer.

If your tax records are affected by identity theft and you receive a notice from the IRS, respond right away to the name and phone number printed on the IRS notice or letter.

If your tax records are not currently affected by identity theft but you think you are at risk due to a lost or stolen purse or wallet, questionable credit card activity, or a questionable credit report, contact the IRS Identity Theft Hotline at 800-908-4490 or submit Form 14039.

For more information, see Pub. 5027, Identity Theft Information for Taxpayers.

Victims of identity theft who are experiencing economic harm or a systemic problem, or are seeking help in resolving tax problems that have not been resolved through normal channels, may be eligible for Taxpayer Advocate Service (TAS) assistance. You can reach TAS by calling the TAS toll-free case intake line at 877-777-4778 or TTY/TDD 800-829-4059.

Protect yourself from suspicious emails or phishing schemes. Phishing is the creation and use of email and websites designed to mimic legitimate business emails and websites. The most common act is sending an email to a user falsely claiming to be an established legitimate enterprise in an attempt to scam the user into surrendering private information that will be used for identity theft.

The IRS does not initiate contacts with taxpayers via emails. Also, the IRS does not request personal detailed information through email or ask taxpayers for the PIN numbers, passwords, or similar secret access information for their credit card, bank, or other financial accounts.

If you receive an unsolicited email claiming to be from the IRS, forward this message to *phishing@irs.gov*. You may also report misuse of the IRS name, logo, or other IRS property to the Treasury Inspector General for Tax Administration (TIGTA) at 800-366-4484. You can forward suspicious emails to the Federal Trade Commission at *spam@uce.gov* or report them at *www.ftc.gov/complaint*. You can contact the FTC at *www.ftc.gov/idtheft* or 877-IDTHEFT (877-438-4338). If you have been the victim of identity theft, see *www.IdentityTheft.gov* and Pub. 5027.

Go to *www.irs.gov/IdentityTheft* to learn more about identity theft and how to reduce your risk.

Privacy Act Notice

Section 6109 of the Internal Revenue Code requires you to provide your correct TIN to persons (including federal agencies) who are required to file information returns with the IRS to report interest, dividends, or certain other income paid to you; mortgage interest you paid; the acquisition or abandonment of secured property; the cancellation of debt; or contributions you made to an IRA, Archer MSA, or HSA. The person collecting this form uses the information on the form to file information returns with the IRS, reporting the above information. Routine uses of this information include giving it to the Department of Justice for civil and criminal litigation and to cities, states, the District of Columbia, and U.S. commonwealths and territories for use in administering their laws. The information may also be disclosed to other countries under a treaty, to federal and state agencies to enforce civil and criminal laws, or to federal law enforcement and intelligence agencies to combat terrorism. You must provide your TIN whether or not you are required to file a tax return. Under section 3406, payors must generally withhold a percentage of taxable interest, dividends, and certain other payments to a payee who does not give a TIN to the payor. Certain penalties may also apply for providing false or fraudulent information.

P L E A S E B E A D V I S E D !

Every party to a public contract and every party bidding on public contracts are required to have a written sexual harassment policy that contains:

(1)a statement that sexual harassment is illegal;

(2)a definition of sexual harassment under state law:

(3)a description of sexual harassment utilizing examples;

(4)an internal formalized complaint process, including penalties;

(5)the legal recourse, investigative and complaint process available through the Department of Human Rights and the Illinois Human Rights Commission;

(6)directions on how to contact the Illinois Department of Human Rights and Illinois Human Rights Commission – **Illinois companies.** **Out-of-State** companies must include directions on how to contact the enforcement agency within their state. Companies that issue a standard policy for all business locations must prepare an addendum providing directions on how to contact the appropriate enforcement agency.

(7)a recitation that there cannot be any retaliation against employees who elect to file charges, as provided in Sections 6-101 and 6-101.5 of the Illinois Human Rights Act.

Recommendation: Your sexual harassment policy should be drafted in language easy to understand and any revisions should be reviewed by legal counsel. A copy of your policy should be posted in a prominent and accessible location to assure all employees will be notified of the company's position.

In order to conduct business with the THE PEORIA PARK DISTRICT, you must have a written sexual harassment policy that conforms to the Illinois Human Rights Act and/or the laws of your jurisdiction.

FAILURE TO DO SO
WILL DISQUALIFY YOU AS AN ELIGIBLE VENDOR!!!

SAMPLE ADDENDUM

Peoria Park District
Planning, Design and Construction Department
1314 N. Park Road
Peoria, IL 61604
Telephone: (309) 686-3386

ADDENDUM NO.

PROJECT TITLE:

ISSUANCE DATE:

LOCATION:

The proposed Contract Documents for this Work are modified as follows:

I. **GENERAL INFORMATION:**

II. **DRAWINGS**: (Delete/Change/Modify/Etc.)

III. **PROJECT MANUAL/SPECIFICATIONS**.:
(Delete/Change/Modify/Etc.)

IV. **INVITATION TO BID**: (Delete/Change/Modify/Etc.)

END OF ADDENDUM NO. _____

(Addendum may be bound into Project Manual, attached to front cover, faxed, mailed, emailed or delivered to bidders.)

Addendum No. _____
Page 1 of 1

Pleasure Driveway and Park District of Peoria, Illinois

Sample Agreement Between Owner and Contractor

This **AGREEMENT** for

CHILLER REPLACEMENT
NOBLE CENTER
1125 W LAKE AVENUE
PEORIA, ILLINOIS

is made as of the _____ day of _____ in the year of Two Thousand Twenty-Six (2026)

Between the Owner:

PLEASURE DRIVEWAY AND PARK DISTRICT OF PEORIA, ILLINOIS
1125 W. LAKE AVENUE
PEORIA, IL 61614

And the Contractor:

The Owner's Representative is:

PLANNING, DESIGN AND CONSTRUCTION DEPARTMENT
1314 N. PARK ROAD
PEORIA, IL 61604

The Architect or Engineer is:

KEDbluestone
707 NE JEFFERSON AVENUE
PEORIA, IL 61603

The Owner and Contractor agree as follows:

I. THE CONTRACT DOCUMENTS. The Contract Documents consist of this AGREEMENT, the Plans/Drawings for the Project dated March 3, 2026, all sections of the Project Manual dated April 7, 2026, including but not limited to the Instructions and Supplementary Instructions to Bidders, the Bid Form, the General Conditions (2017 AIA Document A201) and Supplementary General Conditions, the General Requirements, the Specifications, and other documents as enumerated in Section 10 and Attachment #1 of this AGREEMENT**,** and including addenda issued prior to the execution of this AGREEMENT. The Contract Documents form the CONTRACT between the Owner and the Contractor. The CONTRACT represents the entire and integrated contract for the construction of the Work of the Project between the parties hereto and supersedes prior proposals, contracts, negotiations, or representations, either written or oral.

II. THE WORK OF THE CONTRACT. The Contractor shall execute the entire Work described in the Contract Documents, unless modified in Section XI of this AGREEMENT**.**

III. BASIS OF PAYMENT. The Work of the CONTRACT shall be performed on a Lump Sum basis.

IV. CONTRACT SUM. The Owner shall pay the Contractor the sum of

V. DATES OF COMMENCEMENT AND COMPLETION OF THE WORK. The Owner's Representative will issue a written Notice to Proceed with the Work of the Project after receiving the required Performance Bond, Labor and Material Payment Bond, and Certificate of Insurance (in proper form and providing the required coverages and amounts from a company [or companies] acceptable to the Owner, and naming the Owner as an Additional Insured), and any other pre-construction submittals required by the Contract Documents. The Contractor hereby acknowledges and agrees that failure to provide such submittals in a timely manner shall not be cause to adjust the date(s) for completion of the Work.

- **A. LIQUIDATED DAMAGES.** Owner and Contractor recognize that time is of the essence of this CONTRACT and that Owner will suffer financial loss if the Contractor has not achieved Substantial Completion and Final Completion of the Work within the time specified below, plus any extensions thereof allowed in accordance with Article 8 of the General Conditions. They also recognize the delays, expense and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time.
- **B. SUBSTANTIAL COMPLETION.** Accordingly, instead of requiring any such proof, Owner and Contractor agree that as Liquidated Damages for delay (but not as a penalty), Contractor shall pay Owner TWO HUNDRED FIFTY dollars ($250.00) for each calendar day that expires after THREE HUNDRED AND FIFTY TWO (352) calendar days from Notice of Award until Substantial Completion is attained. The work is tentatively scheduled to begin on MAY 14, 2026 and be at Substantial Completion by APRIL 30, 2027. Actual work to begin on site starting October 2, 2026. Start up procedure for the new chiller system must be completed no later than APRIL 30, 2027.
- **C. FINAL COMPLETION.** After Substantial Completion if Contractor shall neglect, refuse, or fail to complete the remaining Work necessary to achieve Final Completion within FOURTEEN (14) calendar days or any proper extension thereof granted by Owner, Contractor shall pay Owner TWO HUNDRED FIFTY dollars ($250.00) for each day that expires after the time specified.

VI. PROGRESS PAYMENTS, REDUCTION OF RETAINAGE AND FINAL PAYMENT.

- **A.** Unless otherwise specified elsewhere in the Contract Documents, the Contractor may submit monthly applications for progress payments ("Application for Payment") to the Owner's Representative. Each Application for Payment must be certified by the Architect or Engineer (if applicable), or the Owner's Representative if an Architect or Engineer has not been engaged for construction phase services. An Application for Payment shall be for a period of no less than one calendar month ending on the last day of the month, unless otherwise approved in writing by the Owner's Representative. Application forms shall be subject to Owner's approval. Each Application for Payment shall be based upon the Schedule of Values submitted by the Contractor, in accordance with the Contract Documents. The Schedule of Values shall be approved by the Owner's Representative and the Architect or Engineer (if applicable) in advance of the Contractor's first Application for Payment and the approved schedule shall be used by the Contractor as the basis for submitting payment requests. The Owner's Representative and/or Architect/Engineer's (if applicable) approval of the Schedule of Values shall not constitute a complete check for accuracy, and shall not relieve the Contractor from responsibility for errors of any sort.
- **B.** An Application for Payment (certified by the Architect or Engineer, if applicable) shall be submitted to the Owner's Representative no later than the fifth (5th) day of the month following the period for which the application is being submitted. In such case, the Owner shall make the progress payment to the Contractor not later than the twentieth day of the next month. A progress payment request on an Application for Payment (certified by the Architect or Engineer, if applicable) received by the Owner's Representative after the fifth (5th) day of a month shall be made by the Owner not later than forty-five days after receipt by the Owner's Representative.
- **C.** Based upon its review of the certified (by the Architect or Engineer, if applicable) Application for Payment, the Owner shall make a progress payment to the Contractor in such amount as the Owner reasonably determines is properly due, subject to a retainage of ten percent (10%) of the value of the Work completed and covered by the Application for Payment, less the aggregate of previous payments in each case. In determining the amount properly due, the Owner shall consider the value of labor, materials and equipment incorporated in the Work, or properly allocable to materials and equipment suitably stored at the site or at some other location previously agreed upon in writing by the parties. The Owner's Representative shall have the sole right to determine that materials or equipment stored off-site have been properly delivered, protected, and/or secured. The Owner's Representative (or the Architect or Engineer, if applicable) may nullify or withhold a Certificate of Payment, in whole or in part, for the reasons set forth in Section 9.5 of the General Conditions. Upon Substantial Completion of the Work, the Owner shall pay the

Contractor a sum sufficient to increase the total payments to ninety-five percent (95%) of the Contract Sum, less such amounts as the Owner's Representative shall determine for incomplete work and unsettled claims.

VII. Final payment, constituting the entire unpaid balance of the Contract Sum, shall be made by the Owner when **1)** the Contract has been fully performed by the Contractor except for the Contractor's responsibility to correct nonconforming Work as provided in Subparagraph 12.2.2 of the General Conditions and to satisfy other requirements, if any, which necessarily survive final payment; and **2)** a final Certificate of Payment has been issued by the Architect/Engineer or Owner's Representative; such final payment shall be made by the Owner not more than forty-five (45) days after the receipt of the final Certificate of Payment by the Owner.

VIII. CHANGE ORDERS. The Owner and Contractor agree that changes in the Work are sometimes required and necessary, and that timely: **a)** submission of proposed changes in the Work or the scope of Work by the Owner, **b)** pricing by the Contractor, **c)** review by the Owner's Representative and/or Architect/Engineer, and **d)** final approval by the Owner are necessary in order to assure that the Work of the Project is completed on schedule. The Contractor hereby acknowledges and agrees that an increase in the scope of the Work does not grant or imply an increase in the Contract Time, unless specifically so stated on the final approved Change Order. The Contractor also agrees that any and all Work which deviates from the plans and specifications and/or results in additional Work performed by Contractor's forces, including those of his sub-contractor's, will not result in additional expense to the Owner, unless **finally approved both by the Owner and the Architect/Engineer (if applicable) prior to the additional Work being performed.** No claim for an addition to the Contract Sum shall be valid unless approved by a written Change Order signed by the Owner and the architect/engineer (if applicable) **prior to the additional Work being performed.**

IX. TERMINATION OR SUSPENSION. The CONTRACT may be terminated by the Owner or the Contractor as provided by Article 14 of the General Conditions. The Work may be suspended by the Owner as provided in Article 14 of the General Conditions.

X. ENUMERATION OF CONTRACT DOCUMENTS. The Contract Documents, except for modifications issued after the execution of this Agreement, consist of:

- **A.** this Standard Form of Agreement Between Owner and Contractor, of the Pleasure Driveway and Park District of Peoria, Illinois.
- **B.** the Plans or Drawings titled “Noble Center Chiller Replacement”, dated MARCH 3, 2026, and enumerated in ATTACHMENT #1 - "LIST OF DRAWINGS".
- **C.** Supplementary and other Conditions of the CONTRACT, and the Specifications, are those found in the Project Manual titled "CHILLER REPLACEMENT – NOBLE CENTER", and dated APRIL 7, 2026 enumerated as follows:
  - **1)** Supplementary Instructions to Bidders
  - **2)** Contractor's Proposal, as accepted by the Owner
  - **3)** General Conditions of the Contract for Construction, AIA Document A201, 2017 Edition
  - **4)** Supplementary General Conditions
  - **5)** Subcontractor List
  - **6)** Certification of Compliance for Listed Provisions and Laws
  - **7)** Company Ownership Certification
  - **8)** Peoria Park District Certificate of Equal Employment Opportunity Compliance for Contractors and Vendors
  - **9)** Workforce Profile
  - **10)** Minority/Women Owned Contact Sheet, if bid is over $50,000.00
  - **11)** Contractor/Subcontractor Workforce Plan, if bid is over $50,000.00
  - **12)** Performance Bond
  - **13)** Labor and Material Payment Bond
  - **14)** Proof of Insurance
  - **15)** Specifications: Division 010000, "General Requirements"; Divisions 020000-350000 as applicable
  - **16)** Attachment A.6 - Insurance Requirements
  - **17)** Attachment B – Solicitation & Hiring for Qualifying Construction Contracts & Forms
  - **18)** Attachment C – Directory of Minority & Women Owned Business Enterprises
  - **19)** Attachment D – IDOL Prevailing Wages of Peoria County
  - **20)** Proof of Certified Payroll Submitted to IDOL per “The Illinois Prevailing Wage Act”

XI. MISCELLANEOUS PROVISIONS. Other Provisions of this Agreement are as follows:

This AGREEMENT is entered into as of the day and year first written above and is executed in at least three original copies of which one is to be delivered to the Contractor, one to the Architect/Engineer (if any) for use in the administration of the CONTRACT, and one to the Owner.

OWNER:	**CONTRACTOR :**
_____	_____
(Signature)	(Signature)
ROBERT L. JOHNSON, SR., Park Board President	_____
	(Printed Name and Title)
ATTEST:	ATTEST:

ATTACHMENT #1 - LIST OF DRAWINGS

Number	Title	Date
1	**MECHANICAL TITLE SHEET**	**04/03/2026**
2	**LOWER LEVEL – MECHANICAL DEMOLITION**	**04/03/2026**
3	**LOWER LEVEL – MECHANICAL NEW WORK**	**04/03/2026**
4	**MECHANICAL DETAILS**	**04/03/2026**
5	**MECHANICAL SCHEDULES**	**04/03/2026**
6	**ELECTRICAL TITLE SHEET**	**04/03/2026**
7	**LOWER LEVEL – ELECTRICAL DEMOLITION**	**04/03/2026**
8	**LOWER LEVEL – ELECTRICAL NEW WORK**	**04/03/2026**
9	**ELECTRICAL PANEL & MATERIAL SCHEDULES**	**04/03/2026**

PERFORMANCE BOND

TO: PLEASURE DRIVEWAY AND PARK DISTRICT OF PEORIA
PEORIA, ILLINOIS

KNOW ALL MEN BY THESE PRESENTS;

That_____
_____
as Principal, and_____
_____as
corporation of the State of _____, as Surety, are held and firmly bound unto the PLEASURE DRIVEWAY AND PARK DISTRICT OF PEORIA, PEORIA, ILLINOIS, as Obligee, in the amount of _____
_____
($_____), for the payment whereof Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, Principal has by written agreement dated _____, 20 _____ entered into a contract with Obligee for _____
_____
in accordance with contract documents prepared by the Architect-Engineer, which Contract is by reference made a part hereof and is hereinafter referred to as "the Contract".

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that if Principal shall promptly and faithfully perform the Contract and all changes thereof, and during the life of any guaranty or warranty required under the Contract, and, if Principal shall fully secure and protect the Obligee from all liability and from all loss or expense of any kind, including all court costs, engineering fees and attorneys' fees made necessary or arising from the failure, refusal or neglect of Principal to comply with all obligations assumed by Principal in connection with the performance of the Contract and all changes thereof, then this obligation shall be null and void; otherwise it shall remain in full force and effect.

Surety hereby waives notice of any changes in the Contract, including extensions of time for the performance thereof. Whenever Principal shall be and is declared to be in default under the Contract, Obligee having performed Obligee's obligations thereunder, Surety shall, after notice of such default, reserve all rights against all parties, take over and complete the Contract and become entitled to payment of the balance of any monies due or to become due to such defined Principal in accordance with the progress of the work.

A condition of this Bond is that the Principal shall faithfully perform in accordance with the prevailing wage clause provided in the bid specification or Contract pursuant to Illinois Compiled Statutes 820 ILCS 130/1 *et. seq.*

No right of action shall accrue on this Bond to or for the use of any person or corporation other than the Obligee named herein.

Signed and Sealed this _____ day of _____, 20 _____.

CONTRACTOR

_____
Contractor Firm Name

By: _____
Signature

_____
Title

SURETY

_____
Surety Name

By:_____
Attorney-in-Fact

_____
Resident Agent

ATTEST:

_____
Corporate Secretary (Corporations only)

LABOR & MATERIAL PAYMENT BOND

TO: PLEASURE DRIVEWAY AND PARK DISTRICT OF PEORIA
PEORIA, ILLINOIS

KNOW ALL MEN BY THESE PRESENTS:

That: _____
_____
as Principal, and _____
_____
a corporation of the State of _____ as Surety, are held and firmly bound unto the PLEASURE DRIVEWAY AND PARK DISTRICT OF PEORIA, PEORIA, ILLINOIS, as Obligee, for the use and benefit of claimants as hereinafter defined in the amount of _____Dollars ($_____), for the payment whereof Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, Principal has by written agreement dated _____, 20 _____, entered into a Contract with Obligee for _____
_____
in accordance with contract documents prepared by the Architect-Engineer which Contract is by reference made a part hereof, and is hereinafter referred to as "the Contract".

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that if Principal shall promptly pay for all laborers, workers and mechanics engaged in the work under the Contract, and not less than the general prevailing rate of hourly wages of a similar character in the locality in which the work is performed, as determined by the State of Illinois Department of Labor pursuant to the Illinois Compiled Statutes 820 ILCS 130/1 et. seq. and for all material used or reasonably required for use in the performance of the Contract, then this obligation shall be void; otherwise it shall remain in full force and effect.

1. A claimant is defined as any person, firm, or corporation having contracts with the Principal or with any of Principal's subcontractors for labor or materials furnished in the performance of the Contract on account of which this Bond is given.

2. Nothing in this Bond contained shall be taken to make the Obligee liable to any subcontractor, materialman or laborer, or to any other person to any greater extent than it would have been liable prior to the enactment of The Public Construction Bond Act, approved June 20, 1931, as amended; provided further, that any person having a claim for labor and materials furnished in the performance of the Contract shall have no right of action unless he shall have filed a verified notice of such claim with the Obligee within 180 days after the date of the last item of work or the furnishing of the last item of materials, which claim shall have been verified and shall contain the name and address of the claimant, the business address of the claimant within the State of Illinois, if any, or if the claimant be a foreign corporation having no place of business within the State the principal place of business of the corporation, and in all cases of partnership the names and residences of each of the partners, the name of the Contractor for the Obligee, the name of the person, firm or corporation by whom the claimant was employed or to whom such claimant furnished materials, the amount of the claim and a brief description of the public improvement for the construction or installation of which the Contract is to be performed. No defect in the notice herein provided for shall deprive the claimant of its right of action under the terms and provisions of this Bond unless it shall affirmatively appear that such defect has prejudiced the rights of an interested party asserting the same.

3. No action shall be brought on this Bond until the expiration of 120 days after the date of the last item of work or of the furnishing of the last item of material except in cases where the final settlement between the Obligee and the Contractor shall have been made prior to the expiration of the 120 day period, in which case action may be taken immediately following such final settlement; nor shall any action of any kind be brought later than 6 months after the acceptance by the Obligee of the work. Such suit shall be brought only in the circuit court of this State in the judicial district in which the Contract is to be performed.

4. Surety hereby waives notice of any changes in the Contract, including extensions of time for the performance thereof.

5. The amount of this Bond shall be reduced by and to the extent of any payment or payments made in good faith hereunder.

6. The Principal and Surety shall be liable for any attorneys fees, engineering costs, or court costs incurred by the Obligee relative to claims made against this Bond.

Signed and Sealed this _____ day of _____, 20 _____.

CONTRACTOR

Contractor Firm Name:

_____

By: _____
Signature

_____
Title

SURETY

_____

By:_____
Attorney-in-Fact

_____
Resident Agent

ATTEST:

_____
Corporate Secretary (Corporations only)

CONTRACTOR'S AFFIDAVIT

STATE OF ILLINOIS)
) SS
COUNTY OF PEORIA)

TO WHOM IT MAY CONCERN:

THE undersigned, being duly sworn, deposes and says that he is _____ _____ of the _____ who is the contractor for the _____ building located at _____ owned by _____.

That the total amount of the contract including extras is $_____ on which he has received payment of $_____ prior to this payment. That all waivers are true, correct and genuine and delivered unconditionally and that there is no claim either legal or equitable to defeat the validity of said waivers. That the following are the names of all parties who have furnished material or labor, or both, for said work and all parties having contracts or sub-contracts for specific portions of said work or for material entering into the construction thereof and the amount due or to become due to each, and that the items mentioned include all labor and material required to complete said work according to plans and specifications:

NAMES	WHAT FOR	CONTRACT PRICE	AMOUNT PAID	THIS PMT.	BALANCE DUE

TOTAL ALL LABOR AND MATERIAL TO COMPLETE

There are no other contracts for said work outstanding, and that there is nothing due or to become due to any person for material, labor or other work of any kind done or to be done upon or in connection with said work other than above stated.

Signed this _____ day of _____, 20 _____.

Signature: _____

Subscribed and sworn to before me this _____ day of _____, 20 ___.

_____
Notary Public

FINAL WAIVER OF LIEN

STATE OF ILLINOIS)
) SS
COUNTY OF PEORIA)

TO WHOM IT MAY CONCERN:

WHEREAS, the undersigned _____ha_____ been employed by THE PEORIA PARK DISTRICT to furnish material and labor for the _____

at the premises commonly known as _____

located in the City of _____, County of Peoria, State of Illinois.

The undersigned, for and in consideration of _____ ($_____) Dollars, and other good and valuable considerations, the receipt whereof is hereby acknowledged, do_____ hereby waive and release any and all lien or claim or right of lien under the statutes of the State of Illinois relating to mechanics' liens, with respect to and on said above-described premises and improvements thereon and on the money, funds or other considerations due or become due from the owner on account of labor or services, material, fixtures, apparatus or machinery heretofore furnished or which may be furnished at any time hereafter by the undersigned for the above described premises.

Dated this _____ day of _____ 20 _____.

[Affix corporate seal here.]

_____
(Name of sole owner, corporation or partnership)

ATTEST:

_____ _____(SEAL)
(Signature of secretary of corporation) (Signature of sole owner or authorized representative of corporation or partnership)

WAIVER OF LIEN

GENERAL CONTRACTOR'S PARTIAL
TO COVER ONLY CERTAIN PAYMENTS

STATE OF ILLINOIS)
) SS
COUNTY OF PEORIA)

TO ALL WHOM IT MAY CONCERN:

WHEREAS, the undersigned _____ has been employed by THE PEORIA PARK DISTRICT to furnish material and labor for the _____at the premises commonly known as _____

_____

located in the City of Peoria, County of Peoria, and State of Illinois.

NOW, THEREFORE, the undersigned, for and in consideration of the sum of _____ _____ Dollars, and other good and valuable considerations, the receipt whereof is hereby acknowledged by the undersigned, does hereby waive and release to the extent only of the aforesaid amount of _____ Dollars, paid simultaneously herewith, any and all lien or right or claim of lien under the statutes of the State of Illinois relating to mechanics' liens, with respect to and on said above-described premises, and the improvements thereon and on the money, funds, or other consideration due or to become due from the owner on account of labor, services, material, fixtures, apparatus or machinery, furnished by the undersigned, to or on account of the said owner, for the above-described premises, but only to the extent of the payment aforesaid.

Dated this _____ day of _____, 20 _____.

[Affix corporate seal here]

_____
(Name of sole owner, corporation or partnership)

ATTEST:

_____
(Signature of secretary of corporation)

_____(SEAL)
(Signature of sole owner or authorized representative of corporation or partnership)

SUB-CONTRACTOR'S FINAL WAIVER OF LIEN

STATE OF ILLINOIS)
) SS
COUNTY OF PEORIA)

TO WHOM IT MAY CONCERN:

WHEREAS, the undersigned _____
(sub-contractor)
ha____ been employed by _____
(general contractor)
to furnish material and labor for the _____ at the

premises commonly known as _____, in the City of _____,

County of Peoria, State of Illinois.

The undersigned, for and in consideration of _____

_____ ($_____) Dollars, and other good and valuable considerations, the receipt whereof is hereby acknowledged, do _____ hereby waive and release any and all lien or claim or right of lien under the statutes of the State of Illinois relating to Mechanics Liens, on the above described premises and improvements thereon and on the money, funds or other considerations due or become due from the owner on account of labor or services, material, fixtures, apparatus or machinery heretofore furnished or which may be furnished at any time hereafter by the undersigned for the above described premises.

Dated this _____ day of _____, 20 _____.

[Affix corporate seal here.]

ATTEST:_____

_____
(Name of sole owner, corporation or partnership)

_____ _____(SEAL)
(Signature of sole owner or authorized representative of corporation of partnership)
(Signature of secretary of corporation)

WAIVER OF LIEN

SUB-CONTRACTOR'S PARTIAL
TO COVER ONLY CERTAIN PAYMENTS

STATE OF ILLINOIS)
) SS
COUNTY OF PEORIA)

TO WHOM IT MAY CONCERN:

THE undersigned, _____
(sub-contractor)
has been employed by _____
(general contractor)
to furnish material and labor for the _____

_____

at the premises commonly known as _____

_____
located in the City of Peoria, County of Peoria, and State of Illinois.

NOW, THEREFORE, the undersigned, for and in consideration of the sum of _____ _____ Dollars, and other good and valuable considerations, the receipt whereof is hereby acknowledged by the undersigned, does hereby waive and release to the extent only of the aforesaid amount of _____ Dollars, paid simultaneously herewith, any and all lien or right or claim of lien under the statutes of the State of Illinois relating to mechanics' liens, with respect to and on said above-described premises, and the improvements thereon and on the money, funds, or other consideration due or to become due from the owner on account of labor, services, material, fixtures, apparatus or machinery, furnished by the undersigned, but only to the extent of the payment aforesaid.

Dated this _____ day of _____, 20 _____.

[Affix corporate seal here.]

_____
(Name of sole owner, corporation or partnership)

ATTEST:

_____
(Signature of secretary of corporation)

_____(SEAL)
(Signature of sole owner or authorized representative of corporation or partnership)

A complete copy of AIA Document A201, 2017 Edition, with Supplementary General Conditions incorporated, is available for review in the Peoria Park District's Planning, Design and Construction Office.

SUPPLEMENTARY GENERAL CONDITIONS

1. A. "GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION", AIA Document A201, 2017 Edition, published by the American Institute of Architects, including revisions adopted before the date of the Project Manual, is hereby made part of these Specifications with same force and effect as though set forth in full.

B. The following modifies, changes, deletes from or adds to the General Conditions of the Contract for Construction (AIA Document A201, Sixteenth Edition, 2017). Where any Article of the General Conditions is modified or any Paragraph, Subparagraph or Clause thereof is modified or deleted by these Supplementary Conditions, the unaltered provisions of that Article, Paragraph, Subparagraph or Clause shall remain in effect.

C. Parenthesis ( ) indicates the appropriate section and Subparagraph of the General Conditions which each paragraph of the Supplementary General Conditions modifies or refers to.

ARTICLE 1: GENERAL PROVISIONS

1.1 - Basic Definitions

INSERT THE FOLLOWING PHRASE TO PARAGRAPH (1.1.1) AFTER THE WORDS "The Contract Documents consist of the Agreement Between Owner and Contractor (hereinafter the Agreement) and consists of the Agreement,":

"the Contractor's Bid, the Advertisement for Bids, the Instructions to Bidders, sample forms and addenda relating to these,"

DELETE THE LAST SENTENCE OF PARAGRAPH (1.1.1).

PARAGRAPH (1.1.8) IN THE HEADING DELETE "Initial Decision Maker" SUBSTITUTE "Initial Recommendation Maker"

PARAGRAPH (1.1.8) DELETE "Initial Decision Maker" **AND SUBSTITUTE** "Initial Recommendation Maker"

IN PARAGRAPH (1.1.8) REPLACE "decisions" **WITH** "recommendations"**.**

1.2 - Correlations and intent of the Contract Documents

ADD THE FOLLOWING SENTENCES TO END OF PARAGRAPH (1.2.1):

The Contractor shall notify the Owner's Representative immediately if discrepancies are discovered. Full-size or large-scale details or drawings shall govern small-scale drawings that the former are intended to amplify. Dimensions from drawings shall not be determined by scale or rule. Where the Drawings and Specifications conflict with each other or with themselves, the Owner's Representative (in consultation with the Architect, if any) will decide which conflicting requirement governs. Should discrepancies or doubt occur, Contractor shall not proceed with the Work without clarification from the Owner. Contractor shall request clarification in a reasonable time to avoid delays and increases in the Contract Sum.

ADD THE FOLLOWING PARAGRAPHS TO SECTION (1.2):

1.2.4 If any item or material shown on the Drawings is omitted from the Specifications, or vice-versa (except when the Drawings and Specifications clearly exclude such omitted item), and when such item or material is clearly required to complete the detail shown or specified, the Contractor shall furnish and install such item or material of the type and quality established by the balance of the detail shown and specified at no increase to the Contract Sum.

1.2.5 Where a typical or representative detail is shown on the Drawings, this detail shall constitute the standard for workmanship and materials throughout those parts of the Work.

1.2.6 Any Summary of Work as outlined in the Specifications shall not be deemed to limit the work required by the Contract Documents. The Contractor and each Subcontractor shall be responsible for carefully examining all Drawings, including all details, plans, elevations, sections, schedules and diagrams for each particular type of work, and for coordinating the Work described in the Drawings, with the related Specifications. The Contractor shall also be responsible for determining the exact scope of work for each type of work per the Contract Documents and Contractor shall endeavor to check cross-references of work excluded from any division. The Contract Sum is deemed to be based on a complete installation. When additional details or instructions are clearly required to complete the work, the Contractor is deemed to have made an allowance in the Contract Sum for completion of such Work consistent with the local standard of care.

1.2.7 The Drawings are intended to show the arrangement, design and extent of the Work and are schematic in nature. They are not to be scaled for roughing-in measurements or used as shop drawings.

1.5 – Ownership and Use of Drawings, Specifications, and Other Instruments of Service

ADD THE FOLLOWING PARAGRAPH TO SECTION (1.5):

1.5.3 Neither any oral representation by or oral agreement with any officer, agent, or employee of Owner or Architect before execution of this Contract shall affect or modify any of the Contractor's rights or obligations hereunder. Contractor is not aware of any facts that make misleading or inaccurate in any material respect any information Owner or Architect has furnished to Contractor which would have a material adverse affect on the Contract Time or Contract Sum which Contractor has not advised Owner or Architect of, and if, during the course of the performance of the Work, Contractor learns of any such facts it will so advise Owner. Contractor shall not be entitled to any adjustments in the Contract Time or the Contract Sum as a consequence of Contractor's breach of the terms of this Subparagraph.

1.7 – Digital Data use and Transmission

DELETE THE SECOND SENTENCE IN PARAGRAPH (1.7).

1.8 – Building Information Models Use and Reliance

DELETE PARAGRAPH (1.8) IN ITS ENTIRETY.

ARTICLE 2: OWNER

2.3 – Information and Services Required of the Owner

DELETE PARAGRAPH (2.3.4) IN ITS ENTIRETY.

2.4 – Owner's Right to stop the Work

ADD THE FOLLOWING SENTENCE AT THE END OF PARAGRAPH (2.4):

"The Owner shall not be liable for any extra cost incurred by the Contractor by such an order."

2.5 – Owner's Right to Carry Out the Work

IN PARAGRAPH (2.5), IN THE SECOND SENTENCE, DELETE "Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect and".

ARTICLE 3: CONTRACTOR

3.2 - Review of Contract Documents and Field Conditions by Contractor

IN PARAGRAPH (3.2.2, 3.2.3, AND (3.2.4) AFTER THE WORD "Architect**" ADD THE WORDS "**and Owner**".**

ADD THE FOLLOWING PARAGRAPH TO SECTION (3.2):

3.2.5 Before starting any work, the Contractor shall examine work performed by others to which his work adjoins or is applied to and report to the Owner's Representative any conditions that will prevent the satisfactory accomplishment of his work. Failure to notify the Owner's Representative of deficiencies or faults in preceding work prior to commencing work shall constitute acceptance thereof and waiver of any claim of its unsuitability.

3.4 – Labor and Materials

ADD THE FOLLOWING PARAGRAPHS TO SECTION (3.4):

3.4.4 Before ordering any material or doing any Work, the Contractor shall verify all measurements at the Project site and he shall be responsible for the correctness of same. No extra charge or compensation will be allowed to the Contractor on account of any difference between actual dimensions and the measurements shown on the Project Drawings.

3.4.5 The Contractor shall carefully inspect all materials delivered on and to the Project site and reject defective materials without waiting for the Owner's Representative or other representative of Owner to observe the materials.

3.5 - Warranty

ADD THE FOLLOWING PARAGRAPHS TO SECTION (3.5):

3.5.3 The Contractor agrees to assign to the Owner any and all manufacturer's warranties relating to materials and equipment furnished as part of the Work and further agrees to perform the Work in such manner so as to preserve any and all such manufacturer's warranties subject to installation directives and other terms of the Contract Documents. The Contractor agrees to deliver to the Owner, upon final payment, such assignments along with or as part of a reference manual, in form and detail reasonably acceptable to Owner, showing all such warranties and guarantees provided by

the Contractor and Subcontractors. Such warranties and guarantees shall commence no sooner than the date of purchase from the supplier.

3.5.4 The warranty of Contractor provided in Paragraph 3.5 shall in no way limit or abridge the warranties of the suppliers of equipment and systems which are to comprise a portion of the Work, if they are broader, and all of such warranties shall be in form and substance as required by the Contract Documents. Contractor shall take no action or fail to act in any way which results in the termination or expiration of such third party warranties or which otherwise results in prejudice to the rights of the Owner under such warranties subject to installation directives and other terms of the Contract Documents. Contractor agrees to provide all notices required for the effectiveness of such warranties and shall include provisions in the contracts with the providers and manufacturers of such systems and equipment whereby Owner shall have a direct right of enforcement of such warranty obligations.

3.6 - Taxes

IN PARAGRAPH (3.6), DELETE THE WORD "Sales".

ADD THE FOLLOWING AT THE END OF PARAGRAPH (3.6):

The Peoria Park District is exempt from Federal, State and Local taxes. A certificate of exemption will be furnished upon request.

3.10 - Contractor's Construction and Submittal Schedules

IN PARAGRAPH (3.10.2), IN THE FIRST SENTENCE BEFORE THE WORD "Architect's approval" **ADD THE WORDS** "Owner's and".

IN PARAGRAPH (3.10.2), IN THE SECOND SENTENCE BEFORE THE WORD "Architect's" **ADD THE WORDS** "Owner's and".

IN PARAGRAPH (3.10.2), IN THE THIRD SENTENCE BEFORE THE WORD "Architect" **ADD THE WORDS** "Owner's Representative and".

ADD THE FOLLOWING PARAGRAPHS TO SECTION (3.10):

3.10.4 The construction schedule shall provide for the most expeditious and practicable execution of the Work. The Contractor shall also work closely with the Owner to confirm that the construction schedule accurately reflects the status of the Project. The Contractor's construction schedule shall be updated every month by the Contractor and submitted to the Owner.

.1 Whenever it becomes apparent from the updated construction schedule that any substantial completion previously established by the construction schedule cannot be met, the Contractor shall, at the Owner's request, take any or all of the following actions with no increase to the Contract Sum or Contract Time (unless the delay is caused by an event set forth in paragraph 8.3 of these General Conditions thereby permitting adjustment of the Contract Sum and/or Contract Time:

.1.1 Increase construction manpower to substantially return the Project to schedule;

.1.2 Increase the number of working hours per shift, shifts per day or the amount of construction equipment or any combination of the foregoing which will substantially return the Project to schedule;

.1.3 Reschedule activities to concurrently accomplish activities, to the maximum degree practicable, in the time required by the Contract Documents.

If the Contractor fails to take any of these actions Owner shall have the notice and other rights set forth in Paragraph 2.5.

ARTICLE 4: ARCHITECT

4.1 - General

IN PARAGRAPH (4.1.1) DELETE THE FIRST SENTENCE AND SUBSTITUTE THE FOLLOWING:

"The Architect, Owner's Representative, and Owner's Project Manager are defined in Paragraph C of "Section 014200 - General" of "Division 010000 - General Requirements".

4.2 – Administration of the Contract

IN PARAGRAPH (4.2.1) DELETE THE WORDS "and will be an Owner's Representative**".**

IN PARAGRAPH (4.2.5) DELETE THE WORD "Architect's" **AND** "Architect"**AND SUBSTITUTE THE WORDS** "Owner Representative's" **AND** "Owner Representative"**.**

IN PARAGRAPH (4.2.6) IN THE SECOND SENTENCE AFTER THE WORDS "will have authority" **INSERT THE WORDS** "upon written authorization from the Owner".

IN PARAGRAPH (4.2.8) DELETE THE WORD "prepare" **AND SUBSTITUTE THE WORDS** "assist the Owner's Representative in preparing".

IN PARAGRAPH (4.2.9) DELETE THE WORD "Architect" **AND SUBSTITUTE WORDS** "Owner's Representative, assisted by the Architect".

IN PARAGRAPH (4.2.11) IN THE FIRST SENTENCE DELETE THE WORDS "and decide".

IN PARAGRAPH (4.2.12) IN THE FIRST SENTENCE DELETE THE WORD "and decisions".

IN PARAGRAPH (4.2.12) IN THE SECOND SENTENCE DELETE THE WORDS "and initial decisions" **AND** "or decisions".

ADD PARAGRAPH TO SECTION (4.2):

4.2.15 Notwithstanding any other provision of this Agreement to the contrary, the Architect shall have no authority to order or approve any material deviation from the Contract Documents, whether or not such deviation affects the Contract Sum or other Substantial Completion Date (as defined herein). In the event any such deviation is sought, prior written approval from the Owner's Representative and the Owner must be obtained. The Architect may decide quality issues and may approve non-material deviations from the Contract Documents.

ARTICLE 5: SUBCONTRACTORS

5.2 – Award of Subcontracts and Other Contracts for Portions of the Work

IN PARAGRAPH (5.2.1) DELETE THE FIRST SENTENCE AND SUBSTITUTE:

"The subcontractors/suppliers listed by the Contractor on the Subcontractor/Supplier List (submitted with the Bid) shall not be changed without the written consent of the Owner."

IN PARAGRAPH (5.2.1) IN THE SECOND SENTENCE DELETE THE WORDS "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

IN PARAGRAPH (5.2.1) IN THE LAST SENTENCE DELETE THE WORDS "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

ARTICLE 6: CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

6.2 – Mutual Responsibility

IN PARAGRAPH (6.2.2) BEFORE THE WORD "Architect" **ADD THE WORDS** "Owner and".

6.3 – Owner's Right to Clean Up

IN PARAGRAPH (6.3) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORD** "Owner".

ARTICLE 7: CHANGES IN THE WORK

7.2 – Change Orders

IN PARAGRAPH (7.2.1) DELETE THE WORDS "the Architect" **AND SUBSTITUTE THE WORDS** "the Owner's Representative".

ADD THE FOLLOWING PARAGRAPHS TO SECTION (7.2):

7.2.2 A Change Order shall include all of the Contractor's costs associated therewith.

7.2.3 The Contractor shall not accept any request for a Change Order from any person other than the Owner and may not perform any work asserted to constitute a change in the Work until the Owner has approved the Change Order in writing, unless the Owner authorizes the Contractor, in writing, to proceed with a change prior to the Owner's final approval. Notwithstanding anything to the contrary herein, the Contractor shall not charge for overtime services in the performance of any Change Order Work, unless the Owner has specifically authorized overtime in writing. Owner may competitively bid changes in the Work and Contractor, Subcontractor and suppliers shall provide Owner with all documents Owner requests to facilitate such competitive bidding of changes in the Work.

7.2.4 There shall be no change in the Work, whether an alteration or addition to the Contract Sum or to any amounts due under the Contract Documents or to a change in the Contract Time, unless and until such alteration or addition has been authorized by a written Change Order executed and issued in accordance and compliance with the requirements with this Article 7 or by written authorization to proceed with such change in the Work signed by the Owner or as otherwise provided pursuant to the Contract Documents. The requirements set forth in this Paragraph 7.2.4 are of the essence. No claim that the Owner has been unjustly enriched by any alteration or addition to the Work, whether or not any such unjust enrichment to the Work or to the Owner in fact exists, shall form the basis of any claim for an increase in any amount due under the Contract Documents or a change in the Contract Time, and the terms of a fully-executed Change Order shall be conclusive.

7.3 – Construction Change Directives

IN PARAGRAPH (7.3.1) DELETE THE WORDS "the Architect" **AND SUBSTITUTE THE WORDS** "the Owner's Representative".

IN PARAGRAPH (7.3.4) DELETE THE WORD "determine" **AND SUBSTITUTE THE WORD** "recommend".

IN PARAGRAPH (7.3.6) DELETE THE WORD "Architect" **ADD SUBSTITUTE THE WORDS** "Owner's Representative".

IN PARAGRAPH (7.3.8) IN THE FIRST SENTENCE AFTER THE WORD "Architect" **ADD THE WORDS** "and the Owner's Representative"**.**

IN PARAGRAPH (7.3.9) DELETE THE WORDS "Architect" **AND** "Architect's" **AND SUBSTITUTE THE WORDS** "Owner's Representative" and "Owner's Representative's".

IN PARAGRAPH (7.3.10) DELETE THE WORD "determination" **AND SUBSTITUTE THE WORD** "recommendation".

ARTICLE 8: TIME

8.1 - Definitions

IN PARAGRAPH (8.1.3) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

8.2 – Progress and Completion

ADD THE FOLLOWING PARAGRAPHS TO SECTION (8.2) .

8.2.4 All work shall be "Substantially Complete" as required by the **Instructions to Bidders** and the **Agreement Between Owner and Contractor.**

8.2.5 It is further agreed that said completion schedule is reasonable, and the Contractor shall prosecute said work regularly, diligently and continuously at such rate of progress as will insure full completion thereof within the time specified.

8.2.6 Provided, however, the following exceptions:

.1 Any preference, priority or allocation order duly issued by the United States Government.

.2 Any unforeseeable cause beyond the control and without the fault or negligence of the Contractor, including acts of God, or of a public enemy, acts of the Owner, acts of another Contractor in performance of a separate contract with the Owner, fire, floods, epidemics, quarantine restrictions, strikes, freight embargoes and unusually severe weather. The criteria on which the unusually severe weather shall be based is the average precipitation/temperatures received in the project area, as recorded over a period of the last five (5) years at the local area United States Weather Station. Any extension of time due to unusually severe weather must be requested by the Contractor on the basis of documented records of the actual precipitation/temperatures during the contract time period, compared with the normal/average for the area. Also, the criteria shall include the number of excessive precipitation or extreme cold days (i.e., days in which the temperature would adversely affect the type of work being

constructed) over the same period and whether or not the Contractor's force worked on said days or stage of construction was affected.

.3 Any delays of subcontractors occasioned by any of the causes specified in this paragraph.

8.2.7 Provided further that the Contractor shall, within seven (7) days from the beginning of any such delay during the performance of the Contract, notify the Owner's Representative in writing of the alleged cause of such delay.

8.3 – Delays and Extensions of Time

IN PARAGRAPH (8.3.1) DELETE THE WORDS "and binding dispute resolution".

IN PARAGRAPH (8.3.1) DELETE THE WORD "determine" **AND SUBSTITUTE THE WORD** "recommend".

ARTICLE 9: PAYMENTS AND COMPLETION

9.2 – Schedule of Values

DELETE PARAGRAPH (9.2) AND SUBSTITUTE THE FOLLOWING UNDER (9.2):

"Where the Contract is based on a stipulated sum or Guaranteed Maximum Price, the Contractor shall submit a schedule of values to the Owner's Representative before the first Application for Payment, allocating the entire Contract Sum to the Various portions of the Work. The schedule of values shall be prepared in the form, and supported by the data to substantiate its accuracy, required by the Architect and Owner's Representative. This schedule, unless objected to by the Architect and Owner's Representative, shall be used as a basis for reviewing the Contractor's Applications for Payment. Any changes to the schedule of values shall be submitted to the Architect and Owner's Representative and supported by such data to substantiate its accuracy as the Architect and Owner's Representative may require, and unless objected to by the Architect and Owner's Representative, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment."

9.3 – Applications for Payments

IN THE FIRST SENTENCE OF (9.3.1), CHANGE "ten" **TO** "thirty".

IN PARAGRAPH (9.3.1) IN THE FIRST AND SECOND SENTENCE DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

ADD THE FOLLOWING TO THE END OF PARAGRAPH (9.3.1):

"Payment requests shall consist of AIA Documents #702 "Application and Certificate for Payment"; AIA #703 "Continuation Sheet"; Contractors Affidavit of Payment to Subcontractors and Suppliers; Certified Payroll Form; EEO Documents; and Waivers of Lien. (Waivers of Lien are required from the general contractor in the full amount of the current payment application, and from all subcontractors, suppliers, or workers who provide more than $10,000 of project material/labor of the Work. The waiver shall be in the amount(s) listed in the Contractor's Affidavit.) For final payment, the general contractor shall also provide a Waiver of Lien in the full amount of the contract price.

The Waiver of Lien and Contractor Affidavit forms used shall be the Peoria Park District's standard form(s): 1) "Final Waiver of Lien" (for general contractors), 2) "Waiver of Lien - General Contractor's Partial To Cover Only Certain Payments", 3) "Sub-Contractor's Final Waiver of Lien", 4)

"Waiver of Lien - Sub-Contractor's Partial To Cover Only Certain Payments, and 5) "Contractor's Affidavit". (These forms are included in the Project Manual, and are the required Waiver of Lien forms for the project.)

(If the Contractor is unable to provide the required sub-contractor waiver at the time the application for payment is submitted (preferred method) alternatively, it may be provided at the time that payment is delivered by the District. If the sub-contractor waiver(s) still cannot be provided at that time, the District will provide "two-party" checks in which the Contractor and the sub-contractor are named jointly as payees.)

Format of AIA #703 shall follow that of "Schedule of Values". All payment requests shall reflect retainage in the amount of 10% of completed work."

IN PARAGRAPH (9.3.1.1) DELETE THE WORDS "or by interim determination of the Architect, but not yet included in Change Orders".

ADD THE FOLLOWING SUB-PARAGRAPHS TO PARAGRAPH (9.3.1):

9.3.1.3 Upon Substantial Completion, the Owner will pay 95% percent of the amount due to the Contractor on account.

9.3.1.4 Monthly progress payments will be made by the Owner on projects lasting more than sixty days (from award of the bid to the Substantial Completion date given in the Supplementary Instructions to Bidders).

ADD THE FOLLOWING SUB-PARAGRAPHS TO PARAGRAPH (9.3.2):

9.3.2.1 Material stored on site will be considered for payment only when a Schedule of Stored Materials with appropriate values accompany the payment request as an attachment.

9.3.2.2 All material and work covered by partial payments made shall thereupon become the sole property of the Owner, but this provision shall not be construed as relieving the Contractor from the sole responsibility for the care and protection of material and work upon which payments have been made or the restoration of any damaged work, or as a waiver of the contract.

9.4 – Certificates for Payment

IN PARAGRAPH (9.4.1) DELETE THE WORDS "Architect" **AND** "Architect's" **AND SUBSTITUTE THE WORDS "**Owner's Representative" **AND** "Owner's Representative's".

IN PARAGRAPH (9.4.1) DELETE THE PHRASE "with a copy to the Contractor".

IN THE FIRST SENTENCE OF PARAGRAPH (9.4.2) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

IN THE FIRST SENTENCE OF PARAGRAPH (9.4.2) AFTER THE WORDS "Architect's" **ADD THE WORDS** "and Owner's Representative's".

IN THE THIRD SENTENCE OF PARAGRAPH (9.4.2) DELETE THE WORDS "Architect has" **AND SUBSTITUTE THE WORDS** "Owner's Representative and Architect have".

9.5 – Decisions to Withhold Certification

IN PARAGRAPH (9.5.1) DELETE THE WORDS "Architect" **AND** "Architect's" **AND SUBSTITUTE THE WORDS** "Owner's Representative **AND** "Owner's Representative's".

IN PARAGRAPH (9.5.2) DELETE THE WORD "Architect's" **AND SUBSTITUTE THE WORDS** "Owner's Representative's".

IN PARAGRAPH (9.5.4) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

9.6 – Progress Payments

IN PARAGRAPHS (9.6.1), (9.6.3), AND (9.6.4) DELETE THE WORDS "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

9.7 – Failure of Payment

IN PARAGRAPH (9.7) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

IN PARAGRAPH (9.7) DELETE THE WORDS "or awarded by binding dispute resolution".

9.8 – Substantial Completion

IN PARAGRAPH (9.8.2) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORDS "**Owner's Representative".

IN THE FIRST SENTENCE OF PARAGRAPH (9.8.3) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative assisted by the Architect".

IN THE SECOND AND THIRD SENTENCES OF PARAGRAPH (9.8.3) DELETE THE WORDS "Architect's" and "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative's" and "Owner's Representative".

IN PARAGRAPH (9.8.4) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

9.9 – Partial Occupancy or Use

IN PARAGRAPH (9.9.1) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

9.10 – Final Completion and Final Payment

IN PARAGRAPH (9.10.1) IN THE FIRST AND SECOND SENTENCE AFTER THE FIRST TWO APPEARANCES OF THE WORD 'Architect" **ADD THE WORDS** "and Owner's Representative".

IN PARAGRAPH (9.10.1) DELETE THE THIRD AND FOURTH APPEARANCES OF THE WORD "Architect" and "Architect's" **AND SUBSTITUTE THE WORDS** "Owner's Representative" and "Owner's Representative's".

IN PARAGRAPH (9.10.1) AFTER THE FIFTH APPEARANCE OF THE WORD "Architect's" **ADD THE WORDS** "and Owner's Representative's".

IN THE LAST SENTENCE OF PARAGRAPH (9.10.1) DELETE THE WORD "Architect's" **AND SUBSTITUTE THE WORDS** "Owner's Representative's".

IN PARAGRAPH (9.10.2) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORD** "Owner's Representative".

ADD THE FOLLOWING SUB-PARAGRAPH TO PARAGRAPH (9.10.2):

9.10.2.1 When all items including items noted within Division 10000 General Requirements are found to be complete and in conformance with the Contract Documents, a final payment will be issued.

IN PARAGRAPH (9.10.3) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

ARTICLE 11: INSURANCE AND BONDS

11.1 – Contractor's Insurance and Bonds

IN PARAGRAPH (11.1.1) IN THE FIRST SENTENCE DELETE THE WORDS "the Agreement or elsewhere in the Contract Documents" **AND SUBSTITUTE THE FOLLOWING WORDS** "Attachment A – Project Specific Insurance Requirements" (which is included in the last section of the Project Manual and the requirements therein shall be made part of the Contract Documents). In addition, if any of the work occurs within fifty feet of an active railroad line and the Contractor's general liability coverages provide for exclusions of coverage when working on or near a railroad, the Contractor shall provide a separate Railroad Protective Liability Insurance Policy naming the railroad as the insured party, with the coverage limits required by that railroad."

IN PARAGRAPH (11.1.1) IN THE LAST SENTENCE, DELETE THE WORDS "the Contract Documents" **AND ADD THE WORDS** "Attachment A".

AT THE END OF PARAGRAPH (11.1.2) ADD THE FOLLOWING:

"The Contractor shall furnish a Performance Bond and a separate Labor and Material Payment Bond, each for one hundred percent (100%) of the Contract Sum. Form of these bonds shall be as provided by the Owner in the Project Manual and no other form will be accepted. The Surety shall be authorized to do business in the State of Illinois and be acceptable to the Owner."

ADD THE FOLLOWING SUB-PARAGRAPHS TO PARAGRAPH (11.1)

11.1.5 The Contractor may, at his option, furnish Owner's Protective Liability Insurance in lieu of naming the Owner Additional Insured on the Contractor's policy, as required above. This insurance shall protect the Owner from claims as set forth in Paragraph 11.1.1 of the General Conditions, and to the limits required herein, as shown in "Attachment A".

11.1.6 The Contractor shall furnish two copies of each of the required Certificates or Endorsements for each copy of the Agreement which shall specifically set forth evidence of all coverage required by the Contract Documents. The form of the Certificate(s) or Endorsement(s) shall be those as required in "Attachment A". The Contractor shall also furnish to the Owner copies of any endorsements which limit coverage, or are subsequently issued amending coverage or limits of coverage.

11.2 – Owner's Insurance

IN PARAGRAPH (11.2.1) DELETE THE FIRST AND SECOND SENTENCE.

ADD THE FOLLOWING TO PARAGRAPH (11.2.1) "If the work of the Project is being completed by one general or prime contractor rather than multiple prime contractors, the Contractor shall purchase and maintain property insurance upon the entire Work at the site to the full replacement value thereof. Such insurance shall be in a company or companies against which the Owner has no reasonable objection. This insurance shall include the interests of the Owner, the Contractor, Subcontractors and Sub-subcontractors in the Work."

DELETE PARAGRAPHS (11.2.2) AND (11.2.3) IN THEIR ENTIRETY.

11.3 – Waiver of Subrogation

DELETE PARAGRAPHS (11.3.1) AND (11.3.2) IN THEIR ENTIRETY.

11.4 – Loss of Use, Business Interruption, and Delay in Completion Insurance

DELETE PARAGRAPH (11.4) IN ITS ENTIRETY:

11.5 – Adjustment and Settlement of Insured Loss

DELETE PARAGRAPHS (11.5.1) AND (11.5.2) IN THEIR ENTIRETY.

ARTICLE 12: UNCOVERING AND CORRECTION OF WORK

12.1 – Uncovering of Work

IN PARAGRAPH (12.1.1) DELETE THE WORD "Architect's" **AND SUBSTITUTE WORDS** "Owner's Representative's and Architect's".

IN PARAGRAPH (12.1.1) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

IN PARAGRAPH (12.1.2) AFTER THE WORD "Architect" **ADD THE WORDS** "and Owner's Representative".

12.2 – Correction of Work

IN PARAGRAPH (12.2.1) AFTER THE WORD "Architect" **ADD THE WORDS** "and Owner's Representative".

ARTICLE 13: MISCELLANEOUS PROVISIONS

13.4 – Tests and Inspections

IN PARAGRAPH (13.4.4) AFTER THE WORD "Architect" **ADD THE WORDS** "and Owner's Representative".

ARTICLE 14: TERMINATION OR SUSPENSION OF THE CONTRACT

14.1 – Termination by the Contractor

IN SUB-PARAGRAPH (14.1.1.3) DELETE THE WORD "Architect" **AND SUBSTITUTE THE WORDS** "Owner's Representative".

14.2 – Termination by the Owner for Cause

IN PARAGRAPH (14.2.2) DELETE THE PHRASE ", upon certification by the Architect that sufficient cause exists to justify such action,".

IN PARAGRAPH (14.2.4) DELETE THE LAST SENTENCE AND ADD THE FOLLOWING "Upon application, the obligation for payment of the amount to be paid to the Contractor or Owner, as the case may be, shall survive termination of the Contract."

14.4 – Termination by the Owner for Convenience

DELETE PARAGRAPH (14.4.3) IN ITS ENTIRETY AND SUBSTITUTE UNDER (14.4.3):

"In case of such termination for the Owner's convenience, the Contractor shall be entitled to receive payment for Work executed, and costs incurred by reason of such termination. In no event, however, will such amounts exceed the Contract Sum reduced by the amount of prior payments except for increases pursuant to the claims procedure in the Contract Documents. Subcontracts, subsubcontracts, and purchase orders will contain appropriate provisions for termination for convenience under this Paragraph 14.4."

ARTICLE 15: CLAIMS AND DISPUTES

15.1 – Claims

IN THE FIRST SENTENCE OF PARAGRAPH (15.1.2) DELETE "requirements of the binding dispute".

IN PARAGRAPH (15.1.3.1) DELETE "Initial Decision Maker" **AND SUBSTITUTE** "Initial Recommendation Maker"

DELETE THE SECOND SENTENCE IN PARAGRAPH (15.1.3.2) IN ITS ENTIRETY.

DELETE PARAGRAPH (15.1.4.2) IN ITS ENTIRETY AND SUBSTITUTE THE FOLLOWING PARAGRAPH (15.1.4.2):

"The contract Sum and Contract Time may be adjusted in accordance with the Initial Recommendation Maker's recommendation, subject to the right of either party to proceed in accordance with this Article 15. The Owner's Representative will issue Certificates for Payment."

DELETE (15.1.7) IN ITS ENTIRETY.

15.2 – Initial Decision

IN PARAGRAPH (15.2) DELETE IN THE HEADING "Initial Decision" AND SUBSTITUTE "Initial Recommendation".

DELETE PARAGRAPH (15.2.1) IN ITS ENTIRETY AND SUBSTITUTE THE FOLLOWING PARAGRAPH (15.2.1):

"Claims, excluding those where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2 or arising under Sections 10.3 10.4, and 11.5, shall be referred to the Initial Recommendation Maker for initial recommendation. The Architect

will serve as the Initial Recommendation Maker, unless otherwise indicated in the Agreement. Except for those Claims excluded by this Section 15.2.1, an initial recommendation shall be required as a condition precedent to mediation of any Claim. If an initial recommendation has not been rendered within 30 days after the Claim has been referred to the Initial Recommendation Maker, the party asserting the Claim may demand mediation without a decision having been rendered. "

DELETE PARAGRAPH (15.2.2) IN ITS ENTIRETY AND SUBSTITUTE THE FOLLOWING PARAGRAPH (15.2.2):

"The Initial Recommendation Maker will review Claims and within ten days of the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) recommend rejecting the Claim in whole or in part, (3) recommend approving the Claim, (4) suggest a compromise, or (5) advise the parties that the Initial Recommendation Maker is unable to recommend a resolution of the Claim if the Initial Recommendation Maker lacks sufficient information to evaluate the merits of the Claim or if the Initial Recommendation Maker concludes that, in the Initial Recommendation Maker's sole discretion, it would be inappropriate for the Initial Recommendation Maker to make recommendation on the Claim."

IN PARAGRAPH (15.2.3) DELETE "Initial Decision Maker" **AND SUBSTITUTE** "Initial Recommendation Maker".

IN PARAGRAPH (15.2.3) IN THE FIRST SENTENCE, DELETE "rendering a decision" **AND SUBSTITUTE** "rendering a recommendation".

IN PARAGRAPH (15.2.4) DELETE "Initial Decision Maker" **AND SUBSTITUTE** "Initial Recommendation Maker".

IN PARAGRAPH (15.2.4) DELETE THE LAST SENTENCE AND SUBSTITUTE THE FOLLOWING "Upon receipt of the response or supporting data, if any, the Initial Recommendation Maker will provide a recommendation regarding the Claim in accordance with Paragraph 15.2.2."

DELETE PARAGRAPH (15.2.5) IN ITS ENTIRETY.

DELETE PARAGRAPH (15.2.6.1) IN ITS ENTIRETY.

15.3 – Mediation

IN PARAGRAPH (15.3.1) DELETE "as a condition precedent to binding dispute resolution".

IN PARAGRAPH (15.3.2) DELETE THE THIRD SENTENCE IN ITS ENTIRETY AND SUBSTITUTE THE FOLLOWING SENTENCE "The request may be made concurrently with the filing of legal or equitable proceedings but, in such event, mediation shall proceed in advance of legal or equitable proceedings which shall be stayed pending mediation for a period of 60 days from the date of filing, unless stayed for a longer period by agreement of the parties or court order."

IN PARAGRAPH (15.3.2) DELETE THE LAST SENTENCE IN ITS ENTIRETY.

DELETE PARAGRAPH (15.3.3) IN ITS ENTIRETY.

IN PARAGRAPH (15.3.4) DELETE THE FIRST SENTENCE IN ITS ENTIRETY.

15.4 – Arbitration

DELETE PARAGRAPHS (15.4.1), (15.4.1.1), (15.4.2), (15.4.3), (15.4.4.1), (15.4.4.2), AND (15.4.4.3) IN THEIR ENTIRETY.

. **ADD THE FOLLOWING <u>ARTICLE 16: LABOR, SAFETY AND WAGE STANDARDS TO THE GENERAL CONDITIONS OF THE CONTRACT:</u>**

ARTICLE 16
LABOR, WAGE, SAFETY, AND OTHER STANDARDS

16.1 LABOR STANDARDS. All employers shall comply with the Employment of Illinois Workers on Public Works Act [30 ILCS 570/1 to 570/7].

16.2 WAGE STANDARDS.

16.2.1 PREVAILING WAGE ACT: Wages and benefits to employees shall comply with all Federal and State of Illinois statutes pertaining to public works projects and specifically: Wages of Employees on Public Works [820 ILCS 130/1 - 12].

16.2.2 Not less than the prevailing rate of wages plus benefits as determined by the Department of Labor shall be paid to all laborers, workers and mechanics performing work under this contract. All contractor's bonds shall include a provision as will guarantee the faithful performance of such prevailing wage clause as provided by this bid specification or contract.

16.2.3 The terms “general prevailing rate of hourly wages”, “general prevailing rate of wages” or “prevailing rate of wages” when used in this Act mean the hourly cash wages plus fringe benefits for training and apprenticeship programs approved by the U.S. Department of Labor, Bureau of Apprenticeship and Training, health and welfare, insurance, vacations and pensions paid generally, in the locality in which the work is being performed, to employees engaged in work of a similar character on public works.

16.2.4 PREVAILING WAGE ACT/FOIA
Contractors and subcontractors shall submit proof to the Park District of certified payroll submission to the Illinois Department of Labor on a monthly basis in compliance with the Illinois Prevailing Wage Act. These records will be kept by the Park District for three years and may be reviewed by others through the Freedom of Information Act (FOIA). The Park District will exclude employee’s address, telephone number, and social security number from public inspection.

16.3 SAFETY STANDARDS.

16.3.1 PROTECTION OF PERSONS AND PROPERTY: The Contractor and his subcontractors shall, at all times, comply with applicable provisions of Federal, State and Local laws.

16.3.1.1 The Contractor and his sub-contractors shall have written programs complying with Occupational Safety and Health Administration standards and/or Illinois Department of Labor requirements including, but not limited to the following: hazardous communications, hearing conservation, respirator use, confined space entry, scaffolding, ladders, ventilation, flammable and combustible liquids, and lockout/tagout. The Contractor shall submit documentation of their programs at the request of the Owner's Representative, or Occupational Safety and Health Administration and/or Illinois Department of Labor officials.

16.4 EQUAL EMPLOYMENT OPPORTUNITY/AFFIRMATIVE ACTION/SEXUAL HARASSMENT

16.4.1 During the performance of the contract, the contractor agrees to the following:

16.4.1.1 That it will not discriminate against any employee or applicant for employment because of race, color, religion, sex, marital status, national origin or ancestry, age, physical or mental handicap unrelated to ability, or an unfavorable discharge from military service; and further that it will examine all job classifications to determine if minority persons or women are under-utilized and will take appropriate affirmative action to rectify any such under-utilization.

16.4.1.2 That, if it hires additional employees in order to perform his contract or any portion thereof, it will determine the availability (in accordance with the Rules and Regulations of the Illinois Department of Human Rights) of minorities and women in the area(s) from which it may reasonably recruit and it will hire for each job classification for which employees are hired in such a way that minorities and women are not under-utilized.

16.4.1.3 That, in all solicitations or advertisements for employees placed by it or on its behalf, it will state that all applicants will be afforded equal opportunity without discrimination because of race, color, religion, sex, marital status, national origin or ancestry, age, physical or mental handicap unrelated to ability or an unfavorable discharge from military service.

16.4.1.4 That it will have a written sexual harassment policy to include at the minimum, the following:

16.4.1.4.1 a definition of sexual harassment under the law;

16.4.1.4.2 a description of sexual harassment utilizing examples;

16.4.1.4.3 a formalized complaint procedure;

16.4.1.4.4 a statement of victim's rights;

16.4.1.4.5 directions on how to contact the Illinois Department of Human Rights. Out-of-state companies must provide directions for filing with the enforcement agency within their state. Companies that issue a standard policy for all business locations must prepare an addendum providing directions on how to contact the appropriate enforcement agency; and

16.4.1.4.6 A recitation that there cannot be any retaliation against employees who elect to file charges.

16.4.1.4.7 In addition, it is recommended that the employer post a copy of the sexual harassment policy in a prominent and accessible location and distribute it in a manner to assure notice to all employees on an annual basis.

16.4.1.4.8 The Illinois Human Rights Act specifically provides that all documents may meet, but cannot exceed, the sixth-grade literacy level. Therefore, the employer’s sexual harassment policy must be stated in plain language and in "laymen's terms".

16.4.1.5 That it will send to each labor organization or representative of workers with which it has or is bound by a collective bargaining or other agreement or understanding, a notice advising such labor organization or representative of the contractor's obligations under the Illinois Human Rights Act and the Department's Rules and Regulations. If any such labor organization or representative fails or refuses to cooperate with the contractor in its efforts to comply with such Act and Rules and Regulations, the contractor will promptly so notify the Department and the contracting agency and will recruit employees from other sources when necessary to fulfill its obligations thereunder.

16.4.1.6. That it will submit reports as required by the Department's Rules and Regulations, furnish all relevant information as may from time to time be requested by the Department or the contracting agency, and in all respects comply with the Illinois Human Rights Act and the Department's Rules and Regulations.

16.4.1.7. That it will permit access to all relevant books, records, accounts and work sites by personnel of the contracting agency and the Department for purposes of investigation to ascertain compliance with the Illinois Human Rights Act and the Department's Rules and Regulations.

16.4.1.8. That it will include verbatim or by reference the provisions of this clause in every subcontract it awards under which any portion of the contract obligations are undertaken or assumed, so that such provisions will be binding upon such subcontractor. In the same manner as with other provisions of this contract, the contractor will be liable for compliance with applicable provisions of this clause by such subcontractors; and further it will promptly notify the contracting agency and the Department in the event any subcontractor fails or refuses to comply therewith. In addition, the contractor will not utilize any subcontractor declared by the Illinois Human Rights Commission to be ineligible for contracts or subcontracts with the State of Illinois or any of its political subdivisions or municipal corporations.

16.4.2 In the event of the contractor's non-compliance with the provisions of the Illinois Human Rights Act, the contractor may be declared ineligible for future contracts or subcontracts with the State of Illinois or any of its political subdivisions or municipal corporation, and the contract may be cancelled or voided in whole or in part, and such other sanctions or penalties may be imposed or remedies invoked as provided by statute or regulations.

END OF SUPPLEMENTARY GENERAL CONDITIONS

SECTION 010000 - GENERAL

A. SUMMARY OF THE WORK

1. The Work covered under this Contract consists of that work described by the Invitation to Bid, the Instructions/Supplemental Instructions to Bidders, the Bid/Proposal Form, the General/Supplemental Conditions of the Contract, these General Requirements, the Plans, and the Technical Specifications.
2. The Contractor shall be responsible for all items incidental to the scope of the Work intended by the bidding documents as per A.1 above, including but not limited to, expenses incurred by the requirements of various Sections of Division 010000, unless specifically stated otherwise herein.
3. Changes to the Work as required by approved Change Orders shall be at the expense of the Owner, however, requests for additional payments made after the fact will not be considered.

B. OCCUPANCY BY OWNER.

1. The Owner reserves the right to occupy any portion of the project before it has been entirely completed, with the understanding that such occupancy shall in no way constitute acceptance of the work, in whole or in part, or of any work performed under the Contract, provided that such occupancy does not substantially interfere with completion of the work by the Contractor.

SECTION 012300 – ALTERNATES

A. Alternates to the Bid are set forth in the Supplementary Instructions to Bidders and are listed in the Bid Form.

1. Accepted Alternates have been incorporated into the Agreement.

B. Bid Alternate pricing, as set forth in the Supplementary Instructions to Bidders and the Bid Form, shall be good for a minimum of 90 calendar days after the date of the Bid opening, and the Owner reserves the right to accept Alternates up to that time.

SECTION 012600 - CHANGE ORDERS

A. OWNER'S REPRESENTATIVE'S FIELD ORDERS

1. From time to time during progress of the Work the Owner's Representative may issue an "Owner's Representative's Field Order" which interprets the Contract Documents or orders minor changes in the Work without change in Contract Sum or Contract Time.
2. Should the Contractor consider that a change in Contract Sum or Contract Time is required he shall submit an itemized proposal to the Owner's Representative **immediately and before proceeding with the Work**. If the proposal is found to be satisfactory and in proper order, the Field Order will be superseded by a Change Order.

B. PROPOSAL REQUESTS

1. From time to time during the progress of work the Owner's Representative may issue a "Proposal Request" for an itemized quotation for changes to the Work which may result in a change to the Contract Sum or Contract Time. This document **is not a Change Order** and is not a direction to proceed with the changes described therein.

C. CHANGE ORDERS

1. Change Orders are written documents describing changes in the Work, in the Contract Sum, in the Contract Time of Completion, or any combination thereof. Change Orders must be signed by both the Owner and the Architect/Owner's Representative prior to proceeding with the Work subject to the Change Order. **REQUESTS FOR "EXTRA'S" OR OTHER ADDITIONAL PAYMENTS OVER AND ABOVE THE CURRENT CONTRACT SUM WILL NOT BE CONSIDERED WITHOUT THE PRIOR, WRITTEN APPROVAL OF BOTH THE OWNER AND THE OWNER'S REPRESENTATIVE.**
    a) INITIATION. Change Orders may be initiated by a "Field Order" or "Proposal Request" per paragraphs "A" and "B" above. In addition, either the Contractor or Owner (or Owner's Representative) may initiate a Change Order through:
        1) Discovery of a discrepancy in the Contract Documents,
        2) Discovery of concealed conditions or,
        3) Discovery, during the course of the Work, of methods of accomplishing the Work in a better or more economical manner.
    b) PROCESSING CHANGE ORDERS.
        1) Change Orders will be dated and will be numbered in sequence.
        2) The Change Order will describe the change or changes, or will refer to the Proposal Requests or Field Orders involved.
        3) The Owner's Representative will issue three copies of each Change Order to the Contractor.
        4) The Contractor promptly shall sign all three copies and return them to the Owner's Representative.
        5) The Owner and Owner's Representative will retain two signed copies in their files, and will forward one signed copy to the Contractor.
        6) Should the Contractor disagree with the stipulated change in Contract Sum or change in Contract Time of Completion, or both:
            i) The Contractor promptly shall return all three of the Change Orders, unsigned by him, to the Owner's Representative with a letter signed by the Contractor stating the reason or reasons for the Contractor's disagreement.
            ii) The Contractor's disagreement with the Change Order shall not in any way relieve the Contractor of his responsibility to proceed with the change as ordered and to seek settlement of the dispute under pertinent provisions of the Contract Documents.

SECTION 012900 – PAYMENT PROCEDURES

A. SCHEDULE OF VALUES

1. Prior to the start of construction, submit a proposed Schedule of Values to the Owner's Representative which shows a detailed breakdown of the agreed Contract Sum showing values allocated to each of the various parts of the Work, as specified herein and in other provisions of the Contract Documents.
    a) The Schedule of Values is required to be compatible (in the same format) with the Application for Payment "Continuation Sheet", AIA G703.
2. If not requested to submit additional data or to modify the submitted Schedule of Values within ten (10) days of submittal, the initially submitted Schedule shall be deemed approved.

B. APPLICATIONS FOR PAYMENT
1. Progress payments will be made only if specifically called for in the Agreement. In all other cases, the Contractor may submit an Application for Payment (3 copies) upon Substantial Completion (95% of the Contract Sum), with the balance of the Contract Sum to be paid at Final Completion.
    a) **Article 9 of the Supplementary General Conditions defines the documentation required for each payment request.**
    b) Applications for payment shall be delivered to the Owner's Project Manager at:

Department of Planning, Design, and Construction
Peoria Park District
Bradley Park Equipment Service
1314 N. Park Road
Peoria, Illinois 61604

SECTION 013100 - PROJECT MEETINGS

A. PRECONSTRUCTION CONFERENCE
1. Conduct a preconstruction conference prior to the start of the Work, at the location of the Work. Provide attendance by the designated personnel of the Contractor, including Sub-contractor's and/or suppliers of major components of the Work, if requested by the Owner's Representative.
    a) AGENDA. Discuss items of significance that could affect progress including such topics as:
        1) Tentative construction schedule.
        2) Critical Work sequencing.
        3) Designation of responsible personnel.
        4) Procedures for processing field decisions and Change Orders.
        5) Procedures for processing Applications for Payment.
        6) Distribution of Contract Documents.
        7) Submittal of Shop Drawings, Product Data and Samples.
        8) Preparation of record documents.
        9) Use of the premises.
        10) Office, Work and storage areas.
        11) Equipment deliveries and priorities.
        12) Safety procedures.
        13) First aid.
        14) Security.
        15) Housekeeping.
        16) Working hours.
        17) Permits and Permitting Agency Requirements

B. PROJECT MEETINGS
1. Project Meetings will be held per the schedule determined at the Preconstruction Conference, or as needed for proper coordination and administration of the project.
    a) AGENDA
        1) Review and correct or approve minutes of the previous progress meeting.
        2) Review progress of the Work since last meeting, including status of submittals for approval.
        3) Identify problems which impede planned progress.
        4) Develop corrective measures and procedures to regain planned schedule.
        5) Complete other current business.

C. REPORTING
1. Distribute copies of the minutes of each meeting to each party present, and to other parties who should have been present, no later than three business days after each meeting.

SECTION 013300 - SUBMITTALS

A. Requirements for shop drawings, samples, mock-ups, product data, etc., relative to specific elements or components of the work are called out in the various sections of the Technical Specifications.
1. Submit items to allow for Owner's Representative's review and approval, potential re-submission if full approval is not given, ordering, delivery, fabrication time, etc., so as to allow the Work to proceed in a timely manner and in conformance with the project schedule.

B. OTHER CONTRACTOR SUBMITTALS
1. Unless otherwise modified the Contractor shall also submit:
    a) A "bar chart" type proposed construction schedule, within ten days after award of the Bid.
    b) Other submittals as required by other section of Division 010000.

C. Submission of the required Bonds and Certificate of Insurance are to be made prior to the Owner's issuance of a Notice to Proceed.

SECTION 014000 – QUALITY/REGULATORY REQUIREMENTS

A. GENERAL: Contractors shall comply with all laws, rules and regulations governing the work.
1. When Contractor observes that contract documents are at variance with specified codes, notify Owner's Representative in writing immediately. Owner's Representative will issue all changes in accord with General Conditions.
2. When Contractor performs any work knowing or having reason to know that the work is contrary to such laws, rules and regulations and fails to so notify the Owner's Representative, Contractor shall pay all costs arising therefrom. However, it will not be the Contractor's primary responsibility to make certain that the contract documents are in accord with such laws, rules and regulations.

B. SAFETY:
1. Comply with all federal, state, and local laws, rules and regulations governing the installation/construction of the work.
2. Develop and utilize safety program and training for workmen and sub-contractor employees.

C. TESTING
1. TESTS AND INSPECTIONS REQUIRED
a) Provide all tests and inspections required by governmental agencies having jurisdiction, as required by provisions of the Contract Documents and/or as specifically required by sections of the Technical Specifications.
2. PAYMENT FOR TESTING
a) Include within the Contract Sum an amount sufficient to cover all testing, re-testing, and inspections required by the Contract documents and/or the Technical Specifications. Additionally pay for all testing and inspections required by all governmental agencies having jurisdiction.
1) The Owner will pay for any testing and inspecting specifically requested by the Owner's Representative which are over and above those described in Paragraph 1.a) above.
2) When initial tests (over and above those defined by 1.a) above) requested by the Owner's Representative indicate non-compliance with the Contract Documents, costs of initial tests associated with that non-compliance will be deducted by the Owner from the Contract Sum, and subsequent retesting occasioned by the non-compliance shall be performed by the same testing laboratory and the costs thereof shall be paid by the Contractor.
3. WAIVER OF INSPECTION AND/OR TESTS
a) Specified inspections and/or tests may be waived only by the specific written approval of the Owner's Representative, and **such waivers will be expected to result in credit to the Owner equal to normal cost of such inspection and/or test.**

SECTION 014200 - REFERENCE STANDARDS AND DEFINITIONS

A. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents.
1. Where copies of standards are needed for performance of a required construction activity the Contractor shall obtain copies directly from the publication source.
2. Although copies of standards needed for enforcement of requirements may be included as part of required submittals the Architect reserves the right to require the Contractor to submit additional copies as necessary for enforcement of requirements.

B. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents they mean the recognized name of the trade association standards generating organization authority having jurisdiction or other entity applicable to the context of the text provision. Refer to the Encyclopedia of Associations, published by Gale Research Co. available in most libraries.

C. Definitions: Architect, Owner's Representative, and Owner's Project Manager
1. ARCHITECT: The Architect shall be the person or entity designated by the Owner as the Owner's Representative and shall be identified as such in the Agreement Between Owner and Contractor, and is referred to throughout the Contract Documents as if singular in number and masculine in gender.
2. OWNER'S REPRESENTATIVE: The duties of the Owner's Representative as listed in the Project Manual, include but are not limited to, construction phase observation and technical administration services.
a) LIMITS OF AUTHORITY: The Owner's Representative shall be authorized to provide approvals and interpretations concerning the plans, specifications and progress of the Work as bid, but is not authorized to change the scope of the Work on behalf of the Owner.
3. OWNER'S PROJECT MANAGER: The Owner's Project Manager will represent, act on behalf of, and provide interface between the Owner and the Contractor in respect to contract administration and/or other matters which affect the scope of the Work.
a) Unless defined otherwise in the Project Manual, the Owner's Project Manager shall be a designated member of the Planning, Design, and Construction Division of the Peoria Park District.
b) The Owner's Project Manager will also be the Owner's Representative and will provide construction phase observation and technical administration services, if a consultant Architect has not been engaged to do so, by the Owner.

SECTION 015000 – TEMPORARY FACILITIES & CONTROLS

A. MOBILIZATION
1. Furnish all labor, tools, materials, equipment, and incidentals necessary for preparatory work.
2. Provide and establish personnel, equipment, supplies, materials, offices or buildings, and other facilities necessary to work on the project.
3. Demobilize all of the above and remove temporary facilities at the completion of the project.

B. BARRIERS, PROTECTION OF SITE AND PROPERTY
1. GENERAL
a) Owner's improvements to remain, existing utilities, as well as adjacent site improvements shall be protected from damage by barriers, guards and coverings. Damaged work shall be replaced or repaired to condition prevailing at time of signing of contract, at no additional cost to Owner.
b) Provide 6' high, continuous chain link or orange plastic (used materials acceptable) construction fence to prohibit unauthorized personnel or public entry from the site of the Work. (Substitutions may be considered; submit request in writing to the Owner's Representative.)
c) Contractor shall provide, erect and maintain additional planking, fences, protective canopies, railings, shoring, lights, warning signs, etc., as needed for the protection of adjacent property and the public.

2. LANDSCAPE PROTECTION
   a) All live, healthy trees, shrubs, etc. on the site or on the street fronts of the site, not specified to be removed and not interfering with installation of new work required hereunder, shall be protected against injury from construction operations.
   b) All shade trees which are to remain and which are liable to damage during the building operations, shall be properly boxed and protected from damage during the course of construction work as directed by the Park District. **No site-related work shall occur until the required tree protection (fencing, boxing, etc.) has been installed and approved by the Owner or his representative.**
      1) LIQUIDATED DAMAGES: The Owner reserves the right to charge the Contractor for damage to existing trees, and to deduct the charges from the amounts due the Contractor, based on the following schedule:

aa)	Broken limbs 1" or over in diameter:	$50 per caliper inch of limb
bb)	Trenching or grading within the tree dripline or 20' from the trunk, whichever is less, of trees 4" or over in caliper diameter:	$100 per tree/per foot within dripline, or within 20' minimum if applicable
cc)	Damage to tree trunks, including "barking", nicking, gouging, etc.	$150 per caliper inch of tree, per each injury

3. BARRIERS/CONSTRUCTION FENCE MATERIALS
   a) 2" open mesh chain link fence, 72" high minimum, galvanized, with appropriately sized posts; gates where indicated.
   b) Alternate barrier fencing materials may be acceptable, however, no additional payments will be made on account of approval of alternate barrier/safety fencing materials.
   c) Materials may be new or used, if in serviceable condition.
4. WATCHMAN SERVICE
   a) The Owner will not be responsible for loss due to theft or other damage which is not covered under Property Insurance. The Contractor shall make such arrangements for watchman service as he considers necessary and he shall be responsible for all loss or damage of his property, equipment, material, etc., at the site, and he shall make good such damage or loss without any additional cost to the Owner.
5. EXISTING IMPROVEMENTS - PROTECTION
   a) The Contractor shall be entirely responsible for all injuries to water pipes, electric conduits or cables, drains, sewers, gas mains, poles, telephones and telegraph lines, streets, pavements, sidewalks, curbs, culverts, retaining walls, building walls, foundation walls, or other structures of any kind met with during the progress of the Work, and shall be liable for damages to public or private property resulting therefrom.

C. CONSTRUCTION ACCESS, ROADS, AND PARKING AREAS
1. CONTRACTOR'S USE OF PREMISES
   a) The Contractor shall require that all personnel who will enter upon the Owner's property certify their awareness of and familiarity with the requirements of this Section.
2. CONSTRUCTION ACCESS
   a) To avoid traffic conflict with vehicles of the Owner's employees and customers, and to avoid over-loading of streets and driveways elsewhere on the Owner's property, limit the access of trucks and equipment to the route shown (IF SHOWN) on the Drawings as "Access Route". If access route is not shown on the Drawings, coordinate construction access and routes with the Owner's Project Manager.
   b) Do not permit such vehicles to park on any street or other area of the Owner's property except in the area shown on the Drawings as "Contractor's Parking Area". If not shown on the drawings, the Contractor's Parking Area shall be as designated by the Owner's Project Manager.
   c) Provide adequate protection for curbs and sidewalks over which trucks and equipment pass to reach the job site.
3. SECURITY
   a) Restrict the access of all persons entering upon the Owner's property in connection with the Work to the Access Route and to the actual site of the Work.

D. TEMPORARY ENVIRONMENTAL CONTROLS
1. GENERAL
   a) Provide temporary environmental controls at the site of the Work to ensure that construction operations have no harmful effects on adjacent properties and on members of the public who may come in proximity to the Work, and/or the employees of the Owner who are engaged in regular daily tasks and operations and are unable to be relocated to another work site during construction operations.
   b) Owner reserves the right to stop the Work, at the Contractor's expense, until the Contractor provides necessary control measures for the conditions listed below; additionally, the Owner reserves the right to perform or have performed necessary control measures, should the Contractor refuse to do so at the time requested and to deduct the cost of those expenses from the amount due the Contractor.
2. DUST CONTROL
   a) Provide dust control materials to minimize dust from construction operations. Prevent air-borne dust from dispersing into the atmosphere.
3. WATER CONTROL
   a). Control surface water to prevent damage to the project, the site and adjoining properties.
      1) Control fill, grading, and ditching to direct surface drainage away from excavations, pits, tunnels, and other construction areas; direct drainage to proper runoff channels or storm drainage utilities.
   b) Provide, operate and maintain hydraulic equipment of adequate capacity to control surface water.
   c) Dispose of drainage water in a manner to prevent flooding, erosion silting, or runoff of silt or sediment or other damage to all portions of the site or to adjoining properties.
4. RODENT CONTROL
   a) Provide rodent control to prevent infestation of construction or storage areas.
      1) Use methods and materials which will not adversely affect conditions at the site or on adjoining properties.
5. DEBRIS CONTROL
   a) Maintain all areas free of extraneous debris, waste, and rubbish.
6. POLLUTION CONTROL
   a) Prevent contamination of soil, water or atmosphere by the discharge of noxious substances from construction operations.
   b) Provide equipment and personnel, perform emergency measures to contain all spillages, and to remove contaminated soils or liquids.
      1) Excavate and dispose of all contaminated earth off-site. Replace with suitable compacted fill and topsoil.
   c) Take special measures, as necessary, to prevent harmful substances from entering public waters, including lakes, streams, intermittent drainage channels, and storm or sanitary sewers.
7. EROSION CONTROL

a) Plan and execute construction and earthwork in a manner to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
   1) Schedule the Work to minimize the areas of bare soil exposed at one time, if possible.
   2) Provide temporary control measures such as berms, dikes, and drains to prevent runoff of silt or sediment from the site.
   3) Comply with Section 015713.

E. PROJECT IDENTIFICATION AND SIGNAGE
1. GENERAL
   a) Provide and install project identification sign, if located and/or called out on the Drawings.
2. SUBMITTALS
   a) Provide shop drawing(s) of proposed sign/sign installation to Owner's Representative for approval, prior to installation
3. INSTALLATION
   a) Provide project sign as detailed on Drawings
   b) If not detailed on Drawings provide project identification sign per the following minimum requirement:
      1) Content
         aa) Name of project
         bb) Name of Owner
         cc) Name of Architect(s) and major consultants
         dd) Names of Contractor and major subcontractors
         ee) Allow additional 200 characters of text explaining the project

      2) Construction
         aa) Size: 4' x 8'
         bb) Materials: Min. 5/8" AC DFPA Exterior Plywood, with (2) 4" x 4" x 12' long pressure treated post supports
         cc) Paint: paint front and back, seal edges, provide content as approved by Owner's Representative. Conform to recognized sign painting standards in selection of paint materials. Use only professional sign painter with three years minimum experience to apply sign graphics and lettering.
      3) Install sign in a manner consistent with length of time of construction operations. Remove sign and fill post holes at project completion.

F. FIELD OFFICES
1. TEMPORARY FACILITIES
   Provide and pay for temporary (new, or used if in serviceable condition) facilities and controls needed for the Work, if called out on the Drawings, which may include, but are not necessarily limited to:
   a) Temporary utilities such as heat, water, electricity, and telephone;
   b) Field office for the Contractor's personnel (required if shown on the Drawings; otherwise at the Contractor's option and expense).
      1) Conform with requirements for Engineer's Field Office Type B, as defined in Article 646.04 of the Standard Specifications for Road and Bridge Construction - Illinois Department of Transportation.
   c) Sanitary facilities;
   d) Enclosures such as tarpaulins, barricades, and canopies;
   e) Temporary fencing of the construction site;
   f) Project sign.
2. Comply with Federal, State, and local codes and regulations.
   a) Maintain temporary facilities and controls in proper and safe condition throughout the progress of the work. The Contractor is responsible for conformance with all safety codes and regulations for all Work under his jurisdiction, including that of Sub-Contractors.
3. Locate temporary facilities as shown on the Drawings, or as approved by the Owner's Representative if not shown on the Drawings.

SECTION 015713 – EROSION & SEDIMENT CONTROL

A. RELATED DOCUMENTS
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. SUMMARY
1. This Section includes the following:
   a) Site erosion and sediment control
   b) Silt fencing
   c) Ditch checks
   d) Erosion control blankets
   e) Culvert and inlet protection
   f) Stabilized entrance
2. Related Sections include the following:
   a) Division 31 – Earthwork.
   b) Division 32 – Exterior Improvements.

3. Erosion and Sediment Control Statement: The Peoria Park District takes the issue of construction related erosion and sediment control extremely seriously. The Peoria Park District is a community leader in the conservation and protection of our area's natural resources. This project will be watched closely by both staff and citizens for compliance with erosion and sediment control regulations and specifications.

C. QUALITY ASSURANCE
1. Materials and methods of construction shall comply with the following standards:
   a) Illinois Department of Transportation
   b) City of Peoria

D. PRODUCTS

1. Silt Fencing

a) Fabric for silt fencing shall consist of woven or nonwoven filaments of polypropylene, polyester, or polyethylene. Fabric shall be resistant to degradation by ultraviolet light and heat exposure. Fabric shall be rot, insect, and mildew proof, and have a high resistance to tearing.

1) Fabric shall comply with the following physical properties:

aa)	Grab tensile strength (lb) – ASTM D4632	200 (min)
bb)	Grab elongation @ break (%) – ASTM D4632	12
cc)	Burst strength (psi) – ASTM D751	250 (min)
dd)	Trapezoidal tear strength (lb) – ASTM D4533	75
ee)	Width (ft)	3.5 (min)
ff)	Weight (oz/sq. yd) – ASTM D3776	4.0
gg)	Equivalent opening size	30 (nonwoven)
hh)	(EOS) sieve no. – Corps of Engrs. CS-02215	50 (woven)

2. Ditch Checks

a) Ditch checks will consist of silt fencing with the addition of wire reinforcement.

b) Wire shall be 9 gauge.

c) Alternate: Straw bales may be used in lieu of silt fencing

3. Posts

a) Posts shall be standard "T" or "U" steel posts or wood with a minimum cross section of 3 square inches. Posts shall be a minimum of 60" in length. Posts shall be driven a minimum of 24" into the ground.

4. Erosion Control Blankets

a) Excelsior Blanket: Excelsior blanket shall consist of a machine produced mat of wood excelsior of 80% 6" or longer fiber length. The wood from which the excelsior blanket is cut shall be properly cured to achieve adequately curled and barbed fibers.

1) The blanket shall be of consistent thickness, with the fiber evenly distributed over the entire area of the blanket. The excelsior blanket shall be covered on the top side with a 90-day biodegradable extruded plastic mesh netting having an approximate minimum opening of 16 x 16 mm (5/8 x 5/8 in.) to an approximate maximum opening of 50 x 25 mm (2 x 1 in.). The netting shall be substantially adhered to the excelsior blanket by a knitting process using biodegradable thread or by an applied degradable adhesive. The netting shall be substantially adhered to the excelsior by a knitting process using biodegradable thread. The netting shall be entwined with the excelsior blanket for maximum strength and ease of handling.

2) The excelsior blanket shall comply with the following:

aa)	Minimum width, ± 25 mm (1 in.)	600 mm (24 in.)
bb)	Minimum mass ± 10%	0.34 kg/sm (0.63 lb/sq yd)
cc)	Minimum length of roll, approximately	45 m (150 ft)

3) The excelsior blanket shall be smolder resistant.

5. Culvert And Inlet Protection

a) Culvert protection shall consist of a ditch check immediately upstream of every culvert entrance. Ditch check shall be installed to protect culvert interior from sedimentation.

b) Inlet protection shall consist of purpose made devices by:

Dandy Products, Inc.
P. O. Box 1980
Westerville, Ohio 43086-1980
Phone: 1-800-591-2284
Fax: 740-881-2791
www.dandyproducts.com
dlc@dandyproducts.com

or

NILEX, Inc.
15171 E. Fremont Drive
Centennial, CO 80112
Phone: 1-800-537-4241
Fax: 303-766-1110
www.nilex.com
denver@nilex.com

c) "Or Equal" substitutions may be made with prior approval of Owner's Representative.

6. Stabilized Entrance

a) Stabilized entrance shall consist of coarse aggregate laid over geotextile fabric.

b) Dimensions: 70' long by 14' wide.

c) Geotextile Fabric: as per requirements of "silt fencing".

d) Aggregate: IDOT Class CA-1, CA-2, cA-3, or CA-4.

E. EXECUTION

1. Site Erosion And Sediment Control

a) Contractor is responsible for fulfilling terms of City of Peoria Erosion Control Permit and all applicable portions of the "Erosion, Sediment, and Stormwater Control Ordinance of the City of Peoria".

b) Install control devices as shown on erosion control plan.

c) Install additional measures as needed to control erosion and sedimentation on the site.

2. Silt Fencing Installation

a) Install silt fencing according to details in plans. The silt fence shall be entrenched to a minimum depth of 8".

b) The silt fence shall be installed on the contour, with the ends extending up-slope.

c) Install silt fencing before commencing site clearing work.

3. Ditch Check Installation

a) Install ditch checks according to details in plans.

b) Install ditch checks at locations shown on plans.

c) Install additional ditch checks as needed to control erosion within drainage swales as site conditions and weather dictate.
d) Install ditch checks immediately after swales are graded.

4. Erosion Control Blankets Installation
   a) Install erosion control blankets as needed to control erosion in drainage swales and at the direction of the Owner's Representative.
   b) Anchor stakes shall be driven at a spacing of 2 feet on center.
5. Culvert And Inlet Protection Installation
   a) Install culvert protection at upstream entrances to all culverts.
   b) Install culvert protection to intercept waterborne silt and sediment and prevent it from entering culvert pipes.
   c) Install immediately after culvert installation.
   d) Install inlet protection according to manufacturer's written instructions at each inlet immediately after inlet construction.
6. Stabilized Construction Entrance Installation
   a) Install stabilized construction entrance and other approved measures as necessary to limit tracking of soil on to all paved surfaces.
   b) Comply with all City of Peoria codes limiting tracking of soil on to City streets.
7. Maintenance
   a) Inspect silt fences after each rainfall. Repair fencing, failures, end runs, and erosion cuts immediately.
   b) Remove soil from silt fencing after each rainfall.
   c) Erosion control maintenance and repair shall be considered incidental to the contract.
   d) Tracked soil and sediment shall be removed from all paved surfaces on a daily basis.
   e) Replace or provide new erosion and sediment control measures as needed during construction to provide protection to site and surrounding property for the entire time of construction, or until project is complete.
8. Close-Out
   a) Remove silt fencing and other erosion and sediment control devices after lawn or seeding has been established.
   b) Soil deposits remaining in place after silt fence is no longer required shall be dressed to conform to existing grade, and seeded with appropriate seed material.

SECTION 016000 – PRODUCT REQUIREMENTS

A. MATERIALS AND EQUIPMENT
1. STANDARD SPECIFICATIONS
   a) Reference herein to known standard specifications of governmental agencies or technical societies shall refer to the latest edition of such specifications, adopted and published at date of these Specifications.
2. MANUFACTURED ARTICLES
   a) All manufactured articles, materials and equipment to be incorporated in the work shall be new (unless otherwise specified) and of the quality specified and shall be used, erected, installed, connected, cleaned and conditioned as directed by and in conformity with job conditions to produce the best results obtainable.
      1) Field measurements for all special products and materials which requires close tolerances or fitting into other items or components of the Work shall be taken on the job by the party furnishing the materials.
3. QUALITY ASSURANCE
   a) Per the Supplementary Instructions to Bidders, the Bidder by submission of a signed bid form, agrees to install products and equipment by brand and model name or names specified in the Technical Specifications, Divisions 02-35. Substitutions are allowed only in conformance to the following:
      1) Proprietary Specification Requirement: Where only a single product or manufacturer is named, provide the product indicated. No substitutions will be permitted.
      2) Semiproprietary Specification Requirement: Where two or more products or manufacturers are named, provide one of the products indicated. No substitutions will be permitted
         aa) Where either of the two cases above prevail, and the named product is accompanied by "or approved equal" substitutions will be allowed only upon written approval of the Owner's Representative prior to submission of bids.
      3) Non-Proprietary Specification Requirement: When the Specifications lists products or manufacturers that are available and are accompanied by "or equal", the Contractor may propose any available product that complies with the Specifications' requirements; however, the Owner's Representative shall determine if the produced item complies with those requirements.
      4) Descriptive Specification Requirement: Where Specifications describe a product or assembly listing exact characteristics required, with or without use of a brand, trade, or model name, provide a product or assembly that provides the characteristics and otherwise complies with the Contract Documents.
      5) Performance Specification Requirement: Where Specifications require compliance with performance requirements, provide products or assembly that comply with these requirements and are recommended by the manufacturer for the application indicated.
      6) Compliance with Standards, Codes, and Regulations: Where the Specifications only require compliance with an imposed code, standard, or regulation, select a product that complies with the standard, code, or regulation specified.
   b) VISUAL MATCHING AND SELECTION. Where the Specifications require matching an established sample or call for "as selected", the Owner's Representative's decision will be final on whether a proposed product matches satisfactorily.

B. STORAGE AND PROTECTION
1. GENERAL
   a) Contractor shall provide and maintain:
      1) Storage for materials and equipment to be installed in Project.
      2) Protection and security for stored materials and equipment, on and off site.
      3) Protection of existing on-site elements to remain.
      4) Protection of adjacent properties improvements
2. METHODS
   a) Store off grade and cover with impervious material all moisture or water vulnerable materials.
   b) Store finished products and equipment in an enclosed building, on or off site.
   c) Maintain integrity of shipping cartons until ready for installation.
   d) Provide separate storage for combustible and non-combustible products.

e) Follow storage recommendations of product and equipment manufacturers.
f) Other methods shall be subject to Owner's prior written approval.

3. The Contractor shall maintain an emergency phone number where a contact person can be notified at any time, Sundays and holidays included, of an emergency condition due to the work which requires immediate repair or protection.

C. SUBSTITUTIONS
1. See "SECTION 016000 – A. MATERIALS AND EQUIPMENT" for requirements pertaining to substitution of specified materials, products, equipment, etc.
2. Contractor may propose substitute materials, products, equipment, etc., after award of the Bid; however, such proposals are expected to result in a cost savings to the Owner and/or higher quality Work at no additional cost to the Owner.

D. WARRANTIES AND BONDS
1. GENERAL
a) This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturer's standard warranties on products and special warranties.
b) Warranties for the Work and products and installations of each Contractor shall be one (1) year unless specified otherwise in the individual Sections of Divisions 02 through 35.
c) Disclaimers and Limitations:
1) Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and Contractors required to countersign special warranties with the Contractor.
2) The responsibility of the Contractor in respect to the required warranties shall not be relieved or limited in any way by the failure of installed components, equipment, materials, etc., due to naturally occurring and/or re-occurring conditions at the site or area of the Work including, but not limited to:
aa) ground and soil conditions, especially as related to frost heave;
bb) high wind velocities (except those exceeding velocities normally used for calculating wind loading at the site of the Work);
cc) rain and water damage (unless caused by winds exceeding normal design limits);
dd) ice/snow loading on structures
ee) and other naturally occurring or re-occurring site conditions
3) The Contractor shall notify the Owner's Representative, prior to the award of the contract, of any part or component of the Work that is, in his opinion, not designed to accommodate the existing, naturally occurring, or re-occurring conditions of the site, and whether or not a change in the proposed methods of construction, types of equipment, etc., will affect the bid price.
aa) Should the proposed change in construction methods, equipment type, etc., result in additional expense, the Owner reserves the right to request proposals from the other bidders and to make award the contract based on the bid amount which includes the proposed change.
2. WARRANTY REQUIREMENTS
a) Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
b) Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

c) Replacement cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
d) Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights or remedies.
aa) Rejection of Warranties: The Owner reserves the rights to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
e) The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
f) For specific warranty requirements related to landscape materials, refer to the applicable Section.
3. SUBMITTALS
a) Submit written warranties to the Owner's Representative prior to the date certified for Substantial Completion. If the Owner's Representative's Certificate of Substantial Completion designates a commencement date for warranties other that the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Owner's Representative.
1) When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Owner's Representative within fifteen days of completion of that designated portion of the Work.
b) Form of Submittal: At Final Completion, compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, Subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
c) Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
d) Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.

e) Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS", the project title or name, and the name of the Contractor.
f) When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

SECTION 017300 – EXECUTION

A. GEOTECHNICAL DATA
1. If the Owner has caused borings or other subsurface investigations to be made, the data or report pursuant to these investigations will be included in the Project Manual, as an Appendix, and labeled as such.
2. The Owner and Owner's Representative do not guarantee the accuracy or validity of the data, nor do they assume any responsibility for the Contractor's interpretation of the data.
3. The Contractor's may, at his option, perform additional subsurface investigation, however, it shall be at the Contractor's sole expense.

B. FIELD ENGINEERING

Provide such field engineering services as are required for proper completion of the Work including, but not limited to:
1. Establishing and maintaining lines and levels
2. Structural design of shores, forms, and similar items provided by the Contractor as part of his means and methods of construction.
3. Verify layout information shown on the Drawings, in relation to the property survey and existing benchmarks and control points. Preserve permanent reference points during construction.

C. COORDINATION OF TRADES AND SUB-CONTRACTORS
1. The Contractor shall be responsible for the proper fitting of all work and for the coordination of the operation of all trades, sub-contractors, or materials and men engaged upon the work. He shall be prepared to guarantee to each of his subcontractors the dimensions which may be required for fitting of their work to all surrounding work and shall do, or cause his agents to do, all cutting, fitting, adjusting and patching necessary to make the several parts of the work come together properly and fit the work to receive, or be received by that of other contractors.
2. When two or more prime contracts are being executed at one time in such manner that the work on one contract may interfere with the work of another, the Owner's Representative shall decide which contractor shall cease work and which shall continue, or whether the work on both contracts may progress at the same time and in what manner.
a) The Contractor shall not cause any unnecessary hindrance or delay to any other contractors on the premises, and shall be responsible for all damages done to the work of other contractors caused by him or by his employees.

D. REFERENCE AND CONTROL POINTS PROVIDED BY OWNER

In addition to layout procedures provided by the Contractor for proper performance of the Contractor's responsibilities:
1. Locate and protect existing control points before starting work on the site.
2. Preserve permanent reference points during progress of the Work.
3. Do not change or relocate reference points or items of the Work without specific approval from the Owner's Representative.
4. Promptly advise the Owner's Representative when a reference point is lost or destroyed, or requires relocation because of other changes in the Work.
5. Upon direction of the Owner's Representative, require the field engineer to replace reference stakes or markers.
6. Locate such replacement according to the original survey control.

E. REFERENCE AND CONTROL POINTS PROVIDED BY THE CONTRACTOR
1. If not provided by the Owner (and defined as the responsibility of the Owner in the Contract Documents) establish sufficient general reference points in the form of permanent bench marks, grade stakes or other markers as will enable the Contractor to proceed with the Work.
2. The Contractor may lay out his own work, or cause the Work to be laid out by a qualified party such as a Registered Land Surveyor or a Professional Engineer, as necessary.
3. The Contractor shall establish and be responsible for all lines, elevations and measurements of the structure utilities, installations, and other Work executed by him under the contract.
a) Exercise proper precautions to verify the figures and dimensions shown on the drawings before laying out the work; be responsible for any error resulting from failure to exercise such precaution.

SECTION 017329 - CUTTING AND PATCHING

A. CHASES AND OPENINGS
1. The Contractor is responsible for the provision and/or coordination of all chases, openings and recesses required by work of his own forces, subcontractors or separate contractors.
a) Each subcontractor or separate contractor shall be responsible for furnishing advance information to the General Contractor as to exact dimensions and locations of such chases and openings, and shall provide and set in place all necessary sleeves, inserts and forms.
b) Openings shall be accurately located, neatly cut, and no larger than necessary. Provide all rebuilding, patching, refinishing and painting required to restore the construction to original condition.
2. Provide shoring, bracing, and support as required to maintain structural integrity of the project.
3. Provide protection from cutting and patching operations as required for other portions of the project; protect the Work and existing improvements in proximity to the cutting and patching operations from the elements.

SECTION 017419 – CONSTRUCTION WASTE MANAGEMENT & DISPOSAL

A. PERIODIC CLEANING
1. Each Contractor shall clean up after his own work as needed and/or ensure that sub-contractors clean up after their work and remove accumulations of waste, debris, and rubbish caused by construction operations.
a) Remove all waste, rubbish and debris on a daily basis (if needed), as they accumulate, and after completion of the Work.

B. PROJECT COMPLETION
1. On completion of the project, the entire job shall be cleaned up and left in perfect condition, including adjacent areas.
a) Marred surfaces shall be patched or repaired and touched up to match adjoining surfaces.

b) All rubbish shall be removed from the site before acceptance.
c) New surfaces and/or exposed elements of the Work shall be protected from stain and marring. These surfaces shall be cleaned to the satisfaction of the Owner's Representative or replaced if said stains or mars are unable to be completely removed

C. GOVERNMENTAL REGULATIONS
1. Conduct cleaning and disposal operations in compliance with Federal, State and local ordinances and anti-pollution laws and regulations.

SECTION 017700 - PROJECT CLOSEOUT

A. GENERAL

Work includes:

1. Substantial Completion.
2. Final Completion
3. Closeout submittals.
4. Instruction

B. SUBSTANTIAL COMPLETION
1. Prepare and submit the list ("punch-list") required by the first sentence of Paragraph 9.8.2 of the General Conditions.
   a) Within a reasonable time after receipt of the list the Owner's Representative will inspect to determine status of completion. Should the Owner's Representative determine that the Work is not Substantially Complete:
      1) The Owner's Representative will so notify the Contractor, in writing, giving the reasons therefore.
      2) Remedy the deficiencies and notify the Owner's Representative when ready for reinspection.
      3) The Owner's Representative will reinspect the Work.
   b) When the Owner's Representative concurs that the Work is Substantially Complete:
      1) The Owner's Representative will prepare a "Certificate of Substantial Completion" on AIA form G704, accompanied by the Contractor's list of items to be completed or corrected, as verified and approved by the Owner's Representative.
      2) The Owner's Representative will submit the Certificate to the Owner and to the Contractor for their written acceptance of the responsibilities assigned to them in the Certificate.

C. FINAL COMPLETION
1. Prepare and submit the notice required by the first sentence of Paragraph 9.10.1 of the General Conditions.
   a) Verify that the Work is complete including, but not necessarily limited to, the items mentioned in Paragraph 9.8.2 of the General Conditions. Certify that:
      1) the Contract Documents have been reviewed;
      2) the Work has been inspected for compliance with the Contract Documents;
      3) the Work has been completed in accordance with the Contract Documents;
      4) equipment and systems have been tested as required, and are operational;
      5) the Work is completed and ready for final inspection.
   b) The Owner's Representative will make a final inspection to verify status of completion and if all "punch-list" items have been completed, and upon receipt of the Contractor's Final Application for Payment, issue a Certificate of Final Completion. Should the Owner's Representative determine that the Work is incomplete or defective:
      1) The Owner's Representative will so notify the Contractor, in writing, listing the incomplete or defective work.
      2) Remedy the deficiencies promptly, and notify the Owner's Representative when ready for reinspection.
   c) FINAL APPLICATION FOR PAYMENT
      1) Submit a final Application for Payment to the Owner's Representative, showing all adjustments to the Contract Sum.
      2) If needed, the Owner's Representative will prepare a final Change Order showing adjustments to the Contract Sum which were not made previously by Change Orders.
      3) Include final waivers of lien from the Contractor, sub-contractors, and major suppliers.
      4) Final payment will not be released until all close-out submittals have been made, final cleaning has been performed, and required instruction(s) to Owner's personnel have been accomplished.

D. CLOSEOUT SUBMITTALS
1. When the Owner's Representative determines that the Work is acceptable under the Contract Documents, he will request the Contractor to make closeout submittals. Closeout submittals include, but are not necessarily limited to:
   a) Project record documents described in "Section 017839".
   b) Operation and maintenance manuals/data as described in "Section 017823".
   c) Warranties and bonds as described in "Section 016000".
   d) Keys and keying schedule;
   e) Spare parts and materials extra stock;
   f) Evidence of compliance with requirements of governmental agencies having jurisdiction including, but not necessarily limited to:
      1) Certificates of Inspection, as required
      2) Certificate(s) of Occupancy
   g) Certificates of Insurance for products and completed operations;
   h) Evidence of payment and release of liens.
      1) Consent of Surety to Final Payment
      2) Contractor's Final Waiver of Lien
      3) Separate releases or Waivers of Lien for sub-contractors, suppliers and others with lien rights against the Owner, together with a list of those parties.
   i) List of subcontractors, service organizations, and principal vendors, including names, addresses, and telephone numbers where they can be reached for emergency service at all times including nights, weekends, and holidays.

SECTION 017823 - OPERATING/MAINTENANCE MANUALS & INSTRUCTION

A. GENERAL

1. Compile operating/product data and related information appropriate for Owner's maintenance and operation of products and equipment provided under the Contract.
2. Instruct Owner's personnel in operation and maintenance of products, equipment and systems.
3. OPERATIONS AND MAINTENANCE DATA REQUIRED:
    a) Operating and maintenance manuals are required for each area of Work which is listed below, if that area of Work is included within the scope of Work of the project:
        1) HVAC
        2) Plumbing – including water supply, sewage and waste disposal
        3) Electrical
        4) Landscape irrigation system
        5) Fire sprinkler system
        6) Communications equipment and systems
        7) Materials and finishes

B. OPERATIONS/MAINTENANCE MANUALS - FORM OF SUBMITTAL
1. Prepare operating and maintenance manuals in the form of an instructional manual, utilizing heavy-duty, durable 3-ring vinyl covered loose-leaf binders, for use by the Owner's operating personnel. Organize into suitable sets of manageable size. Where possible, assemble instructions for similar equipment into a single binder. Provide when drawings or diagrams are required as part of the manual.
2. Provide sturdy manila or kraft envelope, accordion type file folder, or cardboard file boxes, properly labeled, of sufficient size to contain all submittals.
3. Submit one copy of data in final form at least fifteen days before final inspection. This copy will be returned within fifteen days after final inspection, with comments. After final inspection make corrections or modifications to comply with the Owner's Representative's comments and submit three copies of each approved manual to the Owner's Representative
4. WARRANTIES, BONDS AND SERVICE CONTRACTS
    a) Provide a copy of each warranty, bond or service contract in the appropriate manual for the information of the Owner's operating personnel. Provide written data outlining procedures to be followed in the event of product failure. List circumstances and conditions that would affect validity of the warranty or bond. Provide list for each product containing name, address, and phone number of:
        1) Contractor.
        2) Subcontractor.
        3) Maintenance contractor, as appropriate.
        4) Local supply source for parts and replacement.
    b) Identify area of responsibility of each contractor.

C. MANUAL FOR MATERIALS AND FINISHES
1. Submit two (2) copies of complete manual in final form.
2. Refer to individual Specification Sections for additional requirements on care and maintenance of materials and finishes.
3. Content for products, applied materials and finishes:
    a) Manufacturer's data, giving full information on products.
        1) Catalog number, size, composition.
        2) Color and texture designations.
        3) Information for re-ordering special-manufactured products.
4. Instructions for care and maintenance.
    a) Manufacturer's recommendations for types of cleaning agents and methods.
    b) Cautions against cleaning agents and methods detrimental to product.
    c) Recommended cleaning and maintenance schedule.
5. Moisture-Protection and Weather-Exposed Products: Provide complete manufacturer's data with instructions on inspection, maintenance and repair of products exposed to the weather or designed for moisture-protection purposes.
6. Manufacturer's Data: Provide manufacturer's data giving detailed information, including the following, as applicable:
    a) Applicable standards.
    b) Chemical composition.
    c) Installation details.
    d) Inspection procedures.
    e) Maintenance information.
    f) Repair procedures.

D. INSTRUCTION
1. Instruct the Owner's personnel in proper operation and maintenance of systems, equipment, and similar items which were provided as part of the Work including, but not limited to;
    a) Mechanical
    b) Water supply
    c) Electrical service/distribution and lighting
    d) Other items or systems as required in individual sections of the Technical Specifications
2. Instructions for the Owner's Personnel: For instruction of the Owner's operating and maintenance personnel, use experienced instructors thoroughly trained and experienced in the operation and maintenance of the equipment or system involved.

SECTION 017839 - PROJECT RECORD DOCUMENTS (AS-BUILTS)

A. DOCUMENTS REQUIRED AT SITE
1. The Contractor shall maintain at the job site one copy of all Drawings, Specifications, Addenda, approved Shop Drawings, Change Orders, and other Contract modifications.
    a) Each of these project record documents shall be clearly marked **"Project Record Copy"**
    b) Shall be maintained in good condition
    c) shall be available at all times for inspection by the Park District, and shall not be used for construction purposes.

B. Project-record drawings shall be marked up to show significant changes made during construction progress, referenced to visible and accessible features of the structures. Project-record drawings shall be kept current and no work shall be concealed until required information has been recorded.

C. Record-documents shall be submitted in satisfactory condition to the Park District at the completion of the project. **FINAL COMPLETION OF THE PROJECT WILL NOT BE ATTAINED, AND FINAL PAYMENT WILL BE WITHHELD, UNTIL PROJECT "AS-BUILTS" ARE SUBMITTED TO AND APPROVED BY THE OWNER'S REPRESENTATIVE.**

END OF GENERAL REQUIREMENTS

SECTION 23 0516
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Flexible-hose packless expansion joints.
   2. Alignment guides and anchors.
   3. Pipe loops and swing connections.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
   2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
   3. Alignment Guide Details: Detail field assembly and attachment to building structure.
   4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.02 PACKLESS EXPANSION JOINTS

A. Flexible-Hose Packless Expansion Joints FHEJ-01:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flex Pression Ltd.
      b. Flex-Hose Co., Inc.
      c. Flexicraft Industries.
      d. Mason Industries, Inc.
      e. Metraflex
   2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
   3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.

4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
    a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged end connections.
    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.

2.03 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides AG-01:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Advanced Thermal Systems, Inc.
    b. Flex-Hose Co., Inc.
    c. Flexicraft Industries.
    d. Flex-Weld, Inc.
    e. Hyspan Precision Products, Inc.
    f. Mason Industries, Inc.
    g. Metraflex Company (The).
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:
1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
    a. Stud: Threaded, zinc-coated carbon steel.
    b. Expansion Plug: Zinc-coated steel.
    c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
    a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
    b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
    c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.01 EXPANSION JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.02 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.03 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION

SECTION 23 0519
METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Liquid-in-glass thermometers.
   2. Light-activated thermometers.
   3. Thermowells.
   4. Dial-type pressure gauges.
   5. Gauge attachments.
   6. Test plugs.

B. Related Requirements:
   1. Section 231123 "Facility Natural-Gas Piping" for gas meters.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gauge.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 LIQUID-IN-GLASS THERMOMETERS

A. Plastic/Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ernst Flow Industries.
      b. Marsh Bellofram.
      c. Miljoco Corporation.
      d. Palmer Wahl Instrumentation Group.
      e. REOTEMP Instrument Corporation.
      f. WATTS.
      g. Weiss Instruments, Inc.
   2. Standard: ASME B40.200.
   3. Case: Plastic or Metal; 7-inch nominal size unless otherwise indicated.
   4. Case Form: Adjustable angle unless otherwise indicated.
   5. Tube: Glass with magnifying lens and blue or red organic liquid.
   6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
   7. Window: Glass or plastic.
   8. Stem: Aluminum, brass, or stainless steel and of length to suit installation.
      a. Design for Thermowell Installation: Bare stem.
   9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
   10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.02 LIGHT-ACTIVATED THERMOMETERS

A. Direct-Mounted, Light-Activated Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flo Fab Inc.
      b. REOTEMP Instrument Corporation.
      c. Trerice, H. O. Co.
      d. Weiss Instruments, Inc.
      e. Weksler Glass Thermometer Corp.
   2. Case: Plastic or Metal; 7-inch nominal size unless otherwise indicated.
   3. Scale(s): Deg F and Deg C.
   4. Case Form: Adjustable angle.
   5. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
   6. Stem: Aluminum and of length to suit installation.
      a. Design for Thermowell Installation: Bare stem.
   7. Display: Digital.
   8. Accuracy: Plus or minus 2 deg F.

2.03 THERMOWELLS

A. Thermowells:
   1. Standard: ASME B40.200.
   2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
   3. Material for Use with Copper Tubing: CNR or CUNI.
   4. Material for Use with Steel Piping: CRES or CSA.
   5. Type: Stepped shank unless straight or tapered shank is indicated.
   6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
   7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
   8. Bore: Diameter required to match thermometer bulb or stem.
   9. Insertion Length: Length required to match thermometer bulb or stem.
   10. Lagging Extension: Include on thermowells for insulated piping and tubing.
   11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.04 DIAL-TYPE PRESSURE GAUGES

A. Direct-Mounted, Plastic/Metal-Case, Dial-Type Pressure Gauges:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ametek U.S. Gauge.
      b. Flo Fab Inc.
      c. Tel-Tru Manufacturing Company.
      d. Trerice, H. O. Co.
      e. WATTS.
      f. Weiss Instruments, Inc.
   2. Standard: ASME B40.100.
   3. Case: Sealed type(s); cast aluminum, drawn steel or plastic; 4-1/2-inch nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
   8. Pointer: Dark-colored metal.

9. Window: Glass or plastic.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.05 GAUGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.06 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flow Design, Inc.
2. Miljoco Corporation.
3. Nexus Valve, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. WATTS.

B. Description: Test-station fitting made for insertion in piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

H. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

I. Install permanent indicators on walls or brackets in accessible and readable positions.

J. Install connection fittings in accessible locations for attachment to portable indicators.

K. Install thermometers in the following locations:
1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Two inlets and two outlets of each chiller.
4. Inlet and outlet of each hydronic coil in air-handling units.
5. Two inlets and two outlets of each hydronic heat exchanger.

L. Install pressure gauges in the following locations:
1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.

3.02 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.03 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.04 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:
   1. Direct-mounted, light-activated type.
   2. Plastic/Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers

B. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
   1. Direct-mounted, light-activated type.
   2. Plastic/Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers

C. Thermometers at inlets and outlets of each chiller shall be one of the following:
   1. Direct-mounted, light-activated type.
   2. Plastic/Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers

D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
   1. Direct-mounted, light-activated type.
   2. Plastic/Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers

E. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:
   1. Direct-mounted, light-activated type.
   2. Plastic/Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers

F. Thermometer stems shall be of length to match thermowell insertion length.

3.05 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.

B. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F.

3.06 PRESSURE-GAUGE SCHEDULE

A. Pressure gauges at discharge of each pressure-reducing valve shall be one of the following:
   1. Sealed, direct-mounted, metal case.
   2. Sealed, direct-mounted, plastic case.

B. Pressure gauges at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
   1. Sealed, direct-mounted, metal case.
   2. Sealed, direct-mounted, plastic case.

C. Pressure gauges at suction and discharge of each pump shall be one of the following:
   1. Sealed, direct-mounted, metal case.
   2. Sealed, direct-mounted, plastic case.

3.07 PRESSURE-GAUGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 psi.

B. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

END OF SECTION

SECTION 23 0523.12
BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Bronze ball valves.

1.03 DEFINITIONS

A. CWP: Cold working pressure.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and weld ends.
   3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded-end valves.
   2. ASME B16.18 for solder-joint connections.
   3. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Refer to HVAC valve schedule articles for applications of valves.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
   1. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:
   1. Include 2-inch stem extensions.
   2. Extended operating handle of non-thermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
   3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Regular Port and Stainless-Steel Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Hammond Valve.
c. Jenkins Valves; Crane Energy Flow Solutions.
d. Nibco.

2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Regular.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

3.04 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: bronze ball valves, two piece, with stainless-steel trim, full port, threaded, or solder joint ends.

3.05 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: bronze ball valves, two piece with stainless-steel trim, full port, threaded, or solder joint ends.

END OF SECTION

SECTION 23 0523.13
BUTTERFLY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Iron, single-flange butterfly valves.
   2. Iron, grooved-end butterfly valves.

1.03 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. SWP: Steam working pressure.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set butterfly valves closed or slightly open.
B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
B. ASME Compliance:
   1. ASME B16.1 for flanges on iron valves.
   2. ASME B16.5 for pipe flanges and flanged fittings, NPS 1/2 through NPS 24.
   3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   4. ASME B31.9 for building services piping valves.
C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
E. Valve Sizes: Same as upstream piping unless otherwise indicated.
F. Valve Actuator Types:
   1. Handlever: For valves NPS 6 and smaller.
G. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.

2.02 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABZ Valve and Controls.
      b. Apollo Flow Controls; Conbraco Industries, Inc.

c. Hammond Valve.
d. NIBCO INC.
e. Stockham; Crane Energy Flow Solutions.

2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

2.03 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES

A. Iron, Grooved-End Butterfly Valves, 175 CWP:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International.
b. Grinnell Mechanical Products.
c. Kennedy Valve Company; a division of McWane, Inc.
d. Mueller Steam Specialty; A WATTS Brand.
e. NIBCO INC.
f. Shurjoint Piping Products USA Inc.
2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 175 psig.
c. Body Material: Coated, ductile iron.
d. Stem: Two-piece stainless steel.
e. Disc: Coated, ductile iron.
f. Seal: EPDM.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
D. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze disc, 200 CWP, and EPDM seat.
2. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 175 CWP.

3.05 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze disc, 200 CWP, and EPDM seat.
2. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 175 CWP.

END OF SECTION

SECTION 23 0523.14
CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Bronze lift check valves.
   2. Bronze swing check valves.
   3. Iron swing check valves.
   4. Iron, grooved-end swing check valves.

1.03 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. SWP: Steam working pressure.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Block check valves in either closed or open position.
B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded-end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   4. ASME B16.18 for solder joint.
   5. ASME B31.1 for power piping valves.
   6. ASME B31.9 for building services piping valves.
C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
F. Valve Sizes: Same as upstream piping unless otherwise indicated.
G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE LIFT CHECK VALVES

A. Bronze Lift Check Valves with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Crane; Crane Energy Flow Solutions.
2. Description:
    a. Standard: MSS SP-80, Type 1.
    b. CWP Rating: 200 psig.
    c. Body Design: Vertical flow.
    d. Body Material: ASTM B 61 or ASTM B 62, bronze.
    e. Ends: Threaded.
    f. Disc: Bronze.

B. Bronze Lift Check Valves with Nonmetallic Disc, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Flo Fab Inc.
    b. Hammond Valve.
    c. KITZ Corporation.
    d. Mueller Steam Specialty; A WATTS Brand.
    e. NIBCO INC.
2. Description:
    a. Standard: MSS SP-80, Type 2.
    b. CWP Rating: 200 psig.
    c. Body Design: Vertical flow.
    d. Body Material: ASTM B 61 or ASTM B 62, bronze.
    e. Ends: Threaded.
    f. Disc: NBR or PTFE.

2.03 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 150:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. American Valve, Inc.
    b. Apollo Flow Controls; Conbraco Industries, Inc.
    c. Crane; Crane Energy Flow Solutions.
    d. Jenkins Valves; Crane Energy Flow Solutions.
    e. KITZ Corporation.
    f. Macomb Groups (The).
    g. NIBCO INC.
2. Description:
    a. Standard: MSS SP-80, Type 3.
    b. CWP Rating: 300 psig.
    c. Body Design: Horizontal flow.
    d. Body Material: ASTM B 62, bronze.
    e. Ends: Threaded.
    f. Disc: Bronze.

B. Bronze Swing Check Valves with Nonmetallic Disc, Class 150:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Crane; Crane Energy Flow Solutions.
    b. Hammond Valve.
    c. Jenkins Valves; Crane Energy Flow Solutions.
    d. Milwaukee Valve Company.
2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE.

2.04 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Crane; Crane Energy Flow Solutions.
c. Hammond Valve.
d. Jenkins Valves; Crane Energy Flow Solutions.
e. KITZ Corporation.
f. NIBCO INC.
2. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

2.05 IRON, GROOVED-END SWING CHECK VALVES

A. Iron, Grooved-End Swing Check Valves, 300 CWP:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International.
b. Grinnell Mechanical Products.
c. Shurjoint Piping Products USA Inc.
2. Description:
a. CWP Rating: 300 psig.
b. Body Material: ASTM A 536, ductile iron.
c. Seal: EPDM.
d. Disc: Spring operated, ductile iron or stainless steel.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.
F. Install valve tags. Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
      b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
   3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
   6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.05 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Bronze swing check valves with bronze disc, Class 150.
B. Pipe NPS 2-1/2 and Larger:
   1. NPS 2-1/2 to NPS 4: Iron valves may be provided with threaded ends instead of flanged ends.
   2. NPS 2-1/2 to NPS 12: Iron swing check valves with lever and spring closure control, Class 125.
   3. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.

3.06 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Bronze swing check valves with bronze disc, Class 150.
B. Pipe NPS 2-1/2 and Larger:
   1. NPS 2-1/2 to NPS 4: Iron valves may be provided with threaded ends instead of flanged ends.

2. NPS 2-1/2 to NPS 12: Iron swing check valves with lever and spring-closure control, Class 125.
3. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.

END OF SECTION

SECTION 23 0529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Fiberglass pipe hangers.
   4. Metal framing systems.
   5. Thermal-hanger shield inserts.
   6. Fastener systems.
   7. Pipe stands.
   8. Equipment supports.

B. Related Requirements:
   1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
   2. Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts" for duct hangers and supports.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Fiberglass strut systems.
   4. Pipe stands.
   5. Equipment supports.

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.05 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
   3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

2.02 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers:
1. Description: Similar to MSS SP-58, Type 1, factory-fabricated steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of fiberglass polyurethane or stainless steel.
3. Flammability: ASTM D 635, ASTM E 84, and UL 94.

B. Strap-Type, Fiberglass Pipe Hangers:
1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
a. Flammability: ASTM D 635, ASTM E 84, and UL 94.
2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.04 PLASTIC PIPE HANGERS

A. Description: Similar to MSS SP-58, Types 1 through 58, factory-fabricated steel pipe hanger except hanger is made of plastic.

B. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.

C. Flammability: ASTM D 635, ASTM E 84, and UL 94.

2.05 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. B-line, an Eaton business.
b. Flex-Strut Inc.
c. G-Strut.
d. Haydon Corporation.
e. MIRO Industries.
f. Thomas & Betts Corporation; A Member of the ABB Group.
2. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with inturned lips.
5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Paint Coating: Green epoxy, acrylic, or urethane.

B. Non-MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International.
b. Carpenter & Paterson, Inc.

c. Empire Industries, Inc.
d. ERICO International Corporation.
e. Gripple Inc.

2. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with inturned lips.
5. Channel Width: Select for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Paint Coating: Green epoxy, acrylic, or urethane.

2.06 FIBERGLASS STRUT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Champion Fiberglass, Inc.
2. Fabco Plastics Wholesale Limited.
3. G-Strut.

B. Description: Structural-grade, factory-formed, glass-fiber-resin channels and angles for supporting multiple parallel pipes.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Channels: Continuous slotted fiberglass-reinforced plastic channel with inturned lips.
3. Channel Width: Selected for applicable load criteria.
4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
5. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
6. Rated Strength: Selected to suit applicable load criteria.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.07 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Buckaroos, Inc.
2. Carpenter & Paterson, Inc.
3. Clement Support Services.
4. ERICO International Corporation.
5. National Pipe Hanger Corporation.
6. Pipe Shields Inc.
7. Piping Technology & Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psi or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate with 100-psi or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.08 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, 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: Subject to compliance with requirements, provide products by one of the following:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head; Illinois Tool Works, Inc.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors 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: Subject to compliance with requirements, provide products by one of the following:
      a. B-line, an Eaton business.
      b. Empire Tool and Manufacturing Co., Inc.
      c. Hilti, Inc.
   2. Indoor Applications: Zinc-coated or stainless-steel.
   3. Outdoor Applications: Stainless steel.

2.09 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand:
   1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
   2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
   3. Hardware: Galvanized steel or polycarbonate.
   4. Accessories: Protection pads.

C. Low-Profile, Single Base, Single-Pipe Stand:
   1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
   2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
   3. Vertical Members: Two, galvanized-steel, continuous-thread 1/2-inch rods.
   4. Horizontal Member: Adjustable horizontal, galvanized-steel pipe support channels.
   5. Pipe Supports: Strut clamps.
   6. Hardware: Galvanized steel.
   7. Accessories: Protection pads.
   8. Height: 12 inches above roof.

2.10 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.11 MATERIALS

A. Aluminum: ASTM B 221.

B. Carbon Steel: ASTM A 1011/A 1011M.

C. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A 240/A 240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C 1107/C 1107M, 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 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.02 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. 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 for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.

E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. 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.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

O. Insulated Piping:
   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 allowed by 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 degrees.
      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 or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
   6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 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 bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and 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/D1.1M 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 so contours of welded surfaces match adjacent contours.

3.05 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.

3.06 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.07 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and fiberglass pipe hangers and fiberglass strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.
   3. Duct labels.
   4. Valve tags.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Brady Corporation.
      b. Brimar Industries, Inc.
      c. Carlton Industries, LP.
      d. Champion America.
      e. Craftmark Pipe Markers.
      f. Kolbi Pipe Marker Co.
   2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   3. Letter Color: White.
   4. Background Color: Black.
   5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   7. Minimum Letter Size: 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-quarters the size of principal lettering.
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady Corporation.
   2. Brimar Industries, Inc.
   3. Carlton Industries, LP.
   4. Champion America.
   5. Craftmark Pipe Markers.
   6. Kolbi Pipe Marker Co.
   7. LEM Products Inc.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.03 DUCT LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady Corporation.
   2. Brimar Industries, Inc.
   3. Carlton Industries, LP.
   4. Champion America.
   5. Craftmark Pipe Markers.
   6. Kolbi Pipe Marker Co.
   7. LEM Products Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: White.

D. Background Color: Blue, Yellow and Green.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 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-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.04 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. Kolbi Pipe Marker Co.
7. LEM Products Inc.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link chain or beaded chain or S-hook.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.03 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:
   1. Chilled-Water Piping: White letters on a safety-green background.

2. Heating Water Piping: White letters on a safety-green background.
3. Dual-Temperature Piping: White letters on a safety-green background.
4. Low Pressure Steam Piping: White letters on a safety-green background.
5. Condensate Return Piping: White letters on a safety-green background.

3.05 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
   1. Blue: For cold-air supply ducts.
   2. Yellow: For hot-air supply ducts.
   3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.06 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      a. Chilled Water: 1-1/2 inches, round.
      b. Hot Water: 1-1/2 inches, round.
      c. Dual-Temperature: 1-1/2 inches, round.
      d. Low Pressure Steam: 1-1/2 inches, round.
   2. Valve-Tag Colors:
      a. Potable and Other Water: White letters on a safety-green background.

END OF SECTION

SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.
   2. Balancing Hydronic Piping Systems:
      a. Constant-flow hydronic systems.
      b. Variable-flow hydronic systems.
      c. Primary-secondary hydronic systems.
   3. Balancing steam systems.
   4. Testing, Adjusting, and Balancing Equipment:
      a. Heat exchangers.
      b. Motors.
      c. Chillers.
      d. Condensing units.
      e. Boilers.
      f. Heat-transfer coils.
   5. Testing, adjusting, and balancing existing systems and equipment.
   6. Control system verification.

1.03 DEFINITIONS

A. AABC: Associated Air Balance Council.
B. BAS: Building automation systems.
C. NEBB: National Environmental Balancing Bureau.
D. TAB: Testing, adjusting, and balancing.
E. TABB: Testing, Adjusting, and Balancing Bureau.
F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
G. TDH: Total dynamic head.

1.04 INFORMATIONAL SUBMITTALS

A. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
B. Certified TAB reports.
C. Sample report forms.
D. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.05 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC.
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
   2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.
B. TAB Specialists Qualifications: Certified by NEBB or TABB.
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.

2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB as a TAB technician.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.06 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 TAB SPECIALISTS

A. Subject to compliance with requirements, available TAB specialists that may be engaged include the following:

1. Balancing Precision Inc.
2. Illinois Certified LLC
3. Riverplace Technologies LLC

3.02 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
N. Examine system pumps to ensure absence of entrained air in the suction piping.
O. Examine operating safety interlocks and controls on HVAC equipment.
P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.03 PREPARATION

A. Prepare a TAB plan that includes the following:
   1. Equipment and systems to be tested.
   2. Strategies and step-by-step procedures for balancing the systems.
   3. Instrumentation to be used.
   4. Sample forms with specific identification for all equipment.
B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
   1. Airside:
      a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
      b. Duct systems are complete with terminals installed.
      c. Volume, smoke, and fire dampers are open and functional.
      d. Clean filters are installed.
      e. Fans are operating, free of vibration, and rotating in correct direction.
      f. Variable-frequency controllers' startup is complete and safeties are verified.
      g. Automatic temperature-control systems are operational.
      h. Ceilings are installed.
      i. Windows and doors are installed.
      j. Suitable access to balancing devices and equipment is provided.
   2. Hydronics:
      a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
      b. Piping is complete with terminals installed.
      c. Water treatment is complete.
      d. Systems are flushed, filled, and air purged.
      e. Strainers are pulled and cleaned.
      f. Control valves are functioning per the sequence of operation.
      g. Shutoff and balance valves have been verified to be 100 percent open.
      h. Pumps are started and proper rotation is verified.
      i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
      j. Variable-frequency controllers' startup is complete and safeties are verified.
      k. Suitable access to balancing devices and equipment is provided.

3.04 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 Total System Balance" ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.05 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.06 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 total airflow.
    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
2. Measure fan static pressures as follows:
    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report artificial loading of filters at the time static pressures are measured.
3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for

adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

5. 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 occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
   1. Measure airflow of submain and branch ducts.
   2. Adjust submain and branch duct volume dampers for specified airflow.
   3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.
   1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
   2. Measure inlets and outlets airflow.
   3. Adjust each inlet and outlet for specified airflow.
   4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.
   1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
   2. Re-measure and confirm that total airflow is within design.
   3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
   4. Mark all final settings.
   5. Test system in economizer mode. Verify proper operation and adjust if necessary.
   6. Measure and record all operating data.
   7. Record final fan-performance data.

3.07 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:
   1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
   2. Verify that the system is under static pressure control.
   3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
      a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
      b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
      c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
      d. Adjust controls so that terminal is calling for minimum airflow.
      e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
      f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.

g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
   c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
   d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure fan static pressures as follows:
   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
   a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
   b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
   d. Mark final settings.
   e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
   f. Verify tracking between supply and return fans.

3.08 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
   1. Check liquid level in expansion tank.
   2. Check highest vent for adequate pressure.
   3. Check flow-control valves for proper position.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

3.09 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.
   1. Measure total water flow.
      a. Position valves for full flow through coils.
      b. Measure flow by main flow meter, if installed.
      c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
   2. Measure pump TDH as follows:
      a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      c. Convert pressure to head and correct for differences in gage heights.
      d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
      e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
   3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.
   1. Measure flow in main and branch pipes.
   2. Adjust main and branch balance valves for design flow.
   3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   1. Measure flow at terminals.
   2. Adjust each terminal to design flow.
   3. Re-measure each terminal after it is adjusted.
   4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   5. Perform temperature tests after flows have been balanced.

D. For systems with pressure-independent valves at terminals:
   1. Measure differential pressure and verify that it is within manufacturer's specified range.
   2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:
   1. Measure and balance coils by either coil pressure drop or temperature method.
   2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:
   1. Re-measure and confirm that total water flow is within design.
   2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   3. Mark final settings.

G. Verify that memory stops have been set.

3.10 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.

B. Adjust the variable-flow hydronic system as follows:
   1. Verify that the differential-pressure sensor is located as indicated.

2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design gpm.
    a. Measure total water flow.
        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
    b. Measure pump TDH as follows:
        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gage heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
    c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
2. Adjust flow-measuring devices installed in mains and branches to design water flows.
    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.
3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.
4. For systems with pressure-independent valves at terminals:
    a. Measure differential pressure and verify that it is within manufacturer's specified range.
    b. Perform temperature tests after flows have been verified.
5. For systems without pressure-independent valves or flow-measuring devices at terminals:
    a. Measure and balance coils by either coil pressure drop or temperature method.
    b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:
    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.

c. Mark final settings.

10. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
3. Adjust pumps to deliver total design gpm.
   a. Measure total water flow.
      1) Position valves for full flow through coils.
      2) Measure flow by main flow meter, if installed.
      3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
   b. Measure pump TDH as follows:
      1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      3) Convert pressure to head and correct for differences in gage heights.
      4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
      5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
   c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.
5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
   a. Measure differential pressure, and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-

frequency controller to control system differential-pressure set point. Record pump data under both conditions.

11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.
13. Verify that memory stops have been set.

3.11 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.
B. Balance the secondary circuits after the primary circuits are complete.
C. Adjust pumps to deliver total design gpm.
    1. Measure total water flow.
        a. Position valves for full flow through coils.
        b. Measure flow by main flow meter, if installed.
        c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
    2. Measure pump TDH as follows:
        a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        c. Convert pressure to head and correct for differences in gage heights.
        d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
        e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
    3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
D. Adjust flow-measuring devices installed in mains and branches to design water flows.
    1. Measure flow in main and branch pipes.
    2. Adjust main and branch balance valves for design flow.
    3. Re-measure each main and branch after all have been adjusted.
E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
    1. Measure flow at terminals.
    2. Adjust each terminal to design flow.
    3. Re-measure each terminal after it is adjusted.
    4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
    5. Perform temperature tests after flows have been balanced.
F. For systems with pressure-independent valves at terminals:
    1. Measure differential pressure and verify that it is within manufacturer's specified range.
    2. Perform temperature tests after flows have been verified.
G. For systems without pressure-independent valves or flow-measuring devices at terminals:
    1. Measure and balance coils by either coil pressure drop or temperature method.
    2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
H. Verify final system conditions as follows:
    1. Re-measure and confirm that total water flow is within design.
    2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.

3. Mark final settings.

I. Verify that memory stops have been set.

3.12 PROCEDURES FOR HEAT EXCHANGERS

A. Adjust water flow to within specified tolerances.

B. Measure inlet and outlet water temperatures.

C. Measure inlet steam pressure.

D. Check settings and operation of safety and relief valves. Record settings.

3.13 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.14 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator 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. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
3. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
5. Capacity: Calculate in tons of cooling.
6. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.15 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record fan and motor operating data.

3.16 PROCEDURES FOR BOILERS

A. Hydronic Boilers:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Record relief valve pressure setting.

3.17 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:
1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

3.18 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.19 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. 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; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.

c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outdoor-, 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.

D. 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 outdoor, 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.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.
2. Motor Data:
    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Filter static-pressure differential in inches wg.
    f. Preheat-coil static-pressure differential in inches wg.
    g. Cooling-coil static-pressure differential in inches wg.

h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Motor Data:
a. Motor make, and frame type and size.

b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..
2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.

e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Entering-water temperature in deg F.
   c. Leaving-water temperature in deg F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in deg F.
   f. Leaving-air temperature in deg F.

K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and size.
   e. Model number and serial number.
   f. Water flow rate in gpm.
   g. Water pressure differential in feet of head or psig.
   h. Required net positive suction head in feet of head or psig.
   i. Pump rpm.
   j. Impeller diameter in inches.
   k. Motor make and frame size.
   l. Motor horsepower and rpm.
   m. Voltage at each connection.
   n. Amperage for each phase.
   o. Full-load amperage and service factor.
   p. Seal type.

2. Test Data (Indicated and Actual Values):
   a. Static head in feet of head or psig.
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches.
   d. Full-open flow rate in gpm.
   e. Full-open pressure in feet of head or psig.
   f. Final discharge pressure in feet of head or psig.
   g. Final suction pressure in feet of head or psig.
   h. Final total pressure in feet of head or psig.
   i. Final water flow rate in gpm.
   j. Voltage at each connection.
   k. Amperage for each phase.

L. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

END OF SECTION

SECTION 23 0716
HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:
   1. Dual-service heating and cooling pumps.
   2. Dual-service air separator.
   3. Dual-service side-stream filters.
   4. Chilled-water pumps.
   5. Chilled-water air separator.
   6. Chilled-water side-stream filters.
   7. Chilled-water remote evaporator.
   8. Steam-to-Chilled water P&F heat exchanger
   9. Steam-to-Chilled water to Chiller
   10.

B. Related Sections:
   1. Section 230713 "Duct Insulation."
   2. Section 230719 "HVAC Piping Insulation."

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Sustainable Design Submittals:

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail removable insulation at equipment connections.
   4. Detail application of field-applied jackets.
   5. Detail application at linkages of control devices.
   6. Detail field application for each equipment type.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Aeroflex USA, Inc.
    b. Armacell LLC.

2.02 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Aeroflex USA, Inc.
    b. Armacell LLC.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

N. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.04 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.05 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.07 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Plate & Frame Heat-exchanger (water-to-water or DX-to-water for cooling service) insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.

D. Chilled-water pump insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.

E. Chilled-water air-separator insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.

F. Dual-service heating and cooling air-separator insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.

G. Side-Stream filter-housing serving the Chiller, insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.

H. Side-Stream filter-housing serving the Heat Exchanger, insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.

I. Buffer Tank, Insulation shall be one of the following:
1. Factory Provided Insulating Jacket.

END OF SECTION

SECTION 23 0719
HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Condensate drain piping, indoors.
   2. Chilled-water piping, indoors and outdoors.
   3. Heating hot-water piping, indoors.
   4. Refrigerant suction and hot-gas piping, indoors and outdoors.
   5. Dual-service heating and cooling piping, indoors.
   6. Low-pressure steam piping, indoors

B. Related Sections:
   1. Section 230713 "Duct Insulation."
   2. Section 230716 "HVAC Equipment Insulation."

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. 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 and test methods employed.

C. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.07 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.08 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Aeroflex USA, Inc.
    b. Airex Manufacturing.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. CertainTeed Corporation.
    b. Johns Manville; a Berkshire Hathaway company.
    c. Knauf Insulation.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Johns Manville; a Berkshire Hathaway company.
    b. Knauf Insulation.
    c. CertainTeed Corporation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CertainTeed Corporation.
   b. Johns Manville; a Berkshire Hathaway company.
   c. Knauf Insulation.

2.02 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.04 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
2. Service Temperature Range: 0 to 180 deg F.
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

2.05 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.06 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
    a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
6. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.07 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Airex Manufacturing.
    b. Johns Manville; a Berkshire Hathaway company.
    c. P.I.C. Plastics, Inc.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:
1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    a. Sheet and roll stock ready for shop or field sizing.
    b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:
1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.

2.08 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.09 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install 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. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install 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 2 inches o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for

above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.08 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12

3.09 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Do not field paint aluminum or stainless-steel jackets.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1/2 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

B. Chilled Water, above 40 Deg F:
   1. NPS 12 and Smaller: Insulation shall be one of the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.

C. Refrigerant Liquid, Suction and Hot-Gas Piping (See Chiller Bypass):
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.

D. Refrigerant Thermostatic Expansion Valves:
   1. Flexible Elastomeric: 1 inch thick.

E. Dual-Service Heating and Cooling, 40 to 200 Deg F:
   1. NPS 4 thru NPS 8: Insulation shall be one of the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
   2. NPS 1-1/2 thru NPS 3: Insulation shall be one of the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.
   3. NPS 1 and Smaller: Insulation shall be one of the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 2 inches thick. Provide outdoor field applied jacket see below.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick. Provide outdoor field applied jacket see below.

B. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inches thick. Provide outdoor field applied jacket see below.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.

D. Piping, Exposed: PVC Jackets shall be provided on all piping exposed to public view. Exception: In gymnasiums all piping located 20'-0" AFF, PVC Jackets are not required. In addition, all piping in other areas (i.e. Mechanical Rooms, Janitor's Closet, Storage Rooms, Etc.) below 7'-0" AFF exposed to damage from traffic/normal operations shall have PVC jackets.
   1. PVC: 20 mils thick.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor's option.
C. Piping, Exposed:
   1. UV Protected PVC: 20 mils thick.
   2. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.020 inch thick.

END OF SECTION

SECTION 23 0800
COMMISSIONING OF HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.03 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances."

1.04 UNIT PRICES

A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 Section "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.05 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.06 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.07 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.

7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

1.08 SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.02 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.03 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R Subcontractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.04 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

B. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R Subcontractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

C. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

END OF SECTION

SECTION 23 0923
DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Extend Existing System:
   1. Extend the existing Tridium BAS for this project.
   2. All controllers and accessories shall interface with the existing Tridium BAS.

B. TCC shall furnish all labor, materials, equipment, and service necessary for a complete and operating Building Automation System (BAS) using Direct Digital Controls as shown on the drawings and as described herein.

C. All labor, material, equipment and software not specifically referred to herein or on the plans that is required to meet the intent of this specification shall be provided without additional costto the Owner.

D. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

E. Related Requirements:
   1. Section 230923.13 "Energy Meters" for thermal and electric power energy meters that connect to DDC systems.
   2. Section 230993.11 "Sequence of Operations for HVAC DDC" for control sequences in DDC systems.
   3. Communications Cabling:
      a. Section 260523 "Control-Voltage Electrical Power Cables" for balanced twisted pair communications cable.
      b. Section 271513 "Communications Copper Horizontal Cabling" for balanced twisted pair communications cable.
   4. Raceways:
      a. Section 260533 "Raceways and Boxes for Electrical Systems" for raceways for low-voltage control cable.
      b. Section 270528 "Pathways for Communications Systems" for raceways for balanced twisted pair cabling and optical fiber cable.
   5. Section 260553 "Identification for Electrical Systems" for identification requirements for electrical components.
   6. Section 270553 "Identification for Communications Systems" for identification requirements for communications components.

1.03 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BACnet Specific Definitions:
   1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
   2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
   3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.

4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.

D. Binary: Two-state signal where a high signal level represents ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.
F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
G. COV: Changes of value.
H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.
I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.
J. DOCSIS: Data-Over Cable Service Interface Specifications.
K. E/P: Voltage to pneumatic.
L. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
M. HLC: Heavy load conditions.
N. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
O. I/P: Current to pneumatic.
P. LAN: Local area network.
Q. LNS: LonWorks Network Services.
R. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
S. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.
T. Modbus TCP/IP: An open protocol for exchange of process data.
U. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
V. MTBF: Mean time between failures.
W. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.
X. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
Y. Peer to Peer: Networking architecture that treats all network stations as equal partners.
Z. POT: Portable operator's terminal.
AA. PUE: Performance usage effectiveness.
BB. RAM: Random access memory.
CC. RF: Radio frequency.

DD. Router: Device connecting two or more networks at network layer.
EE. Server: Computer used to maintain system configuration, historical and programming database.
FF. TCP/IP: Transport control protocol/Internet protocol.
GG. UPS: Uninterruptible power supply.
HH. USB: Universal Serial Bus.
II. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
JJ. VAV: Variable air volume.
KK. WLED: White light emitting diode.

1.04 ACTION SUBMITTALS

A. Multiple Submissions:
1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

B. Product Data: For each type of product include the following:
1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
a. Workstations.
b. Servers (if required)
c. Printers.
d. Routers.
e. DDC controllers.
f. Enclosures.
g. Electrical power devices.
h. UPS units.
i. Accessories.
j. Instruments.
k. Control dampers and actuators.
l. Control valves and actuators.
6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

C. Software Submittal:

1. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway and DDC controller.
2. Description and technical data of all software provided, and cross-referenced to products in which software will be installed.
3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Listing and description of each engineering equation used with reference source.
6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
7. Description of operator interface to alphanumeric and graphic programming.
8. Description of each network communication protocol.
9. Description of system database, including all data included in database, database capacity and limitations to expand database.
10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.
11. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings:
1. General Requirements:
    a. Include cover drawing with Project name, location, Owner, Architect, Contractor and issue date with each Shop Drawings submission.
    b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
    c. Drawings Size: 11” x 17”.
2. Include plans, elevations, sections, and mounting details where applicable.
3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail means of vibration isolation and show attachments to rotating equipment.
5. Plan Drawings indicating the following:
    a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.
    b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
    c. Each desktop workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
    d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
    e. Network communication cable and raceway routing.
    f. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.
6. Schematic drawings for each controlled HVAC system indicating the following:
    a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.

b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
c. A graphic showing location of control I/O in proper relationship to HVAC system.
d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
g. Narrative sequence of operation.
h. Graphic sequence of operation, showing all inputs and output logical blocks.

7. Control panel drawings indicating the following:
   a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
   b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
   c. Front, rear, and side elevations and nameplate legend.
   d. Unique drawing for each panel.
8. DDC system network riser diagram indicating the following:
   a. Each device connected to network with unique identification for each.
   b. Interconnection of each different network in DDC system.
   c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
   d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
9. DDC system electrical power riser diagram indicating the following:
   a. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
   b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
   c. Each product requiring power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
   d. Power wiring type and size, race type, and size for each.
10. Monitoring and control signal diagrams indicating the following:
    a. Control signal cable and wiring between controllers and I/O.
    b. Point-to-point schematic wiring diagrams for each product.
    c. Control signal tubing to sensors, switches and transmitters.
    d. Process signal tubing to sensors, switches and transmitters.
    e. Pneumatic main air and control signal tubing to pneumatic damper and valve actuators, pilot-positioners if applicable, and associated transducers.
11. Color graphics completed by Owner.

E. System Description:
   1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
   2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
   3. System and product operation under each potential failure condition including, but not limited to, the following:

a. Loss of power.
b. Loss of network communication signal.
c. Loss of controller signals to inputs and outpoints.
d. Operator workstation failure.
e. Server failure.
f. Gateway failure.
g. Network failure
h. Controller failure.
i. Instrument failure.
j. Control damper and valve actuator failure.

4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
   b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
   c. As-built versions of submittal Product Data.
   d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
   e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
   f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
   g. Engineering, installation, and maintenance manuals that explain how to:
      1) Design and install new points, panels, and other hardware.
      2) Perform preventive maintenance and calibration.
      3) Debug hardware problems.
      4) Repair or replace hardware.
   h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
   i. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
   j. List of recommended spare parts with part numbers and suppliers.
   k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
   l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
   m. Licenses, guarantees, and warranty documents.
   n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
   o. Owner training materials.

1.06 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:
   1. Nationally recognized manufacturer of DDC systems and products.
   2. DDC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
   3. DDC systems and products that have been successfully tested and in use on at least five past projects.
   4. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
   5. Having full-time in-house employees for the following:
      a. Product research and development.
      b. Product and application engineering.
      c. Product manufacturing, testing and quality control.
      d. Technical support for DDC system installation training, commissioning and troubleshooting of installations.
      e. Owner operator training.

B. DDC System Provider Qualifications:
   1. Authorized representative of, and trained by, DDC system manufacturer.
   2. In-place facility located within 30 miles of Project.
   3. Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
   4. Demonstrated past experience on five projects of similar complexity, scope and value.
   5. Each person assigned to Project shall have demonstrated past experience.
   6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
   7. Service and maintenance staff assigned to support Project during warranty period.
   8. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.
   9. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

1.07 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.
   1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
   2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
      a. Install updates only after receiving Owner's written authorization.
   3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner's warranty service request.
   4. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 DDC SYSTEM MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Automated Logic Controls By ECSI
   2. Detla Controls By Entec
   3. Distech Controls By TSS

2.02 DDC SYSTEM DESCRIPTION

A. The entire BAS shall be comprised of a network of interoperable, standalone digital controllers communicating via the following protocol to JACE. Building Automation System products shall be as specified below.

B. Rockford Public Schools shall furnish and install a JACE Controller within each facility. The JACE shall connect to the Owner's local or wide area network, depending on configuration. Provide access to the system, either locally in each building or remotely from a central site or sites, through standard Web browsers, via the Internet, and/or via local area network.

C. Provide materials and labor necessary to connect factory supplied control components.

D. Provide central and remote hardware, software, and interconnecting wire and conduit.

E. The BAS shall include automated alarming software capable of calling e-mail compatible cellular telephones and pagers. The e-mail alarm paging system shall be able to segregate users, time schedules, and equipment and be capable of being programmed by the Owner.

2.03 WEB ACCESS

A. DDC system shall be Web based.

1. Web-Based Access to DDC System:
    a. DDC system software shall be based on server thin-client architecture, designed around open standards of Web technology. DDC system server shall be accessed using a Web browser over DDC system network, using Owner's LAN, and remotely over Internet through Owner's LAN.
    b. Intent of thin-client architecture is to provide operators complete access to DDC system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
    c. Web access shall be password protected.

2.04 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional to design DDC system to satisfy requirements indicated.

1. System Performance Objectives:
    a. DDC system shall manage HVAC systems.
    b. DDC system control shall operate HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
    c. DDC system shall respond to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
    d. DDC system shall operate while unattended by an operator and through operator interaction.
    e. DDC system shall record trends and transaction of events and produce report information such as performance, energy, occupancies, and equipment operation.

B. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. DDC System Speed:

1. Response Time of Connected I/O:
    a. AI point values connected to DDC system shall be updated at least every two seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
    b. BI point values connected to DDC system shall be updated at least every two seconds for use by DDC controllers. Points used globally shall also comply with this requirement.

c. AO points connected to DDC system shall begin to respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
d. BO point values connected to DDC system shall respond to controller output commands within two second(s). Global commands shall also comply with this requirement.

2. Display of Connected I/O:
a. Analog point COV connected to DDC system shall be updated and displayed at least every five seconds for use by operator.
b. Binary point COV connected to DDC system shall be updated and displayed at least every five seconds for use by operator.
c. Alarms of analog and digital points connected to DDC system shall be displayed within 15 seconds of activation or change of state.
d. Graphic display refresh shall update within four seconds.
e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.

D. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.

E. DDC System Data Storage:
1. Include capability to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.
2. Local Storage:
a. Provide server workstation with data storage indicated. Server(s) shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.

F. DDC Data Access:
1. When logged into the system, operator shall be able to also interact with any DDC controller connected to DDC system as required for functional operation of DDC system.
2. System(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.

G. Future Expandability:
1. DDC system size shall be expandable to an ultimate capacity of at least two times total I/O points indicated.
2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.

H. Input Point Displayed Accuracy: Input point displayed values shall meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.
1. Energy:
a. Thermal: Within 3 percent of reading.
b. Electric Power: Within 1 percent of reading.
c. Requirements indicated on Drawings for meters not supplied by utility.

2. Flow:
    a. Air: Within 2 percent of design flow rate.
    b. Air (Terminal Units): Within 5 percent of design flow rate.
    c. Water: Within 5 percent of design flow rate.
3. Gas:
    a. Carbon Dioxide: Within 50 ppm.
    b. Carbon Monoxide: Within 5 percent of reading.
    c. Refrigerant: Within 50 ppm.
4. Moisture (Relative Humidity):
    a. Air: Within 2 percent RH.
    b. Space: Within 2 percent RH.
    c. Outdoor: Within 2 percent RH.
5. Level: Within 2 percent of reading.
6. Pressure:
    a. Air, Ducts and Equipment: 1 percent of instrument range.
    b. Space: Within 1 percent of instrument range.
    c. Water: Within 1 percent of instrument range.
7. Speed: Within 5 percent of reading.
8. Temperature, Dew Point:
    a. Air: Within 1 deg F.
    b. Space: Within 1 deg F.
    c. Outdoor: Within 2 deg F.
9. Temperature, Dry Bulb:
    a. Air: Within 1 deg F.
    b. Space: Within 1 deg F.
    c. Outdoor: Within 2 deg F.
    d. Chilled Water: Within 1 deg F.
    e. Condenser Water: Within 1 deg F.
    f. Heating Hot Water: Within 1 deg F.
    g. Energy Recovery Runaround Liquid: Within 1 deg F.
    h. Temperature Difference: Within 0.25 deg F.
    i. Other Temperatures Not Indicated: Within 1 deg F.
10. Temperature, Wet Bulb:
    a. Air: Within 1 deg F.
    b. Space: Within 1 deg F.
    c. Outdoor: Within 2 deg F.

I. Precision of I/O Reported Values: Values reported in database and displayed shall have following precision:
1. Current:
    a. Milliamperes: Nearest 1/100th of a milliampere.
    b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.
2. Energy:
    a. Electric Power:
        1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
        2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
        3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.
    b. Thermal, Rate:

1) Heating: For Btu/h, nearest Btu/h up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For Mbh, round to nearest Mbh up to 1000 Mbh; nearest 10 Mbh between 1000 and 10,000 Mbh; nearest 100 Mbh above 10,000 Mbh.
2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons.

c. Thermal, Usage:
1) Heating: For Btu, nearest Btu up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For Mbtu, round to nearest Mbtu up to 1000 Mbtu; nearest 10 Mbtu between 1000 and 10,000 Mbtu; nearest 100 Mbtu above 10,000 Mbtu.
2) Cooling: For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons.

3. Flow:
a. Air: Nearest 1/10th of a cfm through 100 cfm; nearest cfm between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.
b. Water: Nearest 1/10th gpm through 100 gpm; nearest gpm between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm.
c. Steam: Nearest 1/10th lb/hr through 100 lbs/hr; nearest lbs/hr between 100 and 1000 lbs/hr; nearest 10 lbs/hr above 1000 lbs/hr.

4. Gas:
a. Carbon Dioxide (ppm): Nearest ppm.
b. Carbon Monoxide (ppm): Nearest ppm.
c. Oxygen (Percentage): Nearest 1/10th of 1 percent.
d. Refrigerant (ppm): Nearest ppm.

5. Moisture (Relative Humidity):
a. Relative Humidity (Percentage): Nearest 1 percent.

6. Level: Nearest 1/100th of an inch through 10 inches; nearest 1/10 of an inch between 10 and 100 inches; nearest inch above 100 inches.

7. Speed:
a. Rotation (rpm): Nearest 1 rpm.
b. Velocity: Nearest 1/10th fpm through 100 fpm; nearest fpm between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm.

8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.

9. Pressure:
a. Air, Ducts and Equipment: Nearest 1/10th in. w.c..
b. Space: Nearest 1/100th in. w.c..
c. Steam: Nearest 1/10th psig through 100 psig; nearest psig above 100 psig.
d. Water: Nearest 1/10 psig through 100 psig; nearest psig above 100 psig.

10. Temperature:
a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
b. Outdoor: Nearest degree.
c. Space: Nearest 1/10th of a degree.
d. Chilled Water: Nearest 1/10th of a degree.
e. Condenser Water: Nearest 1/10th of a degree.
f. Heating Hot Water: Nearest degree.
g. Heat Recovery Runaround: Nearest 1/10th of a degree.
h. Steam: Nearest degree.

11. Vibration: Nearest 1/10th in/s.
12. Voltage: Nearest 1/10 volt up to 100 V; nearest volt above 100 V.

J. Control Stability: Control variables indicated within the following limits:
1. Flow:
   a. Air, Ducts and Equipment, except Terminal Units: Within 2 percent of design flow rate.
   b. Air, Terminal Units: Within 5 percent of design flow rate.
   c. Water: Within 2 percent of design flow rate.
2. Gas:
   a. Carbon Dioxide: Within 50 ppm.
   b. Carbon Monoxide: Within 5 percent of reading.
   c. Oxygen: Within 5 percent of reading.
3. Moisture (Relative Humidity):
   a. Air: Within 2 percent RH.
   b. Space: Within 2 percent RH.
   c. Outdoor: Within 2 percent RH.
4. Level: Within 5 percent of reading.
5. Pressure:
   a. Air, Ducts and Equipment: 1 percent of instrument range.
   b. Space: Within 1 percent of instrument range.
   c. Water: Within 1 percent of instrument range.
   d. Steam: Within 1 percent of instrument range.
6. Temperature, Dew Point:
   a. Air: Within 1 deg F.
   b. Space: Within 1 deg F.
7. Temperature, Dry Bulb:
   a. Air: Within 1 deg F.
   b. Space: Within 1 deg F.
   c. Chilled Water: Within 1 deg F.
   d. Condenser Water: Within 1 deg F.
   e. Heating Hot Water: Within 1 deg F.
8. Temperature, Wet Bulb:
   a. Air: Within 1 deg F.
   b. Space: Within 1 deg F.

K. Environmental Conditions for Controllers, Gateways, and Routers:
1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
   a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
   a. Outdoors, Protected: Type 12.
   b. Outdoors, Unprotected: Type 4.
   c. Indoors, Heated with Filtered Ventilation: Type 1.
   d. Indoors, Heated with Non-Filtered Ventilation: Type 2.
   e. Indoors, Heated and Air Conditioned: Type 1.

f. Mechanical Equipment Rooms:
1) Chiller and Boiler Rooms: Type 1.
2) Air-Moving Equipment Rooms: Type 1.
g. Localized Areas Exposed to Washdown: Type 4.
h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 1.
i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.

L. Environmental Conditions for Instruments and Actuators:
1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by instrument and application.
2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
a. Outdoors, Protected: Type 1.
b. Outdoors, Unprotected: Type 4.
c. Indoors, Heated with Filtered Ventilation: Type 1.
d. Indoors, Heated with Non-Filtered Ventilation: Type 2.
e. Indoors, Heated and Air-conditioned: Type 1.
f. Mechanical Equipment Rooms:
1) Chiller and Boiler Rooms: Type 1.
2) Air-Moving Equipment Rooms: Type 1.
g. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 1.
h. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.

M. DDC System Reliability:
1. Design, install and configure DDC controllers, gateways, routers, and to yield a MTBF of at least 40,000 hours, based on a confidence level of at least 90 percent. MTBF value shall include any failure for any reason to any part of products indicated.
2. If required to comply with MTBF indicated, include DDC system and product redundancy to maintain DCC system, and associated systems and equipment that are being controlled, operational and under automatic control.
3. Critical systems and equipment that require a higher degree of DDC system redundancy than MTBF indicated shall be indicated on Drawings.

N. Electric Power Quality:
1. Power-Line Surges:
a. Protect susceptible DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
b. Do not use fuses for surge protection.
c. Test protection in the normal mode and in the common mode, using the following two waveforms:

1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.

2. Power Conditioning:
   a. Protect susceptible DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:
      1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
      2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
      3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
      4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.
3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.

O. Backup Power Source:
1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.

P. UPS:
1. DDC system products powered by UPS units shall include the following:
   a. Desktop workstations.
   b. Printers.
   c. Servers.
   d. Gateways.
   e. DDC controllers, except application-specific controllers.

Q. Continuity of Operation after Electric Power Interruption:
1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.05 SYSTEM ARCHITECTURE

A. System architecture shall consist of no more than two or three levels of LANs.
1. Level one LAN shall connect network controllers and operator workstations.
2. Level one or Level two LAN shall connect programmable application controllers to other programmable application controllers, and to network controllers.
3. Level two or Level three LAN shall connect application-specific controllers to programmable application controllers and network controllers.
4. Level two or Level three LAN shall connect application-specific controllers to application-specific controllers.

B. Minimum Data Transfer and Communication Speed:
1. LAN Connecting Operator Workstations and Network Controllers: 100 Mbps.
2. LAN Connecting Programmable Application Controllers: 1000 kbps.
3. LAN Connecting Application-Specific Controllers: 115,000 bps.

C. DDC system shall consist of dedicated and separated LANs that are not shared with other building systems and tenant data and communication networks.

D. System architecture shall be modular and have inherent ability to expand to not less than two times system size indicated with no impact to performance indicated.
E. System architecture shall perform modifications without having to remove and replace existing network equipment.
F. Number of LANs and associated communication shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all system LANs.
G. System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.

2.06 DDC SYSTEM OPERATOR INTERFACES

A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:
   1. Desktop and portable workstation with hardwired connection through LAN port.
   2. Portable operator terminal with hardwired connection through LAN port.
   3. Portable operator workstation with wireless connection through LAN router.
   4. Mobile device and application with secured wireless connection through LAN router or cellular data service.
   5. Remote connection through web access.
B. Access to system, regardless of operator means used, shall be transparent to operator.
C. Network Ports: For hardwired connection of desktop or portable workstation. Network port shall be easily accessible, properly protected, clearly labeled, and installed at the following locations:
   1. Each mechanical equipment room.
   2. Each boiler room.
   3. Each chiller room or outdoor chiller yard.
   4. Each cooling tower location.
   5. Each different roof level with roof-mounted air-handling units or rooftop units.
D. Desktop Workstations:
   1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
   2. Able to communicate with any device located on any DDC system LAN.
E. Portable Workstations:
   1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
   2. Able to communicate with any device located on any DDC system LAN.
   3. Connect to DDC system Level two or Level three LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
   4. Connect to system through a wireless router connected to Level one LAN.
   5. Connect to system through a cellular data service.
   6. Portable workstation shall be able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
   7. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
   8. Have dynamic graphic displays that are identical to desktop workstations.
F. POT:
   1. Connect DDC controller through a communications port local to controller.
   2. Able to communicate with any DDC system controller that is directly connected or connected to DDC system.
G. Mobile Device:
   1. Connect to system through a wireless router connected to LAN and cellular data service.

2. Able to communicate with any DDC controller connected to DDC system using a dedicated application and secure web access.

H. Critical Alarm Reporting:
1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
3. DDC system shall notify recipients by any or all means, including e-mail, text message and prerecorded phone message to mobile and landline phone numbers.

I. Simultaneous Operator Use: Capable of accommodating up to five simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

2.07 NETWORKS

A. Acceptable networks for connecting workstations, mobile devices, and network controllers include the following:
1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. IP.
4. IEEE 8802-3, Ethernet.

B. Acceptable networks for connecting programmable application controllers include the following:
1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. IP.
4. IEEE 8802-3, Ethernet.

C. Acceptable networks for connecting application-specific controllers include the following:
1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. EIA-485A.
4. IP.
5. IEEE 8802-3, Ethernet.

2.08 NETWORK COMMUNICATION PROTOCOL

A. Network communication protocol(s) used throughout entire DDC system shall be open to Owner and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:
1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

2.09 SYSTEM SOFTWARE

A. System Software Minimum Requirements:
1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating DOS and Microsoft Windows applications.

3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software shall manage and control multiple network communications to provide exchange of global information and execution of global programs.
5. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:
1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Operator sign-on and sign-off activity shall be recorded and sent to printer.
6. Security Access:
   a. Operator access to DDC system shall be under password control.
   b. An alphanumeric password shall be field assignable to each operator.
   c. Operators shall be able to access DDC system by entry of proper password.
   d. Operator password shall be same regardless of which computer or other interface means is used.
   e. Additions or changes made to passwords shall be updated automatically.
   f. Each operator shall be assigned an access level to restrict access to data and functions the operator is cable of performing.
   g. Software shall have at least five access levels.
   h. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
   i. Display menu items to operator with those capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.
7. Data Segregation:
   a. Include data segregation for control of specific data routed to a workstation, to an operator or to a specific output device, such as a printer.
   b. Include at least 32 segregation groups.
   c. Segregation groups shall be selectable such as "fire points," "fire points on second floor," "space temperature points," "HVAC points," and so on.
   d. Points shall be assignable to multiple segregation groups. Display and output of data to printer or monitor shall occur where there is a match of operator or peripheral segregation group assignment and point segregations.
   e. Alarms shall be displayed and printed at each peripheral to which segregation allows, but only those operators assigned to peripheral and having proper authorization level will be allowed to acknowledge alarms.

f. Operators and peripherals shall be assignable to multiple segregation groups and all assignments are to be online programmable and under password control.

8. Operators shall be able to perform commands including, but not limited to, the following:
   a. Start or stop selected equipment.
   b. Adjust set points.
   c. Add, modify, and delete time programming.
   d. Enable and disable process execution.
   e. Lock and unlock alarm reporting for each point.
   f. Enable and disable totalization for each point.
   g. Enable and disable trending for each point.
   h. Override control loop set points.
   i. Enter temporary override schedules.
   j. Define holiday schedules.
   k. Change time and date.
   l. Enter and modify analog alarm limits.
   m. Enter and modify analog warning limits.
   n. View limits.
   o. Enable and disable demand limiting.
   p. Enable and disable duty cycle.
   q. Display logic programming for each control sequence.
9. Reporting:
   a. Generated automatically and manually.
   b. Sent to displays, printers and disk files.
   c. Types of Reporting:
      1) General listing of points.
      2) List points currently in alarm.
      3) List of off-line points.
      4) List points currently in override status.
      5) List of disabled points.
      6) List points currently locked out.
      7) List of items defined in a "Follow-Up" file.
      8) List weekly schedules.
      9) List holiday programming.
      10) List of limits and deadbands.
10. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:
1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface shall use a pointing device with pull-down or penetrating menus, color and animation to facilitate operator understanding of system.
3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
4. Descriptors for graphics, points, alarms and such shall be modified through operator's workstation under password control.
5. Graphic displays shall be online user definable and modifiable using the hardware and software provided.

6. Data to be displayed within a graphic shall be assignable regardless of physical hardware address, communication or point type.
7. Graphics are to be online programmable and under password control.
8. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
9. Graphics shall also contain software points.
10. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding.
11. Back-trace feature shall permit operator to move upward in the hierarchy using a pointing device. Back trace shall show all previous penetration levels. Include operator with option of showing each graphic full screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
12. Display operator accessed data on the monitor.
13. Operator shall select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Defined and linked graphic below that selection shall then be displayed.
14. Include operator with means to directly access graphics without going through penetration path.
15. Dynamic data shall be assignable to graphics.
16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
17. Use color, rotation, or other highly visible means, to denote status and alarm states. Color shall be variable for each class of points, as chosen by operator.
18. Points shall be dynamic with operator adjustable update rates on a per point basis from one second to over a minute.
19. For operators with appropriate privilege, points shall be commanded directly from display using pointing device.
    a. For an analog command point such as set point, current conditions and limits shall be displayed and operator can position new set point using pointing device.
    b. For a digital command point such as valve position, valve shall show its current state such as open or closed and operator could select alternative position using pointing device.
    c. Keyboard equivalent shall be available for those operators with that preference.
20. Operator shall be able to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot and other information on other quadrants on screen. This feature shall allow real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
21. Help Features:
    a. On-line context-sensitive help utility to facilitate operator training and understanding.
    b. Bridge to further explanation of selected keywords. Document shall contain text and graphics to clarify system operation.
        1) If help feature does not have ability to bridge on keywords for more information, a complete set of user manuals shall be provided in an indexed word-processing program, which shall run concurrently with operating system software.
    c. Available for Every Menu Item:
        1) Index items for each system menu item.
22. Graphic generation software shall allow operator to add, modify, or delete system graphic displays.

a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers, valves pumps, and electrical symbols similar to those indicated.
b. Graphic development package shall use a pointing device in conjunction with a drawing program to allow operator to perform the following:
1) Define background screens.
2) Define connecting lines and curves.
3) Locate, orient and size descriptive text.
4) Define and display colors for all elements.
5) Establish correlation between symbols or text and associated system points or other displays.

D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:
1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:
a. Room layouts with room identification and name.
b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
c. Location and identification of each hardware point being controlled or monitored by DDC system.
3. Control schematic for each of following, including a graphic system schematic representation, similar to that indicated on Drawings, with point identification, set point and dynamic value indication, sequence of operation and control logic diagram.
4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, gateways operator workstations and other network devices.

E. Customizing Software:
1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. As a minimum, include the following modification capability:
a. Operator assignment shall include designation of operator passwords, access levels, point segregation and auto sign-off.
b. Peripheral assignment capability shall include assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points and enabling and disabling of print-out of operator changes.
c. System configuration and diagnostic capability shall include communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points and application programs and initiation of diagnostics.
d. System text addition and change capability shall include English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time and trouble condition.
e. Time and schedule change capability shall include time and date set, time and occupancy schedules, exception and holiday schedules and daylight savings time schedules.

f. Point related change capability shall include the following:
   1) System and point enable and disable.
   2) Run-time enable and disable.
   3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
   4) Assignment of alarm and warning limits.

g. Application program change capability shall include the following:
   1) Enable and disable of software programs.
   2) Programming changes.
   3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.

4. Software shall allow operator to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Additions and modifications shall be online programmable using operator workstation, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, database shall be uploaded and recorded on hard drive and disk for archived record.
5. Include high-level language programming software capability for implementation of custom DDC programs. Software shall include a compiler, linker, and up- and down-load capability.
6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:
   a. Proportional control (P).
   b. Proportional plus integral (PI).
   c. Proportional plus integral plus derivative (PID).
   d. Adaptive and intelligent self-learning control.
      1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
      2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.
7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.
9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
10. Relational operators such as "Equal To," "Not Equal To," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.

F. Alarm Handling Software:
1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways and other network devices.
2. Include first in, first out handling of alarms according to alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display shall include the following:

a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.

5. Alarms shall be directed to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
6. Send e-mail alarm messages to designated operators.
7. Send e-mail, page, text and voice messages to designated operators for critical alarms.
8. Alarms shall be categorized and processed by class.
   a. Class 1:
      1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
      2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
      3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.
   b. Class 2:
      1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
      2) Acknowledgement may be through a multiple alarm acknowledgment.
   c. Class 3:
      1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.
      2) Each new alarm received shall cause an audible sound. Audible sound shall be silenced by "acknowledging" alarm or by pressing a "silence" key.
      3) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgement.
      4) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.
   d. Class 4:
      1) Routine maintenance or other types of warning alarms.
      2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.
9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
10. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.

G. Reports and Logs:
   1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
   2. Each report shall be definable as to data content, format, interval and date.
   3. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation server for historical reporting.

4. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
5. Reports and logs shall be stored on workstation and server hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
6. Reports and logs shall be readily printed and set to be printed either on operator command or at a specific time each day.

H. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.
1. All I/O: With current status and values.
2. Alarm: All current alarms, except those in alarm lockout.
3. Disabled I/O: All I/O points that are disabled.
4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
6. Logs:
   a. Alarm history.
   b. System messages.
   c. System events.
   d. Trends.

I. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.

J. Tenant Override Reports: Prepare Project-specific reports.
1. Weekly report showing daily total time in hours that each tenant has requested after-hours HVAC.
2. Monthly report showing daily total time in hours that each tenant has requested after-hours HVAC.
3. Annual summary report that shows after-hours HVAC usage on a monthly basis.

K. HVAC Equipment Reports: Prepare Project-specific reports.
1. Chiller Report: Daily report showing operating conditions of each chiller according to ASHRAE 147, including, but not limited to, the following:
   a. Chilled-water entering temperature.
   b. Chilled-water leaving temperature.
   c. Chilled-water flow rate.
   d. Chilled-water inlet and outlet pressures.
   e. Evaporator refrigerant pressure and temperature.
   f. Condenser refrigerant pressure and liquid temperature.
   g. Condenser-water entering temperature.
   h. Condenser-water leaving temperature.
   i. Condenser-water flow rate.
   j. Refrigerant levels.
   k. Oil pressure and temperature.
   l. Oil level.
   m. Compressor refrigerant discharge temperature.
   n. Compressor refrigerant suction temperature.
   o. Addition of refrigerant.
   p. Addition of oil.
   q. Vibration levels or observation that vibration is not excessive.
   r. Motor amperes per phase.
   s. Motor volts per phase.
   t. Refrigerant monitor level (PPM).

u. Purge exhaust time or discharge count.
v. Ambient temperature (dry bulb and wet bulb).
w. Date and time logged.

L. Utility Reports: Prepare Project-specific reports.
1. Electric Report:
a. Include weekly report showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
b. Include monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each meter.
c. Include annual report showing the monthly electrical consumption and peak electrical demand with time and date stamp for each meter.
d. For each weekly, monthly and annual report, include sum total of submeters combined by load type, such as lighting, receptacles and HVAC equipment showing daily electrical consumption and peak electrical demand.
e. For each weekly, monthly and annual report, include sum total of all submeters in building showing electrical consumption and peak electrical demand.
2. Natural Gas Report:
a. Include weekly report showing daily natural gas consumption and peak natural gas demand with time and date stamp for each meter.
b. Include monthly report showing the daily natural gas consumption and peak natural gas demand with time and date stamp for each meter.
c. Include annual report showing the monthly natural gas consumption and peak natural gas demand with time and date stamp for each meter.
d. For each weekly, monthly and annual report, include sum total of submeters combined by load type, such as boilers and service water heaters showing daily natural gas consumption and peak natural gas demand.
e. For each weekly, monthly and annual report, include sum total of all submeters in building showing natural gas consumption and peak natural gas demand.

M. Energy Reports: Prepare Project-specific daily, weekly, monthly, annual and since-installed energy reports.
1. Prepare report for each purchased energy utility, indicating the following:
a. Time period being reported with beginning and end date, and time indicated.
b. Consumption in units of measure commonly used to report specific utility consumption over time.
c. Gross area served by utility.
d. Consumption per unit area served using utility-specific unit of measure.
e. Cost per utility unit.
f. Utility cost per unit area.
g. Convert all utilities to a common energy consumption unit of measure and report for each utility.
h. Consumption per unit area using common unit of measure.
2. Prepare report for each renewable energy source, indicating the following:
a. Time period being reported with beginning and end date, and time indicated.
b. Harvested energy in units of measure commonly used to report specific harvested energy consumption over time.
c. Gross area served by renewable energy source.
d. Harvested energy per unit area served using specific unit of measure.
e. Cost per purchased utility unit displaced by renewable energy.
f. Cost savings attributed to harvested energy source.
g. Cost savings per unit area attributed to harvested energy.

h. Convert all renewable energy sources to a common energy consumption unit of measure and report for each.
i. Harvested energy per unit area using common unit of measure.

3. Prepare purchased energy utility report for each sub-metered area that indicates the following:
   a. Time period being reported with beginning and end date, and time indicated.
   b. Gross area served.
   c. Energy consumption by energy utility type.
   d. Energy consumption per unit area by energy utility type.
   e. Total energy consumption of all utilities in common units of measure.
   f. Total energy consumption of all utilities in common units of measure per unit area.
   g. Unit energy cost by energy utility type.
   h. Energy cost by energy utility type.
   i. Energy cost per unit area by energy utility type.
   j. Total cost of all energy utilities.
   k. Total cost of all energy utilities per unit area.
4. Prepare Project total purchased energy utility report that combines all purchased energy utilities and all areas served. Project total energy report shall indicate the following:
   a. Time period being reported with beginning and end date, and time indicated.
   b. Gross area served.
   c. Energy consumption by energy utility type.
   d. Energy consumption per unit area by energy utility type.
   e. Total energy consumption of all utilities in common units of measure.
   f. Total energy consumption of all utilities in common units of measure per unit area.
   g. Unit energy cost by energy utility type.
   h. Energy cost by energy utility type.
   i. Energy cost per unit area by energy utility type.
   j. Total cost of all energy utilities.
   k. Total cost of all energy utilities per unit area.

N. HVAC System Efficiency Reports: Prepare Project-specific daily weekly monthly and annual, annual and since-installed HVAC system efficiency reports.
1. Prepare report for each chilled-water system, indicating the following:
   a. Time period being reported with beginning and end date, and time indicated.
   b. Cooling energy supplied during time period.
   c. Power energy consumed during time period by cooling equipment used to produce cooling energy supplied. List power consumed for each individual piece of equipment in system and summed total of all equipment in system.
   d. Energy efficiency coefficient of performance determined by dividing power energy consumed into cooling energy supplied.
   e. Energy efficiency determined by dividing cooling energy supplied into power energy consumed.
   f. Units of measure used in report shall be consistent with units indicated for system.
2. Prepare report for each hot-water system, indicating the following:
   a. Time period being reported with beginning and end date, and time indicated.
   b. Cooling energy supplied during time period.
   c. Fuel consumed during time period by boilers used to produce heating energy supplied. List fuel consumed for each individual piece of equipment in system and summed total of all equipment in system.
   d. Energy efficiency determined by dividing heating energy supplied into fuel energy consumed.
   e. Units of measure used in report shall be consistent with units indicated for system.

O. Weather Reports:
   1. Include daily report showing the following:
      a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
      b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
      c. Daily minimum, maximum, and average outdoor dew point temperature.
      d. Number of heating degree-days for each day calculated from a base temperature of 55 deg F.
      e. Daily minimum, maximum, and average outdoor carbon dioxide level.
      f. Daily minimum, maximum, and average relative humidity.
      g. Daily minimum, maximum, and average barometric pressure.
      h. Daily minimum, maximum, and average wind speed and direction.
   2. Include weekly report showing the following:
      a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
      b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
      c. Daily minimum, maximum, and average outdoor dew point temperature.
      d. Number of heating degree-days for each day calculated from a base temperature of 55 deg F.
      e. Weekly minimum, maximum, and average outdoor carbon dioxide level.
      f. Daily minimum, maximum, and average relative humidity.
      g. Daily minimum, maximum, and average barometric pressure.
      h. Daily minimum, maximum, and average wind speed and direction.
   3. Include monthly report showing the following:
      a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
      b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
      c. Daily minimum, maximum, and average outdoor dew point temperature.
      d. Number of heating degree-days for each day calculated from a base temperature of 55 deg F.
      e. Monthly minimum, maximum, and average outdoor carbon dioxide level.
      f. Daily minimum, maximum, and average relative humidity.
      g. Daily minimum, maximum, and average barometric pressure.
      h. Daily minimum, maximum, and average wind speed and direction.
   4. Include annual (12-month) report showing the following:
      a. Monthly minimum, maximum, and average outdoor dry-bulb temperature.
      b. Monthly minimum, maximum, and average outdoor wet-bulb temperature.
      c. Monthly minimum, maximum, and average outdoor dew point temperature.
      d. Number of heating degree-days for each month calculated from a base temperature of 55 deg F.
      e. Annual minimum, maximum, and average outdoor carbon dioxide level.
      f. Monthly minimum, maximum, and average relative humidity.
      g. Daily minimum, maximum, and average barometric pressure.
      h. Daily minimum, maximum, and average wind speed and direction.
P. Standard Trends:
   1. Trend all I/O point present values, set points, and other parameters indicated for trending.
   2. Trends shall be associated into groups, and a trend report shall be set up for each group.
   3. Trends shall be stored within DDC controller and uploaded to hard drives automatically on reaching 75 of DDC controller buffer limit, or by operator request, or by archiving time schedule.
   4. Preset trend intervals for each I/O point after review with Owner.
   5. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Minimum number of consecutive trend values stored at one time shall be 100 per variable.
   6. When drive storage memory is full, most recent data shall overwrite oldest data.

7. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.

Q. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.
   1. Each trend shall include interval, start time, and stop time.
   2. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation hard drives.
   3. Data shall be retrievable for use in spreadsheets and standard database programs.

R. Programming Software:
   1. Include programming software to execute sequences of operation indicated.
   2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
   3. Programming software shall be as follows:
      a. Graphic Based: Programming shall use a library of function blocks made from preprogrammed code designed for DDC control systems.
         1) Function blocks shall be assembled with interconnection lines that represent to control sequence in a flowchart.
         2) Programming tools shall be viewable in real time to show present values and logical results of each function block.
      b. Menu Based: Programming shall be done by entering parameters, definitions, conditions, requirements and constraints.
      c. Line by Line and Text Based: Programming shall declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.
   4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

S. Database Management Software:
   1. Where a separate SQL database is used for information storage, DDC system shall include database management software that separates database monitoring and managing functions by supporting multiple separate windows.
   2. Database secure access shall be accomplished using standard SQL authentication including ability to access data for use outside of DDC system applications.
   3. Database management function shall include summarized information on trend, alarm, event, and audit for the following database management actions:
      a. Backup.
      b. Purge.
      c. Restore.
   4. Database management software shall support the following:
      a. Statistics: Display database server information and trend, alarm, event, and audit information on database.
      b. Maintenance: Include method of purging records from trend, alarm, event and audit databases by supporting separate screens for creating a backup before purging, selecting database, and allowing for retention of a selected number of day's data.
      c. Backup: Include means to create a database backup file and select a storage location.
      d. Restore: Include a restricted means of restoring a database by requiring operator to have proper security level.

5. Database management software shall include information of current database activity, including the following:
    a. Ready.
    b. Purging record from a database.
    c. Action failed.
    d. Refreshing statistics.
    e. Restoring database.
    f. Shrinking a database.
    g. Backing up a database.
    h. Resetting Internet information services.
    i. Starting network device manager.
    j. Shutting down the network device manager.
    k. Action successful.
6. Database management software monitoring functions shall continuously read database information once operator has logged on.
7. Include operator notification through on-screen pop-up display and e-mail message when database value has exceeded a warning or alarm limit.
8. Monitoring settings window shall have the following sections:
    a. Allow operator to set and review scan intervals and start times.
    b. E-mail: Allow operator to create and review e-mail and phone text messages to be delivered when a warning or an alarm is generated.
    c. Warning: Allow operator to define warning limit parameters, set reminder frequency and link e-mail message.
    d. Alarm: Allow operator to define alarm limit parameters, set reminder frequency and link e-mail message.
    e. Database Login: Protect system from unauthorized database manipulation by creating a read access and a write access for each of trend, alarm, event and audit databases as well as operator proper security access to restore a database.
9. Monitoring settings taskbar shall include the following informational icons:
    a. Normal: Indicates by color and size, or other easily identifiable means that all databases are within their limits.
    b. Warning: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their warning limit.
    c. Alarm: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their alarm limit.

2.10 ASHRAE 135 GATEWAYS

A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, chillers, and variable-speed drives.

B. Include gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment, only when specifically requested and approved by Owner.

C. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.

D. Gateway Minimum Requirements:
    1. Read and view all readable object properties on non-BACnet network to BACnet network and vice versa where applicable.
    2. Write to all writeable object properties on non-BACnet network from BACnet network and vice versa where applicable.

3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet and vice versa.
4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs according to ASHRAE 135.
5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
6. Backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

2.11 ASHRAE 135 PROTOCOL ANALYZER

A. Analyzer and required cables and fittings for connection to ASHRAE 135 network.
B. Analyzer shall include the following minimum capabilities:
1. Capture and store to a file data traffic on all network levels.
2. Measure bandwidth usage.
3. Filtering options with ability to ignore select traffic.

2.12 DDC CONTROLLERS

A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.
E. Environment Requirements:
1. Controller hardware shall be suitable for the anticipated ambient conditions.
2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F.
3. Controllers located outdoors shall be rated for operation at 40 to 150 deg F.
F. Power and Noise Immunity:
1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within36 inches of enclosure.
G. DDC Controller Spare Processing Capacity:
1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
a. Network Controllers: 50 percent.
b. Programmable Application Controllers: Not less than 60 percent.
c. Application-Specific Controllers: Not less than 70 percent.
2. Memory shall support DDC controller's operating system and database and shall include the following:
a. Monitoring and control.
b. Energy management, operation and optimization applications.
c. Alarm management.
d. Historical trend data of all connected I/O points.
e. Maintenance applications.
f. Operator interfaces.
g. Monitoring of manual overrides.
H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:
1. Network Controllers:

a. 10 percent of each AI, AO, BI, and BO point connected to controller.
b. Minimum Spare I/O Points per Controller:
1) AIs: Two.
2) AOs: Two.
3) BIs: Three.
4) BOs: Three.

2. Programmable Application Controllers:
a. 10 percent of each AI, AO, BI, and BO point connected to controller.
b. Minimum Spare I/O Points per Controller:
1) AIs: Two.
2) AOs: Two.
3) BIs: Three.
4) BOs: Three.

3. Application-Specific Controllers:
a. 10 percent of each AI, AO, BI, and BO point connected to controller.
b. Minimum Spare I/O Points per Controller:
1) AIs: One.
2) AOs: One.
3) BIs: One.
4) BOs: One.

I. Maintenance and Support: Include the following features to facilitate maintenance and support:
1. Mount microprocessor components on circuit cards for ease of removal and replacement.
2. Means to quickly and easily disconnect controller from network.
3. Means to quickly and easily access connect to field test equipment.
4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

J. Input and Output Point Interface:
1. Hardwired input and output points shall connect to network, programmable application and application-specific controllers.
2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:
a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.
c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
d. Signal conditioning including transient rejection shall be provided for each AI.
e. Capable of being individually calibrated for zero and span.
f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
5. AOs:
a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.

b. Output signals shall have a range of 4 to 20 mA dc or zero- to 10-V dc as required to include proper control of output device.
c. Capable of being individually calibrated for zero and span.
d. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.

6. BIs:
   a. Controller BIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
   b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
   c. BIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
   d. BIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
   e. Pulse accumulation input points shall comply with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator's command.
7. BOs:
   a. Controller BOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.
      1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.
      2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.
   b. BOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
   c. BOs shall be selectable for either normally open or normally closed operation.
   d. Include tristate outputs (two coordinated BOs) for control of three-point floating-type electronic actuators without feedback.
   e. Limit use of three-point floating devices to VAV terminal unit control applications, and other applications indicated on Drawings. Control algorithms shall operate actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.13 NETWORK CONTROLLERS

A. General Network Controller Requirements:
   1. All network controllers shall be Tridium JACE furnish and installed by Rockford Public Schools.

2.14 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:
   1. Include adequate number of controllers to achieve performance indicated.
   2. Controller shall have enough memory to support its operating system, database, and programming requirements.
   3. Data shall be shared between networked controllers and other network devices.
   4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
   5. Controllers that perform scheduling shall have a real-time clock.

6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

B. Communication:
1. Programmable application controllers shall communicate with other devices on network.

C. Operator Interface:
1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation or mobile device.
2. Local Keypad and Display:
a. Equip controller with local keypad and digital display for interrogating and editing data.
b. Use of keypad and display shall require security password.

D. Serviceability:
1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.15 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.
1. Capable of standalone operation and shall continue to include control functions without being connected to network.
2. Data shall be shared between networked controllers and other network devices.

B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.

C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation. Connection shall extend to port on space temperature sensor that is connected to controller.

D. Serviceability:
1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.16 CONTROLLER SOFTWARE

A. General Controller Software Requirements:
1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
2. I/O points shall be identified by up to 30-character point name and up to 16-character point descriptor. Same names shall be used at operator workstations.
3. Control functions shall be executed within controllers using DDC algorithms.
4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.

B. Security:

1. Operator access shall be secured using individual security passwords and user names.
2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
3. Operator log-on and log-off attempts shall be recorded.
4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.

C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:
1. Weekly Schedule:
   a. Include separate schedules for each day of week.
   b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
   c. Each schedule may consist of up to 10 events.
   d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.
2. Exception Schedules:
   a. Include ability for operator to designate any day of the year as an exception schedule.
   b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.
3. Holiday Schedules:
   a. Include capability for operator to define up to 99 special or holiday schedules.
   b. Schedules may be placed on scheduling calendar and will be repeated each year.
   c. Operator shall be able to define length of each holiday period.

D. System Coordination:
1. Include standard application for proper coordination of equipment.
2. Application shall include operator with a method of grouping together equipment based on function and location.
3. Group may then be used for scheduling and other applications.

E. Binary Alarms:
1. Each binary point shall be set to alarm based on operator-specified state.
2. Include capability to automatically and manually disable alarming.

F. Analog Alarms:
1. Each analog object shall have both high and low alarm limits.
2. Alarming shall be able to be automatically and manually disabled.

G. Alarm Reporting:
1. Operator shall be able to determine action to be taken in event of an alarm.
2. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
3. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.

H. Remote Communication:
1. System shall have ability to dial out in the event of an alarm.

I. Electric Power Demand Limiting:
1. Demand-limiting program shall monitor building or other operator-defined electric power consumption from signals connected to electric power meter or from a watt transducer or current transformer.
2. Demand-limiting program shall predict probable power demand such that action can be taken to prevent exceeding demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined manner. When demand

prediction indicates demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.

3. Demand reduction shall be accomplished by the following means:
   a. Reset air-handling unit supply temperature set points.
   b. Reset space temperature set points.
   c. De-energize equipment based on priority.
4. Demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables shall be based on the means by which electric power service provider computes demand charges.
5. Include demand-limiting prediction and control for any individual meter monitored by system or for total of any combination of meters.
6. Include means operator to make the following changes online:
   a. Addition and deletion of loads controlled.
   b. Changes in demand intervals.
   c. Changes in demand limit for meter(s).
   d. Maximum shutoff time for equipment.
   e. Minimum shutoff time for equipment.
   f. Select rotational or sequential shedding and restoring.
   g. Shed and restore priority.
7. Include the following information and reports, to be available on an hourly, daily, weekly, monthly and annual basis:
   a. Total electric consumption.
   b. Peak demand.
   c. Date and time of peak demand.
   d. Daily peak demand.

J. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.

K. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.

L. Control Loops:
1. Support any of the following control loops, as applicable to control required:
   a. Two-position (on/off, open/close, slow/fast) control.
   b. Proportional control.
   c. Proportional plus integral (PI) control.
   d. Proportional plus integral plus derivative (PID) control.
      1) Include PID algorithms with direct or reverse action and anti-windup.
      2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
      3) Controlled variable, set point, and PID gains shall be operator-selectable.
   e. Adaptive (automatic tuning).

M. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.

N. Energy Calculations:
1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
2. Include an algorithm that calculates a sliding-window average (rolling average). Algorithm shall be flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).

3. Include an algorithm that calculates a fixed-window average. A digital input signal shall define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.

O. Anti-Short Cycling:
1. BO points shall be protected from short cycling.
2. Feature shall allow minimum on-time and off-time to be selected.

P. On and Off Control with Differential:
1. Include an algorithm that allows a BO to be cycled based on a controlled variable and set point.
2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.

Q. Run-Time Totalization:
1. Include software to totalize run-times for all BI and BO points.
2. A high run-time alarm shall be assigned, if required, by operator.

2.17 ENCLOSURES

A. General Enclosure Requirements:
1. House each controller and associated control accessories in a single enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
2. Do not house more than one controller in a single enclosure.
3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
4. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
5. Individual wall-mounted single-door enclosures shall not exceed 36 inches wide and 48 inches high.
6. Individual wall-mounted double-door enclosures shall not exceed 60 inches wide and 36 inches high.
7. Freestanding enclosures shall not exceed 48 inches wide and 72 inches high.
8. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
9. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door. For enclosures with windows, include pocket on bottom of enclosure.

B. Internal Arrangement:
1. Internal layout of enclosure shall group and protect pneumatic, electric, and electronic components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 20 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install a maximum of two wires on each side of a terminal.
9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).

12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch-high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
14. Label each end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Environmental Requirements:
1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.
3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.

D. Wall-Mounted, NEMA 250, Type 1:
1. Enclosure shall be NRTL listed according to UL 50 or UL 50E.
2. Construct enclosure of steel, not less than:
   a. Enclosure size less than 24 in.: 0.053 in. or 0.067 in. thick.
   b. Enclosure size 24 in. and larger: 0.067 in. or 0.093 in. thick.
3. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
   a. Exterior color shall be ANSI 61 gray.
   b. Interior color shall be ANSI 61 gray.
4. Hinged door full size of front face of enclosure and supported using:
   a. Enclosures sizes less than 36 in. tall: Multiple butt hinges.
   b. Enclosures sizes 36 in. tall and larger: Continuous piano hinges.
5. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
   a. Size less than 24 in.: Solid or Perforated steel, 0.053 in. thick.
   b. Size 24 in. and larger: Solid aluminum, 0.10 in. or steel, 0.093 in. thick.
6. Internal panel mounting hardware, grounding hardware and sealing washers.
7. Grounding stud on enclosure body.
8. Thermoplastic pocket on inside of door for record Drawings and Product Data.

E. Wall Mounted NEMA 250, Types 4 and 12:
1. Enclosure shall be NRTL listed according to UL 508A.
2. Seam and joints are continuously welded and ground smooth.
3. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.

4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
5. Single-door enclosure sizes up to 60 inches tall by 36 inches wide.
6. Double-door enclosure sizes up to 36 inches tall by 60 inches wide.
7. Construct enclosure of steel, not less than the following:
    a. Size Less Than 24 Inches: 0.053 inch or 0.067 inch thick.
    b. Size 24 Inches and Larger: 0.067 inch thick.
8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
    a. Exterior color shall be ANSI 61 gray.
    b. Interior color shall be ANSI 61 gray.
9. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.
    a. Sizes through 24 Inches Tall: Two hinges.
    b. Sizes between 24 Inches through 48 Inches Tall: Three hinges.
    c. Sizes Larger 48 Inches Tall: Four hinges.
10. Double-door enclosures with overlapping door design to include unobstructed full-width access.
    a. Single-door enclosures 48 inches and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.
11. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
    a. Size Less Than 24 Inches: Solid or perforated steel, 0.053 inch thick.
    b. Size 24 Inches and Larger: Solid aluminum, 0.10 inch or steel, 0.093 inch thick.
12. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
13. Grounding stud on enclosure body.
14. Thermoplastic pocket on inside of door for record Drawings and Product Data.

F. Freestanding, NEMA 250, Type 1:
1. Enclosure shall be NRTL listed according to UL 508A.
2. Seam and joints are continuously welded and ground smooth.
3. Externally formed body flange around perimeter of enclosure face.
4. Single-door enclosure sizes up to 84 inches tall by 36 inches wide.
5. Double-door enclosure sizes up to 84 inches tall by 72 inches wide.
6. Construct enclosure of steel, not less than 0.067 inch thick.
7. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
    a. Exterior color shall be ANSI 61 gray.
    b. Interior color shall be ANSI 61 gray.
8. Corner-formed flush door, full size of enclosure face, supported using four concealed hinges with easily removable hinge pins.
9. Double-door enclosures with overlapping door design to include unobstructed full-width access.
10. Doors with three-point (top, middle, and bottom) latch system with single heavy-duty handle and integral locking mechanism.
11. Removable back covers.
12. Removable solid steel internal panel, 0.093 inch thick, with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
13. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
14. Grounding stud on enclosure body.
15. Thermoplastic pocket on inside of door for record Drawings and Product Data.

16. Nominal 4-inch-tall integral lifting base, not less than 0.123 inch thick, with predrilled holes for attachment to mounting surface.
17. Each top end of enclosure fitted with lifting tabs, not less than 0.172 inch thick.
18. Internal rack-mount shelves and angles as required by application.

G. Freestanding, NEMA 250, Types 4 and 12:
1. Enclosure shall be NRTL listed according to UL 508A.
2. Seam and joints are continuously welded and ground smooth.
3. Externally formed body flange around perimeter of enclosure face.
4. Type 12 Enclosure Sizes:
   a. Single-door enclosure sizes up to 90 inches tall by 36 inches wide.
   b. Double-door enclosure sizes up to 90 inches tall by 72 inches wide.
5. Type 4 Enclosure Sizes:
   a. Single-door enclosure sizes up to 72 inches tall by 36 inches wide.
6. Construct enclosure of steel, not less than 0.093 inch thick.
7. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
   a. Exterior color shall be ANSI 61 gray.
   b. Interior color shall be ANSI 61 gray.
8. Corner-formed door with continuous perimeter oil-resistant gasket supported using continuous piano hinge full length of door.
9. Doors fitted with three-point (top, middle, and bottom) latch system with latching rod rollers and single, heavy-duty oil-tight handle with integral locking mechanism.
10. Removable solid steel internal panel, 0.093 inch thick, with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
11. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
12. Grounding stud on enclosure body.
13. Thermoplastic pocket on inside of door for record Drawings and Product Data.
14. Top of enclosure fitted with no fewer than two lifting eyes.
15. Internal rack-mount shelves and angles as required by application.

2.18 RELAYS

A. General-Purpose Relays:
1. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Relays shall have LED indication and a manual reset and push-to-test button.
7. Performance:
   a. Mechanical Life: At least 10 million cycles.
   b. Electrical Life: At least 100,000 cycles at rated load.
   c. Pickup Time: 15 ms or less.
   d. Dropout Time: 10 ms or less.
   e. Pull-in Voltage: 85 percent of rated voltage.
   f. Dropout Voltage: 50 percent of nominal rated voltage.
   g. Power Consumption: 2 VA.
   h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.

10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

B. Multifunction Time-Delay Relays:
1. Relays shall be continuous duty and rated for at least 10 A at 240-V ac and 60 Hz.
2. Relays shall be DPDT relay with up to eight programmable functions to provide on/off delay, interval and recycle timing functions.
3. Use a plug-in-style relay with either an 8- or 11-pin octal plug.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a dust-tight cover.
6. Include knob and dial scale for setting delay time.
7. Performance:
   a. Mechanical Life: At least 10 million cycles.
   b. Electrical Life: At least 100,000 cycles at rated load.
   c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
   d. Repeatability: Within 2 percent.
   e. Recycle Time: 45 ms.
   f. Minimum Pulse Width Control: 50 ms.
   g. Power Consumption: 5 VA or less at 120-V ac.
   h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

C. Latching Relays:
1. Relays shall be continuous duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either DPDT or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with a multibladed plug.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Performance:
   a. Mechanical Life: At least 10 million cycles.
   b. Electrical Life: At least 100,000 cycles at rated load.
   c. Pickup Time: 15 ms or less.
   d. Dropout Time: 10 ms or less.
   e. Pull-in Voltage: 85 percent of rated voltage.
   f. Dropout Voltage: 50 percent of nominal rated voltage.
   g. Power Consumption: 2 VA.
   h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
7. Equip relays with coil transient suppression to limit transients to non-damaging levels.
8. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
9. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

D. Current Sensing Relay:
1. Monitors ac current.
2. Independent adjustable controls for pickup and dropout current.
3. Energized when supply voltage is present and current is above pickup setting.
4. De-energizes when monitored current is below dropout current.
5. Dropout current is adjustable from 50 to 95 percent of pickup current.

6. Include a current transformer, if required for application.
7. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.

E. Combination On-Off Status Sensor and On-Off Relay:
1. Description:
   a. On-off control and status indication in a single device.
   b. LED status indication of activated relay and current trigger.
   c. Closed-Open-Auto override switch located on the load side of the relay.
2. Performance:
   a. Ambient Temperature: Minus 30 to 140 deg F.
   b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.
3. Status Indication:
   a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
   b. Current Sensor Range: As required by application.
   c. Current Set Point: Adjustable.
   d. Current Sensor Output:
      1) Solid-state, single-pole double-throw contact rated for 30-V ac and dc and for 0.4 A.
      2) Solid-state, single-pole double-throw contact rated for 120-V ac and 1.0 A.
      3) Analog, zero- to 5- or 10-V dc.
      4) Analog, 4 to 20 mA, loop powered.
4. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.
5. Enclosure: NEMA 250, Type 1 enclosure.

2.19 ELECTRICAL POWER DEVICES

A. Transformers:
1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
2. Transformer shall have both primary and secondary fuses.

B. Power-Line Conditioner:
1. General Power-Line Conditioner Requirements:
   a. Design to ensure maximum reliability, serviceability and performance.
   b. Overall function of the power-line conditioner is to receive raw, polluted electrical power and purify it for use by electronic equipment. The power-line conditioner shall provide isolated, regulated, transient and noise-free sinusoidal power to loads served.
2. Standards: NRTL listed per UL 1012.
3. Performance:
   a. Single phase, continuous, 100 percent duty rated KVA/KW capacity. Design to supply power for linear or nonlinear, high crest factor, resistive and reactive loads.
   b. Automatically regulate output voltage to within 2 percent or better with input voltage fluctuations of plus 10 to minus 20 percent of nominal when system is loaded 100 percent. Use Variable Range Regulation to obtain improved line voltage regulation when operating under less than full load conditions.
      1) At 75 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 35 percent of nominal.

2) At 50 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 40 percent of nominal.
3) At 25 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 45 percent of nominal.

c. With input voltage distortion of up to 40 percent, limit the output voltage sine wave to a maximum harmonic content of 5 percent.
d. Automatically regulate output voltage to within 2.5 percent when load (resistive) changes from zero percent to 100 percent to zero percent.
e. Output voltage returns to 95 percent of nominal level within two cycles and to 100 percent within three cycles when the output is taken from no load to full resistive load or vice-versa. Recovery from partial resistive load changes is corrected in a shorter period of time.
f. K Factor: 30, designed to operate with nonlinear, non-sinusoidal, high crest factor loads without overheating.
g. Input power factor within 0.95 approaching unity with load power factor as poor as 0.6.
h. Attenuate load-generated odd current harmonics 23 dB at the input.
i. Electrically isolate the primary from the secondary. Meet isolation criteria as defined in NFPA 70, Article 250-5D.
j. Lighting and Surge Protection: Compares to UL 1449 rating of 330 V when subjected to Category B3 (6000 V/3000 A) combination waveform as established by IEEE C62.41.
k. Common-mode noise attenuation of 140 dB.
l. Transverse-mode noise attenuation of 120 dB.
m. With loss of input power for up to 16.6 ms, the output sine wave remains at usable ac voltage levels.
n. Reliability of 200,000 hours' MTBF.
o. At full load, when measured at 1-m distance, audible noise is not to exceed 54 dB.
p. Approximately 92 percent efficient at full load.

4. Transformer Construction:
   a. Ferroresonant, dry type, convection cooled, 600V class. Transformer windings of Class H (220 deg C) insulated copper.
   b. Use a Class H installation system throughout with operating temperatures not to exceed 150 deg C over a 40-deg C ambient temperature.
   c. Configure transformer primary for multi-input voltage. Include input terminals for source conductors and ground.
   d. Manufacture transformer core using M-6 grade, grain-oriented, stress-relieved transformer steel.
   e. Configure transformer secondary in a 240/120-V split with a 208-V tap or straight 120 V, depending on power output size.
   f. Electrically isolate the transformer secondary windings from the primary windings. Bond neutral conductor to cabinet enclosure and output neutral terminal.
   g. Include interface terminals for output power hot, neutral and ground conductors.
   h. Label leads, wires and terminals to correspond with circuit wiring diagram.
   i. Vacuum impregnate transformer with epoxy resin.
5. Cabinet Construction:
   a. Design for panel or floor mounting.
   b. NEMA 250, Type 1, general-purpose, indoor enclosure.
   c. Manufacture the cabinet from heavy gauge steel complying with UL 50.

d. Include a textured baked-on paint finish.

C. Transient Voltage Suppression and High-Frequency Noise Filter Unit:
1. The maximum continuous operating voltage shall be at least 125 percent.
2. The operating frequency range shall be 47 to 63 Hz.
3. Protection modes according to NEMA LS-1.
4. The rated single-pulse surge current capacity, for each mode of protection, shall be no less than the following:
   a. Line to Neutral: 45,000 A.
   b. Neutral to Ground: 45,000 A.
   c. Line to Ground: 45,000 A.
   d. Per Phase: 90,000 A.
5. Clamping voltages shall be in compliance with test and evaluation procedures defined in NEMA LS-1. Maximum clamping voltage shall be as follows:
   a. Line to Neutral: 360 V.
   b. Line to Ground: 360 V.
   c. Neutral to Ground: 360 V.
6. Electromagnetic interference and RF interference noise rejection or attenuation values shall comply with test and evaluation procedures defined in NEMA LS-1.
   a. Line to Neutral:
      1) 100 kHz: 42 dB.
      2) 1 MHz: 25 dB.
      3) 10 MHz: 21 dB.
      4) 100 MHz: 36 dB.
   b. Line to Ground:
      1) 100 kHz: 16 dB.
      2) 1 MHz: 55 dB.
      3) 10 MHz: 81 dB.
      4) 100 MHz: 80 dB.
7. Unit shall have LED status indicator that extinguishes to indicate a failure.
8. Unit shall be listed by an NRTL as a transient voltage surge suppressor per UL 1449, and as an electromagnetic interference filter per UL 1283.
9. Unit shall not generate any appreciable magnetic field.
10. Unit shall not generate an audible noise.

D. DC Power Supply:
1. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
2. Enclose circuitry in a housing.
3. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.
4. Performance:
   a. Output voltage nominally 25-V dc within 5 percent.
   b. Output current up to 100 mA.
   c. Input voltage nominally 120-V ac, 60 Hz.
   d. Load regulation within 0.5 percent from zero- to 100-mA load.
   e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
   f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

2.20 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.
1. Wire size shall be at least No. 18 AWG.
2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.

3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
4. Conductor colors shall be black (hot), white (neutral), and green (ground).
5. Furnish wire on spools.

B. Single Twisted Shielded Instrumentation Cable above 24 V:
1. Wire size shall be a minimum No. 20 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
7. Furnish wire on spools.

C. Single Twisted Shielded Instrumentation Cable 24 V and Less:
1. Wire size shall be a minimum No. 20 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
7. Furnish wire on spools.

D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
1. Cable shall be balanced twisted pair.
2. Comply with the following requirements and for balanced twisted pair cable described in Section 260523 "Control-Voltage Electrical Power Cables and Section 271513 "Communications Copper Horizontal Cabling."
a. Cable shall be plenum rated.
b. Cable shall have a unique color that is different from other cables used on Project.

2.21 RACEWAYS

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for raceways for balanced twisted pair cables and optical fiber cables.

2.22 ACCESSORIES

A. Pressure Electric Switches:
1. Diaphragm-operated snap acting switch.
2. Set point adjustable from 3 to 20 psig.
3. Differential adjustable from 2 to 6 psig.
4. Rated for resistance loads at 120-V ac.
5. Body and switch housing shall be metal.

B. Damper Blade Limit Switches:
1. Sense positive open and/or closed position of the damper blades.
2. NEMA 250, Type 13, oil-tight construction.
3. Arrange for the mounting application.

4. Additional waterproof enclosure when required by its environment.
5. Arrange to prevent "over-center" operation.

C. Instrument Enclosures:
1. Include instrument enclosure for secondary protection to comply with requirements indicated in "Performance Requirements" Article.
2. NRTL listed and labeled to UL 50.
3. Sized to include at least 25 percent spare area on subpanel.
4. Instrument(s) mounted within enclosure on internal subpanel(s).
5. Enclosure face with engraved, laminated phenolic nameplate for each instrument within enclosure.
6. Enclosures housing pneumatic instruments shall include main pressure gage and a branch pressure gage for each pneumatic device, installed inside.
7. Enclosures housing multiple instruments shall route tubing and wiring within enclosure in a raceway having a continuous removable cover.
8. Enclosures larger than 12 inches shall have a hinged full-size face cover.
9. Equip enclosure with lock and common key.

D. Manual Valves:
1. Needle Type:
a. PTFE packing.
b. Construct of brass for use with copper and polyethylene tubing and of stainless steel for use with stainless-steel tubing.
c. Aluminum T-bar handle.
d. Include tubing connections.
2. Ball Type:
a. Body: Bronze ASTM B 62 or ASTM B 61.
b. Ball: Type 316 stainless steel.
c. Stem: Type 316 stainless steel.
d. Seats: Reinforced PTFE.
e. Packing Ring: Reinforced PTFE.
f. Lever: Stainless steel with a vinyl grip.
g. 600 WOG.
h. Threaded end connections.

2.23 IDENTIFICATION

A. Control Equipment, Instruments, and Control Devices:
1. Self-adhesive label bearing unique identification.
a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
2. Letter size shall be as follows:
a. Operator Workstations: Minimum of 0.5 inch high.
b. Servers: Minimum of 0.5 inch high.
c. Printers: Minimum of 0.5 inch high.
d. DDC Controllers: Minimum of 0.5 inch high.
e. Gateways: Minimum of 0.5 inch high.
f. Repeaters: Minimum of 0.5 inch high.
g. Enclosures: Minimum of 0.5 inch high.
h. Electrical Power Devices: Minimum of 0.25 inch high.
i. UPS units: Minimum of 0.5 inch high.
j. Accessories: Minimum of 0.25 inch high.
k. Instruments: Minimum of 0.25 inch high.
l. Control Damper and Valve Actuators: Minimum of 0.25 inch high.
3. Legend shall consist of white lettering on black background.

4. Laminated acrylic or melamine plastic sign shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer and shall be fastened with drive pins.
5. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.

B. Valve Tags:
1. Brass tags and brass chains attached to valve.
2. Tags shall be at least 1.5 inches in diameter.
3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

C. Raceway and Boxes:
1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.
3. For raceways housing pneumatic tubing, add a phenolic tag labeled "HVAC Instrument Air Tubing."
4. For raceways housing air signal tubing, add a phenolic tag labeled "HVAC Air Signal Tubing."

D. Equipment Warning Labels:
1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size shall be at least 14-point type with white lettering on red background.
3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least 0.25 inch beyond white border.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Verify compatibility with and suitability of substrates.

B. Examine roughing-in for products to verify actual locations of connections before installation.
1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:

1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
2. Equipment to Be Connected:
    a. Air-terminal units specified in Section 233600 "Air Terminal Units."
    b. Boilers specified in Section 235216 "Condensing Boilers."
    c. Chillers specified in Section 236423.13 "Air-Cooled, Scroll Water Chillers."
    d. Heat wheels and heat exchangers specified in Section 237223 "Air-to-Air Energy Recovery Equipment."
    e. Air-handling units specified in Section 237313 "Modular Indoor Central-Station Air-Handling Units."
    f. Roof-top units specified in Section 237413 "Packaged, Outdoor, Central-Station Air-Handling Units."
    g. Dedicated outdoor-air units specified in Section 237433 "Dedicated Outdoor-Air Units."
    h. Computer-room air-conditioning units specified in Section 238123.11 "Small-Capacity (6 Tons (21 kW) and Smaller), Computer-Room Air-Conditioners, Floor Mounted Units."
    i. Computer-room air-conditioning units specified in Section 238123.13 "Computer-Room Air Conditioners, Ceiling-Mounted Units."
    j. Computer-room air-conditioning units specified in Section 238123.14 "Computer-Room Air Conditioners, Console Units."
    k. Computer-room, rack-mounted cooling equipment specified in Section 238123.18 "Computer-Room, Rack-Cooling Equipment."
    l. Fan-coil units specified in Section 238219 "Fan Coil Units."
    m. Unit ventilators specified in Section 238223 "Unit Ventilators."
    n. Motor-control centers specified in Section 262419 "Motor-Control Centers."
    o. Variable-frequency controllers specified in Section 262923 "Variable-Frequency Motor Controllers."

B. Communication Interface to Other Building Systems:
1. DDC system shall have a communication interface with systems having a communication interface.
2. Systems to Be Connected:
    a. Power monitoring specified in Section 260913 "Electrical Power Monitoring and Control."
    b. Lighting controls specified in Section 260926 "Lighting Control Panelboards."
    c. Lighting controls specified in Section 260943.16 "Addressable-Luminaire Lighting Controls."
    d. Lighting controls specified in Section 260943.23 "Relay-Based Lighting Controls."
    e. Fire-alarm system specified in Section 284621.11 "Addressable Fire-Alarm Systems."
    f. Fire-alarm system specified in Section 284621.13 "Conventional Fire-Alarm Systems."

3.03 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
1. DDC control dampers, which are specified in Section 230923.12 "DDC Control Dampers."

2. Airflow sensors and switches, which are specified in Section 230923.14 "Flow Instruments."
3. Pressure sensors, which are specified in Section 230923.23 "Pressure Instruments."

C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.
1. DDC control valves, which are specified in Section 230923.11 "Control Valves."
2. Pipe-mounted flow meters, which are specified in Section 230923.14 "Flow Instruments."
3. Pipe-mounted sensors, switches and transmitters. Flow meters are specified in Section 230923.14 "Flow Instruments." Liquid temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
4. Tank-mounted sensors, switches and transmitters. Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments." Liquid temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
5. Pipe- and tank-mounted thermowells. Liquid thermowells are specified in Section 230923.27 "Temperature Instruments."

3.04 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to a 50lb force.

D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Section 078413 "Penetration Firestopping."

G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."

H. Welding Requirements:
1. Restrict welding and burning to supports and bracing.
2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.

I. Fastening Hardware:
1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.

J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

K. Corrosive Environments:
1. Avoid or limit use of materials in corrosive airstreams and environments, including, but not limited to, the following:

a. Laboratory exhaust-air streams.
b. Process exhaust-air streams.

2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
3. Where instruments are located in a corrosive airstream and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.05 CONTROLLER INSTALLATION

A. Install controllers in enclosures to comply with indicated requirements.
B. Connect controllers to field power supply and to UPS units where indicated.
C. Install controller with latest version of applicable software and configure to execute requirements indicated.
D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.
E. Installation of Network Controllers:
   1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
   2. Install controllers in a protected location that is easily accessible by operators.
   3. Top of controller shall be within 72 inches of finished floor.
F. Installation of Programmable Application Controllers:
   1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
   2. Install controllers in a protected location that is easily accessible by operators.
   3. Top of controller shall be within 72 inches of finished floor.
G. Application-Specific Controllers:
   1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
   2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

3.06 ENCLOSURES INSTALLATION

A. Install the following items in enclosures, to comply with indicated requirements:
   1. Gateways.
   2. Routers.
   3. Controllers.
   4. Electrical power devices.
   5. UPS units.
   6. Relays.
   7. Accessories.
   8. Instruments.
   9. Actuators
B. Attach wall-mounted enclosures to wall using the following types of steel struts:
   1. For NEMA 250, Type 1 Enclosures: Use painted steel strut and hardware.
   2. For NEMA 250, Type 4X Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.
   3. Install plastic caps on exposed cut edges of strut.
C. Align top or bottom of adjacent enclosures of like size.
D. Install floor-mounted enclosures located in mechanical equipment rooms on concrete housekeeping pads. Attach enclosure legs using galvanized- or stainless-steel anchors.

E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireway used for application shall have protection equal to NEMA 250 rating of connected enclosures.

3.07 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to DDC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

3.08 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.

B. Install self-adhesive labels with unique identification on face for each of the following:
   1. Gateway.
   2. Router.
   3. Protocol analyzer.
   4. DDC controller.
   5. Enclosure.
   6. Electrical power device.
   7. UPS unit.
   8. Accessory.

C. Install unique instrument identification on face of each instrument connected to a DDC controller.

D. Install unique identification on face of each control damper and valve actuator connected to a DDC controller.

E. Where product is installed above accessible tile ceiling, also install matching identification on face of ceiling grid located directly below.

F. Where product is installed above an inaccessible ceiling, also install identification on face of access door directly below.

G. Warning Labels and Signs:
   1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
   2. Shall be located in highly visible location near power service entry points.

3.09 NETWORK INSTALLATION

A. Install balanced twisted pair or optical fiber cable when connecting between the following network devices located in same building:
   1. Network controllers.

B. Install balanced twisted pair or copper cable (as required by equipment) when connecting between the following:
   1. Gateways.
   2. Gateways and network controllers or programmable application controllers.
   3. Routers.
   4. Routers and network controllers or programmable application controllers.
   5. Network controllers and programmable application controllers.
   6. Programmable application controllers.

7. Programmable application controllers and application-specific controllers.
8. Application-specific controllers.

C. Install cable in continuous raceway.
1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.

3.10 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.
B. ASHRAE 135 Networks:
1. MAC Address:
a. Every network device shall have an assigned and documented MAC address unique to its network.
b. Ethernet Networks: Document MAC address assigned at its creation.
c. ARCNET or MS/TP networks: Assign from 00 to 64.
2. Network Numbering:
a. Assign unique numbers to each new network.
b. Provide ability for changing network number through device switches or operator interface.
c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.
3. Device Object Identifier Property Number:
a. Assign unique device object identifier property numbers or device instances for each device network.
b. Provide for future modification of device instance number by device switches or operator interface.
c. LAN shall support up to 4,194,302 unique devices.
4. Device Object Name Property Text:
a. Device object name property field shall support 32 minimum printable characters.
b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.
1) Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."
2) Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".
5. Object Name Property Text for Other Than Device Objects:
a. Object name property field shall support 32 minimum printable characters.
b. Assign object name properties with plain-English names descriptive of application.
1) Example 1: "Zone 1 Temperature."
2) Example 2 "Fan Start and Stop."
6. Object Identifier Property Number for Other Than Device Objects:
a. Assign object identifier property numbers according to Drawings or tables indicated.
b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented and be unique for like object types within device.

3.11 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

A. Comply with NECA 1.
B. Wire and Cable Installation:
1. Comply with installation requirements in Section 260523 "Control-Voltage Electrical Power Cables."
2. Comply with installation requirements in Section 271313 "Communications Copper Backbone Cabling."

3. Comply with installation requirements in Section 271513 "Communications Copper Horizontal Cabling."
4. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
    a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
5. Terminate wiring in a junction box.
    a. Clamp cable over jacket in junction box.
    b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
6. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
7. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
8. Use shielded cable to transmitters.
9. Use shielded cable to temperature sensors.
10. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:
1. Comply with Section "260533 "Raceways and Boxes for Electrical Systems" for control-voltage conductors.
2. Comply with Section 270528 "Pathways for Communications Systems" for balanced twisted pair cabling and optical fiber installation.

3.12 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Testing:
1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
5. Test Equipment: Use an optical fiber time domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

3.13 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests and calibration.
B. Check instruments for proper location and accessibility.
C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.
E. For pneumatic products, verify that air supply for each product is properly installed.
F. Control Damper Checkout:
    1. For pneumatic dampers, verify that pressure gages are provided in each air line to damper actuator and positioner.
    2. Verify that control dampers are installed correctly for flow direction.
    3. Verify that proper blade alignment, either parallel or opposed, has been provided.
    4. Verify that damper frame attachment is properly secured and sealed.
    5. Verify that damper actuator and linkage attachment is secure.
    6. Verify that actuator wiring is complete, enclosed and connected to correct power source.
    7. Verify that damper blade travel is unobstructed.
G. Control Valve Checkout:
    1. For pneumatic valves, verify that pressure gages are provided in each air line to valve actuator and positioner.
    2. Verify that control valves are installed correctly for flow direction.
    3. Verify that valve body attachment is properly secured and sealed.
    4. Verify that valve actuator and linkage attachment is secure.
    5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
    6. Verify that valve ball, disc or plug travel is unobstructed.
    7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.
H. Instrument Checkout:
    1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
    2. Verify that attachment is properly secured and sealed.
    3. Verify that conduit connections are properly secured and sealed.
    4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
    5. Inspect instrument tag against approved submittal.
    6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
    7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
    8. For temperature instruments:
        a. Verify sensing element type and proper material.
        b. Verify length and insertion.

3.14 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.

D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.
E. Provide diagnostic and test equipment for calibration and adjustment.
F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
J. Analog Signals:
    1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
    2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
    3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
K. Digital Signals:
    1. Check digital signals using a jumper wire.
    2. Check digital signals using an ohmmeter to test for contact making or breaking.
L. Control Dampers:
    1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
    2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
    3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
    4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
M. Control Valves:
    1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
    2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
    3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
    4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.
O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.
P. Switches: Calibrate switches to make or break contact at set points indicated.
Q. Transmitters:
    1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
    2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.15 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.
    1. Verify voltage, phase and hertz.

2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.

B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.16 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:
1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify operation is stable and accurate.
4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:
   a. Upper quarter of range.
   b. Lower quarter of range.
   c. At midpoint of range.
8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

3.17 DDC SYSTEM VALIDATION TESTS

A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.

B. After approval of Test Plan, execute all tests and procedures indicated in plan.

C. After testing is complete, submit completed test checklist.

D. Pretest Checklist: Submit the following list with items checked off once verified:
1. Detailed explanation for any items that are not completed or verified.
2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
3. HVAC equipment motors operate below full-load amperage ratings.
4. Required DDC system components, wiring, and accessories are installed.
5. Installed DDC system architecture matches approved Drawings.
6. Control electric power circuits operate at proper voltage and are free from faults.
7. Required surge protection is installed.
8. DDC system network communications function properly, including uploading and downloading programming changes.
9. Using BACnet protocol analyzer, verify that communications are error free.
10. Each controller's programming is backed up.

11. Equipment, products, tubing, wiring cable and conduits are properly labeled.
12. All I/O points are programmed into controllers.
13. Testing, adjusting and balancing work affecting controls is complete.
14. Dampers and actuators zero and span adjustments are set properly.
15. Each control damper and actuator goes to failed position on loss of power.
16. Valves and actuators zero and span adjustments are set properly.
17. Each control valve and actuator goes to failed position on loss of power.
18. Meter, sensor and transmitter readings are accurate and calibrated.
19. Control loops are tuned for smooth and stable operation.
20. View trend data where applicable.
21. Each controller works properly in standalone mode.
22. Safety controls and devices function properly.
23. Interfaces with fire-alarm system function properly.
24. Electrical interlocks function properly.
25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
26. Record Drawings are completed.

E. Test Plan:
1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 10 business days before start of tests.

F. Validation Test:
1. Verify operating performance of each I/O point in DDC system.
    a. Verify analog I/O points at operating value.
    b. Make adjustments to out-of-tolerance I/O points.
        1) Identify I/O points for future reference.
        2) Simulate abnormal conditions to demonstrate proper function of safety devices.
        3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. After 24 Hours following Initial Validation Test:
    a. Re-check I/O points that required corrections during initial test.
    b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
5. After 24 Hours of Second Validation Test:
    a. Re-check I/O points that required corrections during second test.
    b. Continue validation testing until I/O point is normal on two consecutive tests.
6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.

7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

3.18 FINAL REVIEW

A. Submit written request to Architect when DDC system is ready for final review. Written request shall state the following:
   1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
   2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
   3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
   4. DDC system is complete and ready for final review.

B. Review by Architect shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.

E. Prepare and submit closeout submittals and begin procedures indicated in "Extended Operation Test" Article when no deficiencies are reported.

F. A part of DDC system final review shall include a demonstration to parties participating in final review.
   1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
   2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
   3. Demonstration shall include, but not be limited to, the following:
      a. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
      b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
      c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
      d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
      e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
      f. Trends, summaries, logs and reports set-up for Project.
      g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC

systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.

h. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.

i. Software's ability to edit control programs off-line.

j. Data entry to show Project-specific customizing capability including parameter changes.

k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.

l. Execution of digital and analog commands in graphic mode.

m. Spreadsheet and curve plot software and its integration with database.

n. Online user guide and help functions.

o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.

p. System speed of response compared to requirements indicated.

q. For Each Network and Programmable Application Controller:

1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.

2) Operator Interface: Ability to connect directly to each type of digital controller with a portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.

3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.

4) Electric Power: Ability to disconnect any controller safely from its power source.

5) Wiring Labels: Match control drawings.

6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.

7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.

r. For Each Operator Workstation:

1) I/O points lists agree with naming conventions.

2) Graphics are complete.

3) UPS unit, if applicable, operates.

s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability. Requirements must be met even if only one manufacturer's equipment is installed.

1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.

2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.

3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated. Modifications are made with messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.

4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
10) Device and Network Management:
    a) Display of network device status.
    b) Display of BACnet Object Information.
    c) Silencing devices transmitting erroneous data.
    d) Time synchronization.
    e) Remote device re-initialization.
    f) Backup and restore network device programming and master database(s).
    g) Configuration management of routers.

3.19 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.20 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two year(s).
B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two year(s) from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
    1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

3.21 DEMONSTRATION

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.
B. Extent of Training:
    1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
    2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
    3. Minimum Training Requirements:

a. Provide not less than 2 hours of on-site training at completion of Phase 1 and an additional 2 hours of on-site training at completion of Phase 2.
b. In addition to on-site training, provide at least two days (16 hrs) of structured training to occur 6 months after project completion.
c. Stagger training over multiple (2 hr maximum) training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
d. Total days of training shall be broken into approximately eight (8) separate training classes.
e. Training classes may be conducted on-site if approved by owner, otherwise it is expected that off-site training accommodations will be provided.

C. Training Schedule:
1. Schedule training with Owner 20 business days before expected Substantial Completion.
2. Schedule training to provide Owner with at least 20 business days of notice in advance of training.
3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session shall be split in half with 15-minute break between sessions. Morning and afternoon sessions shall be separated by 30-minute lunch period. Training, including breaks and excluding lunch period, shall not exceed eight hours per day.
4. Provide staggered training schedule as requested by Owner.

D. Training Attendee List and Sign-in Sheet:
1. Request from Owner in advance of training a proposed attendee list with name, phone number and e-mail address.
2. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Preprinted sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.

E. Training Attendee Headcount:
1. Plan in advance of training for five attendees.
2. Make allowance for Owner to add up to two attendee(s) at time of training.
3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.

F. Training Attendee Prior Knowledge: For guidance in planning required training and instruction, assume attendees have the following:
1. High school and technical school education and degree.
2. Basic user knowledge of computers and office applications.
3. Intermediate knowledge of HVAC systems.
4. Intermediate knowledge of DDC systems.
5. Intermediate knowledge of DDC system and products installed.

G. Attendee Training Manuals:
1. Provide each attendee with a color hard copy of all training materials and visual presentations.

2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.

H. Instructor Requirements:
1. One or multiple qualified instructors, as required, to provide training.
2. Instructors shall have not less than five years of providing instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.

I. Organization of Training Sessions:
1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate daily operators:
2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.

J. Training Outline:
1. Submit training outline for Owner review at least 10 business day before scheduling training.
2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.

K. On-Site Training:
1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
5. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

L. Off-Site Training:
1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power and data connectivity for each attendee.
2. Provide capability to remotely access to Project DDC system for use in training.
3. Provide a workstation for use by each attendee.

M. Training Content for Daily Operators:
1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine.
5. Operating operator workstations, printers and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports and alarms.

8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.
13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
    a. Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.
    b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
    c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.
    d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
    e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
    f. Each control loop responds to set point adjustment and stabilizes within time period indicated.
    g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

END OF SECTION

SECTION 23 0923.11
CONTROL VALVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes control valves and actuators for DDC systems.

B. Related Requirements:

1. Section 230923 "Direct Digital Control (DDC) System for HVAC" control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993.11 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.11.

1.03 DEFINITIONS

A. Cv: Design valve coefficient.

B. DDC: Direct-digital control.

C. NBR: Nitrile butadiene rubber.

D. PTFE: Polytetrafluoroethylene

E. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control valves to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

D. Backup Power Source: Systems and equipment served by a backup power source shall have associated control valve actuators served from a backup power source.

E. Environmental Conditions:

1. Provide electric control valve actuators, with protective enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Electric control valve actuators not available with integral enclosures, complying with requirements indicated, shall be housed in protective secondary enclosures.
    a. Hazardous Locations: Explosion-proof rating for condition.

F. Determine control valve sizes and flow coefficients by ISA 75.01.01.

G. Control valve characteristics and rangeability shall comply with ISA 75.11.01.

H. Selection Criteria:

1. Control valves shall be suitable for operation at following conditions:
    a. Chilled Water: 150 psig @ 40 deg F
    b. Heating Hot Water: 150 psig @ 225 deg F
2. Control valve shutoff classifications shall be FCI 70-2, Class IV or better unless otherwise indicated.
3. Valve pattern, three-way or straight through, shall be as indicated on Drawings.
4. Modulating straight-through pattern control valves shall have equal percentage flow-throttling characteristics unless otherwise indicated.
5. Modulating three-way pattern water valves shall have linear flow-throttling characteristics. The total flow through the valve shall remain constant regardless of the valve's position.
6. Modulating butterfly valves shall have linear or equal percentage flow-throttling characteristics.
7. Fail positions unless otherwise indicated:
    a. Chilled Water: Close.
    b. Heating Hot Water: Open.
8. Globe-type control valves shall pass the design flow required with not more than 95 percent of stem lift unless otherwise indicated.
9. Rotary-type control valves, such as ball and butterfly valves, shall have Cv falling between 65 and 75 degrees of valve full open position and minimum valve Cv between 15 and 25 percent of open position.
10. Selection shall consider viscosity, flashing, and cavitation corrections.
11. Valves shall have stable operation throughout full range of operation, from design to minimum Cv.
12. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
13. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of 5 psig at design flow unless otherwise indicated.
14. Modulating valve sizes for steam service shall provide a pressure drop at design flow equal to lesser of the following:
    a. 50 percent of the valve inlet pressure.
    b. 50 percent of the absolute steam pressure at the valve inlet.
15. Two-position control valves shall be line size unless otherwise indicated.
16. In water systems, use ball- or globe-style control valves for two-position control for valves NPS 2 and smaller and butterfly style for valves larger than NPS 2.
17. In steam systems, use ball- or globe-style control valves regardless of size.
18. Pneumatic, two-position control valves shall provide a smooth opening and closing characteristic slow enough to avoid water hammer. Valves with pneumatic actuators shall have an adjustable opening time (valve full closed to full open) and an adjustable closing

time (valve full open to full closed) ranging from zero to 10 seconds. Opening and closing times shall be independently adjustable.

19. Control valve, pneumatic-control signal shall not exceed 200 feet. For longer distances, provide an electric/electronic control signal to the valve and an electric solenoid valve or electro-pneumatic transducer at the valve to convert the control signal to pneumatic.

2.02 BALL-STYLE CONTROL VALVES

A. Ball Valves with Full Ball and Characterized V-Notch:

1. Performance:
   a. Process Temperature Rating: Minus 20 to plus 500 deg F.
   b. ASME B16.34, Class 600 for NPS 2 and smaller; Class 150 for larger than NPS 2.
   c. Leakage: FCI 70-2, Class VI, bi-directional.
   d. Rangeability: Varies from 200 to 1 up to 800 to 1 based on notch pattern of ball.
   e. Rotation: Zero to 90 degrees.
   f. Equal percentage flow characteristic.
   g. Full port.
2. Face-to-Face Dimension: ASME B16.10 long pattern.
3. Valves NPS 2 and Smaller: ASME B1.20.1 threaded (NPT) ends and three-piece body.
4. Valves NPS 2-1/2 through NPS 12: Flanged ends suitable for mating to ASME B16.5 flanges and two-piece body.
5. Hole in the stem slot of each ball equalizes pressure between the body cavity and the line media flow.
6. Replaceable seat, ball, and shaft packing.
7. Body: Carbon steel.
8. Ball and Shaft: Brass or Stainless steel.
9. Ball Seat: RPTFE.
10. Stem Seals for Valves NPS 2 and Smaller: Live-loaded, self-adjusting, primary and secondary sealing using belleville washers.
    a. Primary Seal: Combination of thrust washer and thrust washer protector.
    b. Secondary Seal: Adjustable stem packing composed of RPTFE V-rings.
11. Stem Seals for Valves Larger than NPS 2: Independent packing gland, adjusted without removing mounting hardware or operator, and contoured to uniformly distribute load across packing.
    a. Primary Seal: Combination of thrust washer and thrust washer protector.
    b. Secondary Seal: Adjustable stem packing composed of RPTFE V-rings.
12. Label each valve with following:
    a. Manufacturer's name, model number, and serial number.
    b. Body size.
    c. Flow directional arrow.

B. Ball Valves with Segmented Ball, Three-Way Pattern:

1. Arrangement: Two single-port valves mated to a fabricated tee with interconnecting mechanical linkage.
2. Performance:
   a. Process Temperature Rating: Minus 20 to plus 450 deg F.
   b. ASME B16.34, Class 150.
   c. Leakage: FCI 70-2, Class IV.
   d. Rangeability: 300 to 1.
   e. Rotation: Zero to 90 degrees.
   f. Equal percentage flow characteristic.
3. Face-to-Face Dimensions: ASME B16.10.
4. Valves NPS 3 through NPS 6: Flanged ends suitable for mating to ASME B16.5 flanges.
5. Body: Carbon steel.

6. Ball and Shaft: Brass or Stainless steel.
7. Shaft and Segmented Ball: Pinned and welded.
8. Ball Seat: Graphite.
9. Packing: PTFE V-rings and graphite packing follower.
10. Replaceable seat, ball, and shaft packing.
11. Label each valve with following:
    a. Manufacturer's name, model number, and serial number.
    b. Body size.
    c. Flow directional arrow.

2.03 BUTTERFLY-STYLE CONTROL VALVES

A. Commercial-Grade, Two-Way Butterfly Valves:
1. Performance:
    a. Bi-directional bubble tight shutoff at 250 psig.
    b. Comply with MSS SP-67 or MSS SP-68.
    c. Rotation: Zero to 90 degrees.
    d. Linear or modified equal percentage flow characteristic.
2. Body: Cast iron ASTM A 126, Class B, ductile iron ASTM A 536 or cast steel ASTM A 216/A 216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
3. Disc: 316 stainless steel.
4. Shaft: 316 or 17-4 PH stainless steel.
5. Seat: Reinforced EPDM or reinforced PTFE with retaining ring.
6. Shaft Bushings: Reinforced PTFE or stainless steel.
7. Replaceable seat, disc, and shaft bushings.
8. Corrosion-resistant nameplate indicating:
    a. Manufacturer's name, model number, and serial number.
    b. Body size.
    c. Body and trim materials.
    d. Flow arrow.

B. Commercial-Grade, Three-Way Butterfly Valves:
1. Arrangement: Two valves mated to a fabricated tee with interconnecting mechanical linkage.
2. Performance:
    a. Bi-directional bubble tight shutoff at 250 psig.
    b. Comply with MSS SP-67 or MSS SP-68.
    c. Rotation: Zero to 90 degrees.
    d. Linear or modified equal percentage flow characteristic.
3. Body: Cast iron ASTM A 126, Class B, ductile iron ASTM A 536 or cast steel ASTM A 216/A 216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
4. Disc: 316 stainless steel.
5. Shaft: 316 or 17-4 PH stainless steel.
6. Seat: Reinforced EPDM or reinforced PTFE seat with retaining ring.
7. Shaft Bushings: Reinforced PTFE or stainless steel.
8. Replaceable seat, disc, and shaft bushings.
9. Corrosion-resistant nameplate indicating:
    a. Manufacturer's name, model number, and serial number.
    b. Body size.
    c. Body and trim materials.
    d. Flow arrow.

2.04 GLOBE-STYLE CONTROL VALVES

A. General Globe-Style Valve Requirements:
1. Globe-style control valve body dimensions shall comply with ISA 75.08.01.

2. Construct the valves to be serviceable from the top.
3. For cage guided valves, trim shall be field interchangeable for different valve flow characteristics, such as equal percentage, linear, and quick opening.
4. Reduced trim for one nominal size smaller shall be available for industrial valves NPS 1 and larger.
5. Replaceable seats and plugs.
6. Furnish each control valve with a corrosion-resistant nameplate indicating the following:
   a. Manufacturer's name, model number, and serial number.
   b. Body and trim size.
   c. Arrow indicating direction of flow.

B. Two-Way Globe Valves NPS 2-1/2 to NPS 6:
1. Globe Style: Single port.
2. Body: Cast iron complying with ASME B61.1, Class 125.
3. End Connections: Flanged, suitable for mating to ASME B16.5, Class 150 flanges.
4. Bonnet: Bolted.
5. Packing: PTFE cone-ring.
6. Plug: Top or bottom guided.
7. Plug, Seat, and Stem: Brass or stainless steel.
8. Process Temperature Rating: 35 to 281 deg F.
9. Leakage: 0.1 percent of maximum flow.
10. Rangeability: Varies with valve size between 6 and 10 to 1.
11. Modified linear flow characteristic.

C. Three-Way Globe Valves NPS 2-1/2 to NPS 6:
1. Globe Style: Mix flow pattern.
2. Body: Cast iron complying with ASME B61.1, Class 125.
3. End Connections: Flanged suitable for mating to ASME B16.5, Class 150 flanges.
4. Bonnet: Bolted.
5. Packing: PTFE cone-ring.
6. Plug: Top or bottom guided.
7. Plug, Seat, and Stem: Brass or stainless steel.
8. Process Temperature Rating: 35 to 281 deg F.
9. Leakage: 0.1 percent of maximum flow.
10. Rangeability: Varies with valve size between 6 and 10 to 1.
11. Modified linear flow characteristic.
12. Flow Characteristic: Equal percentage.

2.05 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

A. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.
B. Position indicator and graduated scale on each actuator.
C. Type: Motor operated, with or without gears, electric and electronic.
D. Voltage: Voltage selection delegated to professional designing control system.
E. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
F. Function properly within a range of 85 to 120 percent of nameplate voltage.
G. Construction:
1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.

3. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

H. Field Adjustment:
   1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
   2. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.

I. Two-Position Actuators: Single direction, spring return or reversing type.

J. Modulating Actuators:
   1. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
   2. Control Input Signal:
      a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
      b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10-V dc and 4- to 20-mA signals.
      c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
      d. Programmable Multi-Function:
         1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
         2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
         3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

K. Position Feedback:
   1. Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
   2. Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
   3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

L. Fail-Safe:
   1. Where indicated, provide actuator to fail to an end position.
   2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
   3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

M. Integral Overload Protection:
   1. Provide against overload throughout the entire operating range in both directions.
   2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

N. Valve Attachment:
   1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.
   2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.

3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

O. Temperature and Humidity:
1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

P. Enclosure:
1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with heater and control where required by application.

Q. Stroke Time:
1. Operate valve from fully closed to fully open within 75 seconds.
2. Operate valve from fully open to fully closed within 75 seconds.
3. Move valve to failed position within 30 seconds.
4. Select operating speed to be compatible with equipment and system operation.

R. Sound:
1. Spring Return: 62 dBA.
2. Non-Spring Return: 45 dBA.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for valves installed in piping to verify actual locations of piping connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CONTROL VALVE APPLICATIONS

A. Control Valves:
1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
2. Hydronic System, Chilled & Heating Hot Water, Two-Way Applications Controlled by Temperature: Ball valves with single port and characterized disk Ball valves with single port and segmented ball Ball valves with full ball and characterized V-notch Pressure-independent ball valves Butterfly-style valves, commercial-grade, two-way valves Globe-style, two-way valves.

3. Hydronic System, Chilled & Heating Hot Water, Three Way, Controlled by Temperature: Ball valves with two ports and characterized disk Ball valves with segmented ball, three-way pattern Butterfly-style valves, commercial-grade, three-way valves Globe-style, three-way valves.

3.03 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a 50lb force.

D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that

could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.

F. Fastening Hardware:
   1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
   2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
   3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.04 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.05 CONTROL VALVES

A. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

B. Install flanges or unions to allow drop-in and -out valve installation.

C. Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing manual throttling valve in bypass pipe.

D. Valve Orientation:
   1. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
   2. Install valves in a position to allow full stem movement.
   3. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.

E. Clearance:
   1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
   2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.

F. Threaded Valves:
   1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
   2. Align threads at point of assembly.
   3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
   4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

G. Flanged Valves:
   1. Align flange surfaces parallel.

2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.06 CONNECTIONS

A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.07 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with valve identification on valve.

3.08 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.09 CHECKOUT PROCEDURES

A. Control Valve Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check valves for proper location and accessibility.
3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. For pneumatic products, verify air supply for each product is properly installed.
5. For pneumatic valves, verify that pressure gauges are provided in each air line to valve actuator and positioner.
6. Verify that control valves are installed correctly for flow direction.
7. Verify that valve body attachment is properly secured and sealed.
8. Verify that valve actuator and linkage attachment are secure.
9. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
10. Verify that valve ball, disc, and plug travel are unobstructed.
11. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.

C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION

SECTION 23 0923.12
CONTROL DAMPERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes the following types of control dampers and actuators for DDC systems:
   1. Rectangular control dampers.
   2. Round control dampers.
   3. General control-damper actuator requirements.
   4. Electric and electronic actuators.

B. Related Requirements:
   1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
   2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.12.

1.03 DEFINITIONS

A. DDC: Direct-digital control.

B. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
   3. Product description with complete technical data, performance curves, and product specification sheets.
   4. Installation instructions, including factors affecting performance.

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Include diagrams for air and process signal tubing.
   5. Include diagrams for pneumatic signal and main air tubing.

C. Delegated-Design Submittal:
   1. Schedule and design calculations for control dampers and actuators, including the following.
      a. Flow at project design and minimum flow conditions.
      b. Face velocity at project design and minimum airflow conditions.
      c. Pressure drop across damper at project design and minimum airflow conditions.
      d. AMCA 500D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
      e. Maximum close-off pressure.

f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
g. Torque required at worst case condition for sizing actuator.
h. Actuator selection indicating torque provided.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Product installation location shown in relationship to room, duct, and equipment.
2. Size and location of wall access panels for control dampers and actuators installed behind walls.
3. Size and location of ceiling access panels for control dampers and actuators installed above inaccessible ceilings.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control dampers to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
C. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.
D. Backup Power Source: Systems and equipment served by a backup power source shall have associated control damper actuators served from a backup power source.
E. Environmental Conditions:
1. Provide electric control-damper actuators, with protective enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Electric control-damper actuators not available with integral enclosures, complying with requirements indicated, shall be housed in protective secondary enclosures.
F. Selection Criteria:
1. Control dampers shall be suitable for operation at following conditions:
a. Supply Air: 6” w.c. at (-) 75 F to (+) 275 F
b. Return Air: 6” w.c. at (-) 75 F to (+) 275 F
c. Outdoor Air: 6” w.c. at (-) 75 F to (+) 275 F
d. Exhaust Air: 6” w.c. at (-) 75 F to (+) 275 F
2. Fail positions unless otherwise indicated:
a. Supply Air: Open.
b. Return Air: Open.
c. Outdoor Air: Close.
d. Exhaust Air: Close.
3. Dampers shall have stable operation throughout full range of operation, from design to minimum airflow over varying pressures and temperatures encountered.
4. Select modulating dampers for a pressure drop of 5 percent of fan total static pressure unless otherwise indicated.
5. Two-position dampers shall be full size of duct or equipment connection unless otherwise indicated.

2.02 RECTANGULAR CONTROL DAMPERS

A. General Requirements:
1. Unless otherwise indicated, use parallel blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed blade configuration.

2. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
3. Damper actuator shall be factory installed by damper manufacturer as integral part of damper assembly. Coordinate actuator location and mounting requirements with damper manufacturer.

B. Rectangular Dampers with Aluminum Airfoil Blades:
1. Performance:
   a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. against 1-in. wg differential static pressure.
   b. Pressure Drop: 0.05-in. wg at 1500 fpm across a 24-by-24-inch damper when tested according to AMCA 500-D, figure 5.3.
   c. Velocity: Up to 6000 fpm.
   d. Temperature: Minus 40 to plus 185 deg F.
   e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
   f. Damper shall have AMCA seal for both air leakage and air performance.
2. Construction:
   a. Frame:
      1) Material: ASTM B 211, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch thick.
      2) Hat-shaped channel with integral flange(s). Mating face shall be a minimum of 1 inch.
      3) Width not less than 5 inches.
   b. Blades:
      1) Hollow, airfoil, extruded aluminum.
      2) Parallel or opposed blade configuration as required by application.
      3) Material: ASTM B 211, Alloy 6063 T5 aluminum, 0.07 inch thick.
      4) Width not to exceed 6 inches.
      5) Length as required by close-off pressure, not to exceed 48 inches.
   c. Seals:
      1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.
      2) Jambs: Stainless steel, compression type.
   d. Axles: 0.5-inch-diameter plated or stainless steel, mechanically attached to blades.
   e. Bearings:
      1) Molded synthetic or stainless-steel sleeve mounted in frame.
      2) Where blade axles are installed in vertical position, provide thrust bearings.
   f. Linkage:
      1) Concealed in frame.
      2) Constructed of aluminum and plated or stainless steel.
      3) Hardware: Stainless steel.
   g. Transition:
      1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
      2) Factory mount damper in a sleeve with a close transition to mate to field connection.
      3) Damper size and sleeve shall be connection size plus 2 inches.
      4) Sleeve length shall be not less than 12 inches for dampers without jackshafts and shall be not less than 16 inches for dampers with jackshafts.
      5) Sleeve material shall match adjacent duct.
   h. Additional Corrosion Protection for Corrosive Environments:

1) Provide anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch thick.
2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

2.03 ROUND CONTROL DAMPERS

A. Round Dampers, Sleeve Type:
1. Performance:
a. Leakage: Leakage shall not exceed 0.15 cfm/in. of perimeter blade at 4-in. wg differential static pressure.
b. Pressure Drop: 0.02-in. wg at 1500 fpm across a 12-inch damper when tested according to AMCA 500-D, figure 5.3.
c. Velocity: Up to 4000 fpm.
d. Temperature: Minus 25 to plus 200 deg F.
e. Pressure Rating: 8-in. wg for sizes through 12 inches, 6-in. wg for larger sizes.
2. Construction:
a. Frame:
1) Material: Galvanized or stainless steel, 0.04 in thick.
2) Outward rolled stiffener beads positioned approximately 1 inch inboard of each end.
3) Sleeve-type connection for mating to adjacent ductwork.
4) Size Range: 4 to 24 inches.
5) Length not less than 7 inches.
6) Provide 2-inch sheet metal stand-off for mounting actuator.
b. Blade: Double-thickness circular flat blades sandwiched together and constructed of galvanized or stainless steel.
c. Blade Seal: Polyethylene foam seal sandwiched between two sides of blades and fully encompassing blade edge.
d. Axle: 0.5-inch-diameter plated or stainless steel, mechanically attached to blade.
e. Bearings: Stainless-steel sleeve pressed into frame.

B. Round Dampers, Flanged Type:
1. Performance:
a. Leakage: Leakage shall not exceed 0.15 cfm/in. of perimeter blade at 4-in. wg differential static pressure.
b. Pressure Drop: 0.03-in. wg at 1500 fpm across a 12-inch damper when tested according to AMCA 500-D, figure 5.3.
c. Velocity: Up to 4000 fpm.
d. Temperature: Minus 25 to plus 250 deg F.
e. Pressure Rating: 8-in. wg for sizes through 36 inches in diameter, 6-in. wg for larger sizes.
2. Construction:
a. Frame:
1) Size Range: 4 to 60 inches.
2) Material: Galvanized or stainless steel.
a) Sizes through 24 Inches in Diameter: 0.15 inch thick.
b) Sizes 26 through 48 Inches in Diameter: 0.25 inch thick.
c) Larger Sizes: 0.31 inch thick.
3) Flanges:
a) Outward rolled with bolt holes on each end of frame for mating to adjacent ductwork.

b) Face: Not less than 1.25 inch for damper sizes through 12 inches in diameter, 1.5 inch for damper sizes 14 through 24 inches in diameter, and 2 inches for larger sizes.

4) Length (Flange Face to Face): Not less than 8 inches.

5) Provide 3-inch sheet metal stand-off for mounting actuator.

b. Blade: Reinforced circular flat blade constructed of galvanized or stainless steel.

1) Sizes through 24 Inches: 0.15 inch thick.

2) Sizes 26 through 48 Inches: 0.19 inch thick.

3) Larger Sizes: 0.25 inch thick.

c. Blade Stop: Full circumference, located in airstream, minimum 0.5 by 0.25 inch galvanized- or stainless- steel bar.

d. Blade Seal: Neoprene, mechanically attached to blade and fully encompassing blade edge.

e. Axle: Plated or stainless steel, mechanically attached to blade.

1) Sizes through 14 Inches: 0.5 inch in diameter.

2) Sizes 16 through 42 Inches: 0.75 inch in diameter.

3) Larger Sizes: 1 inch in diameter.

f. Bearings: Stainless-steel sleeve pressed into frame.

2.04 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

A. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.

B. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.

C. The total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.

D. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.

E. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.

F. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.

G. Provide mounting hardware and linkages for connecting actuator to damper.

H. Select actuators to fail in desired position in the event of a power failure.

I. Actuator Fail Positions: As indicated below:

1. Exhaust Air: Close.
2. Outdoor Air: Close.
3. Supply Air: Open.
4. Return Air: Open.

2.05 ELECTRIC AND ELECTRONIC ACTUATORS

A. Type: Motor operated, with or without gears, electric and electronic.

B. Voltage:

1. Voltage selection is delegated to professional designing control system.
2. Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
3. Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.

C. Construction:

1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

2. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

D. Field Adjustment:
1. Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.
2. Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

E. Two-Position Actuators: Single direction, spring return or reversing type.

F. Modulating Actuators:
1. Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:
a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input remains in last position.
b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10-V dc and 4- to 20-mA signals.
c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to a pulse duration (length) of signal from a dry-contact closure, triac sink or source controller.
d. Programmable Multi-Function:
1) Control input, position feedback, and running time shall be factory or field programmable.
2) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
3) Service data, including at a minimum, number of hours powered and number of hours in motion.

G. Position Feedback:
1. Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
2. Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

H. Fail-Safe:
1. Where indicated, provide actuator to fail to an end position.
2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

I. Integral Overload Protection:
1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

J. Damper Attachment:
1. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.

2. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

K. Temperature and Humidity:
1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

L. Enclosure:
1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with a heater and controller where required by application.

M. Stroke Time:
1. Operate damper from fully closed to fully open within 90 seconds.
2. Operate damper from fully open to fully closed within 90 seconds.
3. Move damper to failed position within 30 seconds.
4. Select operating speed to be compatible with equipment and system operation.
5. Actuators operating in smoke control systems comply with governing code and NFPA requirements.

N. Sound:
1. Spring Return: 62 dBA.
2. Non-Spring Return: 45 dBA.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CONTROL-DAMPER APPLICATIONS

A. Control Dampers:

B. Select from damper types indicated in "Control Dampers" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
1. Rectangular Exhaust Air Duct Applications with Pressure Rating at 6.0” w.c. and Velocities to 6000 FPM: Rectangular dampers with aluminum airfoil blades Round dampers, sleeve type Round dampers, flange type.
2. Round Exhaust Air Duct Applications with Pressure Rating at 6.0” w.c. and Velocities to 6000 FPM: Rectangular dampers with aluminum airfoil blades Round dampers, sleeve type Round dampers, flange type.
3. Rectangular Outdoor Air Duct Applications with Pressure Rating at 6.0” w.c. and Velocities to 6000 FPM: Rectangular dampers with aluminum airfoil blades Round dampers, sleeve type Round dampers, flange type.
4. Round Outdoor Air Duct Applications with Pressure Rating at 6.0” w.c. and Velocities to 6000 FPM: Rectangular dampers with aluminum airfoil blades Round dampers, sleeve type Round dampers, flange type.

5. Rectangular Return Air Duct Applications with Pressure Rating at 6.0” w.c. and Velocities to 6000 FPM: Rectangular dampers with aluminum airfoil blades Round dampers, sleeve type Round dampers, flange type.
6. Round Return Air Duct Applications with Pressure Rating at 6.0” w.c. and Velocities to 6000 FPM: Rectangular dampers with aluminum airfoil blades Round dampers, sleeve type Round dampers, flange type.
7. Rectangular Supply Air Duct Applications with Pressure Rating at 6.0” w.c. and Velocities to 6000 FPM: Rectangular dampers with aluminum airfoil blades Round dampers, sleeve type Round dampers, flange type.
8. Round Supply Air Duct Applications with Pressure Rating at 6.0” w.c. and Velocities to 6000 FPM: Rectangular dampers with aluminum airfoil blades Round dampers, sleeve type Round dampers, flange type.

3.03 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.
B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a 50 lb force.
C. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
D. Seal penetrations made in fire-rated and acoustically rated assemblies.
E. Fastening Hardware:
   1. Stillson wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
   2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
   3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.04 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.
B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.05 CONTROL DAMPERS

A. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
B. Clearance:
   1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
   2. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.
C. Service Access:
   1. Dampers and actuators shall be accessible for visual inspection and service.

2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 233300 "Air Duct Accessories."

D. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.

E. Attach actuator(s) to damper drive shaft.

F. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

3.06 CONNECTIONS

A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.07 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with damper identification on damper.

3.08 CHECKOUT PROCEDURES

A. Control-Damper Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check dampers for proper location and accessibility.
3. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
4. For pneumatic products, verify air supply for each product is properly installed.
5. For pneumatic dampers, verify that pressure gages are provided in each air line to damper actuator and positioner.
6. Verify that control dampers are installed correctly for flow direction.
7. Verify that proper blade alignment, either parallel or opposed, has been provided.
8. Verify that damper frame attachment is properly secured and sealed.
9. Verify that damper actuator and linkage attachment are secure.
10. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
11. Verify that damper blade travel is unobstructed.

3.09 ADJUSTMENT, CALIBRATION, AND TESTING:

A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressure.

C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION

SECTION 23 0923.14
FLOW INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Airflow sensors.
   2. Airflow switches.
   3. Airflow transmitters.
   4. Liquid flow meters.
   5. Liquid flow sensors.
   6. Liquid flow switches.
   7. Liquid flow transmitters.

B. Related Requirements:
   1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
   2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.14.

1.3 DEFINITIONS

A. Ethernet: Local area network based on IEEE 802.3 standards.

B. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.

C. PEEK: polyetheretherketone.

D. PTFE: Polytetrafluoroethylene.

E. PPS: Polyphenylene sulfide.

F. RS-485: A TIA standard for multipoint communications using two twisted pairs.

G. RTD: Resistance temperature detector.

H. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
   3. Product description with complete technical data, performance curves, and product specification sheets.
   4. Installation instructions, including factors affecting performance.

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.

2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for air and process signal tubing.
5. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Provide parts, as indicated by manufacturer's recommended parts list, for product operation during one-year period following warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Select and size products to achieve specified performance requirements.

B. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 GENERAL REQUIREMENTS FOR FLOW INSTRUMENTS

A. Air sensors and transmitters shall have an extended range of 10 percent above Project design flow and 10 percent below minimum Project flow to signal abnormal flow conditions and to provide flexibility for changes in operation.

B. Liquid and steam sensors, meters, and transmitters shall have an extended range of 10 percent above Project design flow and 10 percent below Project minimum flow to signal abnormal flow conditions and to provide flexibility for changes in operation.

2.3 AIRFLOW SENSORS:

A. Performance Requirements:
1. Adjustable for changes in system operational parameters.
2. Airflow Sensor and Transmitter Range: Extended range of 10 percent above Project design flow and 10 percent below minimum Project flow to signal abnormal flow conditions.
3. Manufacturer shall certify that each flow instrument indicated complies with specified performance requirements and characteristics.
   a. Product certificates are required.

B. Pitot-Tube Airflow Sensor Station:
1. Description: Multiple total- and static-pressure sensors positioned at the center of equal area of the station cross section and interconnected by respective averaging manifolds.
   a. Stations 4 sq. ft. and Smaller: One total-pressure sensor and one static-pressure sensor for every 16 sq. in. of station area.
   b. Stations Larger than 4 sq. ft.: One total-pressure sensor and one static-pressure sensor for every 36 sq. in. of station area.
2. Casing: Galvanized sheet steel at least 0.079 inch thick with coating complying with ASTM A 653/A 653M, G90. Casings shall be stainless steel, 0.0781 inch thick, when connected to stainless duct and aluminum, 0.063 inch thick, when connected to aluminum duct.
   a. Joints and Seams: Continuously weld. Clean galvanized areas damaged by welding and coat with aluminum paint.
   b. Casing Depth: At least 8 inches.
   c. Casing Flanges: Outward flange, minimum flange face 1.5 inches.

d. Casing Configuration and Size: Match shape (rectangular, round, flat oval) and same size as adjacent duct unless otherwise indicated.

3. Include an open parallel cell air straightener or air equalizer honeycomb mechanically fastened to casing.
   a. Construct straightener or equalizer from Type 3003 aluminum or Type 316 stainless steel, depending on casing material. Use stainless steel for units with stainless-steel casings.
4. Construct pressure sensor array from drawn copper or stainless-steel tubing. Use stainless steel for units with stainless-steel casings. Copper tubing shall comply with ASTM B 75 and ASTM B 280. Minimum tube wall thickness shall be 0.030 inch. Include internal piping and external pressure transmitter ports.
5. Station Labeling: Identification label on each station casing indicating model number, size, area, and application-specific airflow range.
6. Performance:
   a. Pressure Loss: 0.015-inch wg at 1000 fpm, or 0.085-inch wg at 2000 fpm.
   b. Accuracy: Within 2 percent of actual airflow.
   c. Self-Generated Sound: NC 40 and sound level within the duct shall not be amplified.
   d. Performance rated and tested according to AMCA 610. Each station shall bear the AMCA seal.

C. Pitot-Tube Fan Inlet Airflow Traverse Sensor:
1. Traverse manifold designed for mounting in fan inlets.
2. Contain multiple total- and static-pressure sensors placed at concentric area centers along the exterior surface of cylindrical manifold and internally connected to their respective averaging manifolds. Sensors shall not protrude beyond the surface of the manifold nor be adversely affected by particle contamination present in airstream.
3. Manifold (two per inlet) shall have dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal takeoffs and fittings.
4. Sensors shall be capable of producing steady, non-pulsating signals of standard total- and static-pressure without need for flow corrections or factors, with an accuracy of 3 percent of actual flow over a turndown range of 6 to 1.
5. Manifold Materials: Copper or anodized aluminum or Type 316 stainless steel.
6. Unless otherwise required by application and without affecting the fan and sensor performance, nominal diameter copper and aluminum manifolds shall be the following:
   a. For Fan Inlets Smaller than 20 Inches: 0.375 inch.
   b. For Fan Inlets 20 Inches and Larger: 0.75 inch.
7. Unless otherwise required by application and without affecting the fan and sensor performance, nominal diameter stainless-steel manifolds shall be the following:
   a. For Fan Inlets Smaller than 20 Inches: 0.375 inch.
   b. For Fan Inlets 20 through 48 Inches: 0.75 inch.
   c. For Fan Inlets Larger than 48 Inches: 1.0 inch.

D. Piezometer Ring Fan Inlet Airflow Sensor:
1. In lieu of externally mounted fan inlet airflow sensors, option to provide fans with airflow measurement integral to fan inlet cones for continuous measurement of air volume flow rate.
2. Multiple pressure sensor points strategically placed along the circumference of the inlet cone and internally connected to an averaging ring manifold located behind the inlet cone.
3. Sensor points shall not protrude beyond the surface of the inlet cone nor be adversely affected by particle contamination present in the airstream.

4. Sensor shall produce steady, non-pulsating signals to achieve accuracy within 5 percent of actual airflow.
5. Sensor shall be non-intrusive and not impact fan performance.
6. Product shall be a standard offering of the fan manufacturer and include published literature with supporting test data to validate sensor performance.

E. Thermal Airflow Station:
1. Source Limitations: Obtain airflow and temperature measuring sensors and transmitters from single manufacturer.
2. Description: Airflow station shall consist of one or more sensor probes mounted in a casing, and a remotely mounted microprocessor-based transmitter.
3. Performance:
   a. Capable of independently processing up to 16 independently wired sensor assemblies.
   b. Airflow rate of each sensor assembly shall be equally weighted and averaged by transmitter prior to output.
   c. Temperature of each sensor assembly shall be velocity weighted and averaged by transmitter prior to output.
   d. Listed and labeled by an NRTL as successfully tested as an assembly according to UL 873, "Temperature-Indicating and Regulating Equipment."
   e. Components shall be interconnected by exposed NRTL-listed plenum-rated cable or non-listed cable placed in conduit.
   f. Each flow station shall be factory calibrated at a minimum of 16 airflow rates and three temperatures to standards that are traceable to NIST.
   g. Airflow Accuracy: Within 2 percent of reading over the entire operating airflow range.
      1) Devices whose accuracy is combined accuracy of transmitter and sensor probes must demonstrate that total accuracy meets the performance requirements throughout the measurement range.
   h. Temperature Accuracy: Within 0.2 deg F over entire operating range of minus 20 to plus 140 deg F.
   i. Sensor Ambient Operating Temperature Range: Minus 20 to plus 160 deg F.
   j. Transmitter Ambient Operating Temperature Range: Minus 20 to plus 120 deg F.
   k. Sensor and Transmitter Ambient Operating Humidity Range: Zero to 99 percent, non-condensing.
   l. Instrument shall compensate for changes in air temperature and density throughout calibrated velocity range for seasonal extremes at Project location.
   m. Pressure Drop: 0.05-inch wg at 2000 fpm across a 24-by-24-inch area.
   n. Instruments mounted in throat or face of fan inlet cone shall not negatively influence fan performance by reducing flow more than 1 percent of Project design flow or negatively impact fan-generated sound. Losses in performance shall be documented with submittal data, and adjustments to compensate for performance impact shall be made to fan in order to deliver Project design airflow indicated.
4. Sensor Assemblies:
   a. Each sensor probe shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
   b. Mount thermistors in sensor using a marine-grade, waterproof epoxy.
   c. Thermistor leads shall be protected and not exposed to the environment.
   d. Each sensor assembly shall independently determine airflow rate and temperature at each measurement point.
   e. Each sensor probe shall have an integral cable for connection to remotely mounted transmitter.

f. Sensor Probe Material: Gold anodized, extruded 6063 aluminum tube or Type 304 stainless steel.
g. Probe Assembly Mounting Brackets Material: Type 304 stainless steel.

5. Casing:
   a. Factory mount sensor probes in an airflow station casing to create a single assembly for field mounting.
   b. Material: Galvanized sheet steel at least 0.079 inch thick with coating complying with ASTM A 653/A 653M, G90. Casings shall be stainless steel, 0.0781 inch thick, when connected to stainless duct and aluminum, 0.063 inch thick, when connected to aluminum duct.
   c. Joints and Seams: Continuously weld. Clean galvanized areas damaged by welding and coat with zinc-rich paint.
   d. Casing Depth: At least 8 inches.
   e. Include casing inlet and discharge connections with a minimum 1.5-inch face flange.
6. Transmitter:
   a. Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.
   b. Capable of field configuration and diagnostics using an onboard push-button interface and digital display.
      1) Include an integral power switch to operate on 24-V ac (isolation not required) and include the following:
         a) Integral protection from transients and power surges.
         b) Circuitry to ensure reset after power disruption, transients, and brownouts.
         c) Integral transformer to convert field power source to operating voltage required by instrument.
   c. Remote Signal Interface:
      1) Linear Analog Signals for Airflow and Temperature: Fuse protected and isolated, field selectable, zero- to 10-V dc or 4 to 20 mA.
      2) RS-485: BACnet-ARCNET, BACnet-MS/TP, and Modbus-RTU.
      3) 10 Base-T Ethernet: BACnet Ethernet, BACnet-IP, Modbus-TCP, and TCP/IP.
      4) LonWorks free topology.

2.4 AIRFLOW SWITCHES

A. Polymer Film Sail Switch:
1. Performance:
   a. Suitable for applications operating at velocities up to 400 fpm.
   b. Suitable for mounting with air direction in horizontal, vertical up or down.
   c. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   d. Voltage: 24-, 120-, 240-V ac.
   e. Normally Open Full Load Current: 2 A at 120-V ac.
   f. Normally Closed Full Load Current: 1 A at 120-V ac.
   g. Normally open switch actuates at 250 fpm and opens at 75 fpm.
   h. Normally closed switch actuates at 75 fpm and closes at 250 fpm.
   i. Maximum Process Temperature: 170 deg F.
   j. Maximum Ambient Temperature: 125 deg F.
2. Construction:
   a. Polyester film sail encasing a wire frame.

b. Sail actuates a SPDT snap switch.
c. Enclosure Material: Zinc-plated steel.
d. Enclosure with removable cover.
e. NEMA 250, Type 1 enclosure.
f. Removable spring counterbalances sail to allow mounting in either vertical (up or down) or horizontal airflow.
g. Electrical Connections: Screw terminals.
h. Conduit Connections: 1/2-inch trade size conduit knock outs on top and bottom.

B. Stainless-Steel Single Vane Switch:
1. Description:
a. Velocities up to 2000 fpm.
b. Suitable for mounting with air direction in horizontal.
2. Performance:
a. Voltage: 125-, 240-, and 480-V ac.
b. Full Load Current: 9.8 A at 125-V ac.
c. Field-Adjustable Velocity Set Point: 400 to 1600 fpm.
d. Maximum Process Temperature: 180 deg F.
e. Maximum Ambient Temperature: 125 deg F.
3. Construction:
a. Stainless-steel vane.
b. Vane actuates a SPDT snap switch.
c. Enclosure Material: Die-cast metal.
d. Enclosure with removable cover.
e. NEMA 250, Type 1 enclosure.
f. Screw set-point adjustment.
g. Electrical Connections: Screw terminals.
h. Conduit Connections: 1-inch trade size conduit knock outs on top and bottom.

2.5 AIRFLOW TRANSMITTERS

A. Airflow Transmitter with 0.10 Percent Accuracy and Auto-Zero Feature:
1. Transmitter shall receive total- and static-pressure signals from a primary element, amplify signals, extract the square root, and scale the signals to produce 4- to 20-mA dc output signals linear to airflow.
2. NEMA 250, Type 1 enclosure.
3. Construct assembly so that shock, vibration, and pressures surges of up to 1 psig will neither harm transmitter, nor affect its accuracy.
4. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals. The automatic zeroing circuit shall re-zero transmitter to within 0.1 percent of true zero.
5. Performance:
a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
b. Calibrated Span: Field adjustable, minus 40 percent of the range.
c. Accuracy: Within 0.10 percent of natural span.
d. Repeatability: Within 0.15 percent of calibrated span.
e. Linearity: Within 0.2 percent of calibrated span.
f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.
6. Integral digital LED or digital display for continuous indication of airflow.

B. Airflow Transmitters with 0.25 Percent Accuracy and Auto-Zero Feature:
1. Transmitter shall receive total- and static-pressure signals from a flow element, amplify signals, extract the square foot, and scale the signals to produce 4- to 20-mA dc output signals linear to airflow.

2. NEMA 250, Type 1 enclosure.
3. Construct assembly so shock, vibration, and pressures surges of up to 1 psig will neither harm transmitter, nor affect its accuracy.
4. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals. The automatic zeroing circuit shall re-zero the transmitter to within 0.1 percent of true zero.
5. Performance:
    a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
    b. Calibrated Span: Field adjustable, minus 40 percent of the range.
    c. Accuracy: Within 0.25 percent of natural span.
    d. Repeatability: Within 0.15 percent of calibrated span.
    e. Linearity: Within 0.2 percent of calibrated span.
    f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.
6. Integral digital display for continuous indication of airflow.

C. Pressure Differential Transmitters for Airflow Measurement:
1. Performance:
    a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
    b. Accuracy: Within 0.5 percent of the full-scale range.
    c. Hysteresis: Within 0.10 percent of full scale.
    d. Repeatability: Within 0.05 percent of full scale.
    e. Stability: Within one percent of span per year.
    f. Overpressure: 10 psig.
    g. Temperature Limits: Zero to 150 deg F.
    h. Compensate Temperature Limits: 40 to 150 deg F.
    i. Thermal Effects: 0.033 percent of full scale per degree F.
    j. Shock and vibration shall not harm the transmitter.
2. Output Signals:
    a. Analog Current Signal:
        1) Two-wire, 4- to 20-mA dc current source.
        2) Signal capable of operating into 800-ohm load.
    b. Analog Voltage Signal:
        1) Three wire, zero to 10 V.
        2) Minimum Load Resistance: 1000 ohms.
3. Display: Four-digit digital with minimum 0.4-inch-high numeric characters.
4. Operator Interface:
    a. Zero and span adjustments located behind cover.
5. Construction:
    a. Plastic casing with removable plastic cover.
    b. Fittings: Swivel fittings for connection to copper tubing or barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.
    c. Screw terminal block for wire connections.
    d. Vertical plane mounting.
    e. NEMA 250, Type 4.
    f. Mounting Bracket: Appropriate for installation.

D. Pressure Differential Indicating Transmitter, Switch, and Controller for Airflow Measurement:
1. Description:
    a. Three-in-one instrument, including digital display, control relay switches, and a transmitter with a current output.

b. Field configurable for pressure, velocity, and volumetric flow applications through user interface.
c. Select instrument range based on application.

2. Performance:
   a. Accuracy including hysteresis and repeatability:
      1) Ranges Less than 5-Inch wg: Within 1 percent.
      2) Other Ranges: Within 0.5 percent at 77 deg F.
   b. Stability: Within 1 percent per year.
   c. Response Time: 250 ms.
   d. Overpressure:
      1) Ranges Less than 50-Inch wg: 5 psi
      2) Range of 100-Inch wg: 9 psi.
   e. Temperature Limits: 32 to 140 deg F.
   f. Thermal Effects: 0.020 percent per deg F.
   g. Warm-up Period: One hour.
3. Controller: Programming through menu keys to access five menus.
   a. Security level.
   b. Pressure, velocity, or flow application.
   c. Engineering units.
   d. K-factor for use with flow application.
   e. Set-point control only; set-point and alarm operation; alarm operation as high, low, or high/low with manual; or automatic reset and delay.
   f. View high and low readings.
   g. Digital dampening for smoothing erratic applications.
   h. Scaling of analog output to fit range and field calibration.
4. Display:
   a. Four-digit digital, with minimum 0.4-inch-high alphanumeric characters.
   b. Four LED indicators; two LEDs for set point and two LEDs for alarm status.
5. Operator Interface:
   a. Set-point adjustment through keypad on face of instrument.
   b. Zero and span adjustments accessible through menu.
   c. Programming through keypad.
6. Output Analog Signal: Two-wire, 4- to 20-mA dc current source; capable of operating into a 900-ohm load.
7. Output Digital Signal: Two, SPDT relays; each rated for 1 A at 30-V ac or 30-V dc.
8. Construction:
   a. Die-cast aluminum casing and bezel.
   b. Connections on side and back.
   c. Vertical plane mounting.
   d. NEMA 250, Type 1 rating.
   e. Nominal 4-inch-diameter face.
   f. Mounting Bracket: Appropriate for installation.

2.6 LIQUID FLOW METERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Onicon, Inc.
   2. Flexim, Inc.

B. General Requirements for Liquid Flow Meters:
   1. Adjustable for changes in system operational parameters.

2. Liquid and Steam Sensors, Meters, and Transmitters: Extended range of 10 percent above Project design flow and 10 percent below Project minimum flow to signal abnormal flow conditions.
3. Manufacturer shall certify that each flow instrument indicated complies with specified performance requirements and characteristics.
4. Product certificates are required.

C. Insertion Turbine Flow Meter:
1. Description:
   a. Operating pressure of 300 psig with a temperature of 200 deg F.
   b. Meters in hot water systems shall be suitable for maximum system temperatures encountered, but not less than 250 deg F.
   c. Pressure drop not to exceed 1 psig at 20-fps flow velocity in a NPS 2 pipe and decreasing in large pipe with lower velocity.
   d. Sensor Accuracy:
      1) Within 1 percent of actual flow between the flow velocity range of 3 to 30 fps.
      2) Within 2 percent of actual flow between the flow velocity range of 0.4 to 20 fps.
      3) Within 0.5 percent of actual reading at the calibrated velocity.
   e. Wet calibrate and tag sensors to standards traceable to NIST, and provide each sensor with a certificate of calibration.
2. Sensor:
   a. For Pipe Sizes NPS 2 and Smaller: Single turbine sensors.
   b. For Pipe Sizes NPS 2-1/2 and Larger: Dual turbine sensors.
   c. Piping with Bi-directional Flow: Bi-directional dual turbine sensors.
   d. Dual turbine sensors shall have dual, contra-rotating turbine elements, each turbine element with its own rotational sensing system, and an averaging circuit.
   e. Rotational sensing of each turbine shall be accomplished electronically by sensing electronic impedance change (non-magnetic and non-photoelectric).
   f. Sensor shall have an integral frequency output linear with flow rate. For dual turbine units, with individual top and bottom turbine outputs for diagnostic purposes.
   g. Bi-directional sensors shall have isolated solid-state dry contacts with a contact rating of 100 mA at 50 V. The contacts shall close when the flow in direction of arrow is 0.18 fps or more.
   h. Flow sensor shall be complete with installation hardware necessary to enable insertion and removal from pipe without system shutdown.
   i. Construct turbine elements of polypropylene with sapphire jewel bearings and tungsten carbide shafts. Construct wetted metal components of Type 316 stainless steel, including installation hardware.
   j. House sensor electronics in a NEMA 250, Type 4 enclosure.
   k. Enclosure shall include connection(s) for field-installed conduit.
   l. Sensor shall have cable of length sufficient to connect to display module.
   m. Sensor housing shall have full port Type 316 stainless-steel ball valve for system isolation.
3. Display Module:
   a. Remote from sensor.
   b. House in a NEMA 250, Type 4X enclosure.
   c. Label terminal strip for all wiring connections.
   d. 120-V ac power supply with 24-V dc output to power the flow sensor.
   e. Remote Interface:

1) Hardwired Analog Outputs for Flow Rate and Totalization: 4 to 20 mA and zero- to 10-V dc.
2) Serial Communication Interface: Compatible with host to share flow rate and totalized flow data.
3) Outputs linear to within 0.1 percent of calibrated span.

f. Digital display for flow rate and totalized flow.
1) At least eight display digits for totalization.
2) Bi-directional units with separate digital display for flow and totalization in each direction.

g. Local reset of flow totalization.
h. Program and data shall be stored in nonvolatile memory in event of power loss.
i. For bi-directional units, with display of flow direction (contacts open or closed).

D. Inline Turbine Flow Meter:
1. Description:
a. Available in NPS 3/4 and NPS 1.
b. Operating pressure of 300 psig with a temperature of 200 deg F.
c. Meters in hot water systems shall be suitable for maximum system temperatures encountered, but not less than 250 deg F.
d. Pressure drop not to exceed 3 psig at 38 gpm.
e. Sensor Accuracy:
1) Within 2 percent of actual flow between the flow range of 0.8 to 38 gpm.
2) Within 0.5 percent of actual reading at the calibrated velocity.
f. Wet calibrate and tag sensors to standards traceable to NIST, and provide each sensor with a certificate of calibration.
2. Sensor:
a. Rotational sensing of turbine shall be accomplished electronically by sensing electronic impedance change (non-magnetic and non-photoelectric).
b. Sensor shall have an integral frequency output linear with flow rate.
c. Sensor shall have threaded union on each end.
d. Construct turbine elements of polypropylene with sapphire jewel bearings and tungsten carbide shafts.
e. Construct wetted metal components of brass or stainless steel.
f. House sensor electronics in a NEMA 250, Type 4 enclosure.
g. Enclosure shall include connection(s) for field-installed conduit.
h. Sensor shall have cable of length sufficient to connect to display module.
3. Display Module:
a. Remote from sensor.
b. Enclosure: NEMA 250, Type 4X.
c. Label terminal strip for all wiring connections.
d. 120-V ac power supply with 24-V dc output to power the flow sensor.
e. Remote Interface:
1) Hardwired Analog Outputs for Flow Rate and Totalization: 4 to 20 mA and zero- to 10-V dc.
2) Serial Communication Interface: Compatible with host to share flow rate and totalized flow data.
3) Outputs linear to within 0.1 percent of calibrated span.
f. Digital display of flow rate and totalized flow.
g. At least eight display digits for totalization.
h. Local reset of flow totalization.
i. Program and data shall be stored in nonvolatile memory in the event of power loss.

E. In-line Body Electromagnetic Flow Meter:

1. Description:
    a. No moving parts.
    b. Suitable for flow measurement of fluids with electrical conductivity more than 5 micro-Seimens per cm.
    c. Inherent bi-directional flow measurement.
    d. Flow measurement with three pipe diameters upstream and two pipe diameters downstream.
    e. Wet calibrate and tag meters to standards traceable to NIST, and provide each meter with a certificate of calibration.
    f. Transmitter integral to remote from meter.
2. Performance:
    a. Accuracy for Velocities between 3.3 and 33 fps: Within 0.2 percent of reading.
    b. Accuracy for Velocities between 1.0 and 3.3 fps: Within 0.75 percent of reading.
    c. Accuracy for Velocities Less than 1.0 fps: Within 0.0075 fps.
    d. Ambient Temperature: Minus 4 to plus 140 deg F.
    e. Process Temperature: Minus 4 to 212 deg F.
    f. Pressure: 225 psig.
3. Analog Output Current Signal:
    a. Two-wire, 4- to 20-mA dc current source.
    b. Signal capable of operating into 1000-ohm load.
    c. Isolated.
4. Digital Output Signal: Two, programmable, digital/pulse outputs configurable for frequency, pulse, or directional flow.
5. Operator Interface:
    a. Keypad.
    b. Digital Display: Multiple-line digital display of alphanumerical characters.
    c. LED for normal and alarm operation.
6. Construction:
    a. Body: Epoxy-coated carbon steel.
    b. Body Liner Material: PTFE.
    c. Flow Tube: Type 304 stainless steel.
    d. Connection: 150 Class flange.
    e. Electrodes: Type 316 stainless steel. Quantity determined by manufacturer based on application.
    f. Electronics Enclosure:
        1) Painted aluminum.
        2) Removable cover.
        3) NEMA 250, Type 6.

F. Insertion Electromagnetic Flow Meter:
1. Description:
    a. No moving parts.
    b. Suitable for flow measurement of fluids with electrical conductivity between 20 to 60000 micro-Seimens per centimeter.
    c. Suitable for pipe sizes NPS 3 through NPS 72.
    d. Wet calibrate and tag meters to standards traceable to NIST, and provide each meter with a certificate of calibration.
    e. Continuous auto-zero function.
    f. Transmitter integral to meter.
2. Performance:
    a. Flow Range: 0.25 to 20 fps.
    b. Accuracy for Velocities between 2 and 20 fps: Within 1 percent of reading.

c. Accuracy for Velocities Less than 2 fps: Within 0.02 fps.
d. Ambient Temperature: Minus 5 to 150 deg F.
e. Process Temperature: 15 to 250 deg F.
f. Pressure: 400 psig.

3. Output Signals:
   a. Field-selectable analog signals.
      1) Current Signal (Isolated): 4 to 20 mA.
      2) Voltage Signal (Isolated): Zero- to 10-V dc.
   b. Digital Signal: Dry-contact closure signaling fault condition.
   c. Frequency Signal: Zero- to 15-V peak pulse, zero to 500 Hz.
   d. Scalable Pulse Output:
      1) Isolated solid-state dry contact.
      2) Contact Rating: 100 mA at 50-V dc.
      3) Pulse Duration: 0.5, 1, 2, or 6 seconds.
4. Construction:
   a. Wetted Metal Parts: Type 316 stainless steel.
   b. Sensor Head: Polysulfone.
   c. Process Connection: 1-inch.
   d. Instrument Isolation Valve: Full port Type 316 stainless-steel ball valve for system isolation.
   e. Electrodes: Type 316 stainless steel.
   f. Electronics Enclosure:
      1) Painted aluminum.
      2) Removable cover.
      3) NEMA 250, Type 4.
      4) Electrical Connection: PVC-jacketed cable, 10 feet long.
      5) Conduit Connection:1/2-inchtrade size.
5. Display Module:
   a. Remote from meter.
   b. House in a NEMA 250, Type 4X enclosure.
   c. Label terminal strip for all wiring connections.
   d. 120-V ac power supply with 24-V dc output to power the flow sensor.
   e. Input Signal from Meter: Zero- to 15-V pulse output.
   f. Output Signals: Additional output signals furnished with flow meter connected to display module terminal strip.
   g. Auxiliary Output Signals: Analog current output (isolated) shall be 4 to 20 mA.
   h. Auxiliary Output Signals: Analog voltage output (isolated) shall be zero to 10 V.
   i. Auxiliary Output Signals: Digital output (isolated) shall be solid-state dry contacts rated for 100 mA at 50 V.
   j. Digital Display:
      1) Flow rate.
      2) Totalized flow.
      3) At least six display digits for flow rate and eight display digits for totalization.
      4) Bi-directional units with separate digital display for flow and totalization in each direction.
   k. Local reset of flow totalization.
   l. Program and data shall be stored in nonvolatile memory in the event of power loss.
   m. For bi-directional units, provide LED display of flow direction (contacts open or closed).

G. Vortex Shedding Flow Meter with Integral Temperature Measurement:

1. Description:
    a. Flow measurement using vortex shedder body with integral 1000-ohm platinum RTD.
    b. Meter NPS 3/8 through NPS 8.
    c. Each meter shall be factory calibrated at five points from zero to 250 fps and tagged accordingly against the manufacturer's flow standards. The manufacturer shall provide a certificate of calibration for meter.
    d. Each meter shall be programmed using project-specific application data.
    e. Meter shall include integral diagnostics to verify installation conditions and proper operation.
2. Performance:
    a. Volumetric Flow Accuracy: Within 1 percent of reading for meter NPS 1 and larger; within 2 percent of reading for smaller sizes.
    b. Mass Flow Accuracy: Within 1.5 percent of reading for NPS 1 and larger; within 2.5 percent of reading for smaller sizes.
    c. Ambient Temperature: Zero to 132 deg F.
    d. Process Temperature: 25 to 464 deg F.
    e. Pressure: Equal to flange rating.
3. Output Signals:
    a. Analog Current Signal of Flow Rate:
        1) Two-wire, 4- to 20-mA dc current source.
        2) Signal capable of operating into 1000-ohm load.
    b. Digital Signal: Pulse output for flow totalization. Two wire, scaled pulse, 0.5 Hz, 100 mA at 30-V dc.
4. Operator Interface:
    a. Keypad.
    b. Digital Display: Two-line digital display of alphanumerical characters. The meter shall display flow rate, flow totalization, and temperature and support field programming of all parameters.
5. Construction:
    a. Material: Type 316L stainless steel for sizes through NPS 4; Type 304 stainless steel for larger sizes.
    b. Connection: Class 300 flange.
    c. Vortex Shedder: Unalloyed titanium.
    d. Shedder Seal: Nickel-plated Inconel.
    e. Enclosure:
        1) Epoxy-painted cast aluminum.
        2) Removable screw-on cover.
        3) NEMA 250, Type 4X.
        4) Electrical Connection: Screw terminals.
        5) Conduit Connection: Two, 1/2-inchtrade size.
6. Remote Display Module:
    a. Remote from meter.
    b. House in a NEMA 250, Type 4 enclosure.
    c. Label terminal strip for all wiring connections.
    d. 120-V ac power supply with 24-V dc output to power the flow meter.
    e. Input Signal from Meter: Analog current, 4 to 20 mA.
    f. Output Signals:
        1) Analog Current Output: Two wire, 4 to 20 mA, maximum loop resistance 275 ohms.

2) Digital Output (Isolated): Solid-state dry contacts rated for 100 mA at 50-V dc.

g. Digital Display:
1) Flow rate.
2) Totalized flow.
3) Display Digits: 3.5 for flow rate and 8 for totalization.

h. Local reset of flow totalization.

i. Program and data shall be stored in nonvolatile memory in the event of power loss.

7. Upstream Flow Straightener:
a. Flow straightener where required by installation.
b. Straightener shall be wafer type, constructed of Type 304 stainless steel, designed to be installed between field-installed flanges.
c. Straightener size shall match meter size.

H. Vortex Shedding Flow Meter with Integral Pressure and Temperature Measurement:
1. Description:
a. Mass flow measurement corrected for density using vortex shedder body with integral piezoelectric pressure sensors and 1000-ohm platinum RTD.
b. Meter NPS 1/2 through NPS 12.
c. Each meter shall be factory calibrated at five points from Zero to 250 fps and tagged accordingly against the manufacturer's flow standards. The manufacturer shall provide a certificate of calibration for meter.
d. Each meter shall be programmed using project-specific application data.
e. Meter shall include integral diagnostics to verify installation conditions and proper operation.

2. Performance:
a. Volumetric Flow Accuracy for Liquid: Within 0.75 percent of reading for Reynolds numbers 20000 and larger.
b. Volumetric Flow Accuracy for Steam and Gas: Within 1 percent of reading for Reynolds numbers 20000 and larger.
c. Mass Flow Accuracy for Steam and Gas: Within 1.5 percent of reading for Reynolds numbers 20000 and larger.
d. Repeatability: Within 0.1 percent.
e. Long-Term Stability: Within 0.1 percent per year.
f. Ambient Temperature: Minus 40 to plus 185 deg F.
g. Process Temperature: Minus 40 to plus 464 deg F.
h. Pressure: Equal to flange rating.

3. Output Signals:
a. Analog Current Signal of Flow Rate:
1) Two-wire, 4- to 20-mA dc current source.
2) Signal capable of operating into 1000-ohm load.
b. Analog Current Signals for Pressure and Temperature: Separate 4- to 20-mA signals for gage pressure and temperature.
c. Digital Signal:
1) Pulse output for flow totalization. Two wire, scaled pulse, 0.5 Hz, 100 mA at 30-V dc.
2) HART, FSK protocol.

4. Operator Interface:
a. Keypad.
b. Digital Display: Two-line digital display of alphanumerical characters. The meter shall display flow rate, flow totalization, pressure, temperature, and support field programming of all parameters.

5. Construction:
    a. Material: Type 316L stainless steel.
    b. Connection: Class 150 flange.
    c. Enclosure:
        1) Epoxy-painted cast aluminum.
        2) Removable screw-on cover.
        3) NEMA 250, Type 6.
        4) Electrical Connection: Screw terminals.
        5) Conduit Connection: Two, 1/2-inchtrade size.
6. Upstream Flow Straightener:
    a. Meter manufacturer shall provide flow straightener where required by installation to comply with manufacturer's installation recommendations.
    b. Straightener shall be wafer type, constructed of Type 304 stainless steel, designed to be installed between field-installed flanges.
    c. Straightener size shall match meter size.

I. Vortex Shedding Flow Meter for Hazardous Environments:
1. Standard: ASME MFC-6M.
2. Description:
    a. FM Approved for hazardous environments.
        1) Intrinsically safe for Class I, Division 1, Groups A, B, C, and D; Class II and III, Division 1, Groups E, F, and G.
        2) Explosion-Proof for Class I, Division 1, Groups B, C, and D.
        3) Dust-Ignition-Proof for Class II and III, Division 1, Groups E, F, and G.
    b. Sensor shall be isolated from process and replaceable without breaking process seals.
    c. Meter immune to vibration.
    d. Clog-free design eliminates gaskets and ports.
    e. Meter NPS 1/2 through NPS 12.
    f. Each meter shall be factory calibrated and provided with a certificate of calibration.
    g. Meter shall be furnished with a permanently attached stainless-steel tag.
    h. Meter shall include integral diagnostics to verify proper operation.
3. Performance:
    a. Flow Accuracy: Within 0.65 percent of reading plus 0.025 percent of span for Reynolds numbers 20000 and larger.
    b. Repeatability: Within 0.1 percent of flow rate.
    c. Long-Term Stability: Within 0.1 percent of flow rate per year.
    d. Response Time: Greater of three vortex shedding cycles or 0.2 seconds.
    e. Dampening: Adjustable between 0.2 to 255 seconds.
    f. Ambient Temperature: Minus 58 to plus 250 deg F.
    g. Humidity: Zero to 95 percent noncondensing.
    h. Process Temperature: Minus 40 to plus 450 deg F.
    i. Pressure: Equal to flange rating.
4. Output Signals:
    a. Analog Current Signal of Flow Rate:
        1) Two-wire, 4- to 20-mA dc current source.
        2) Signal capable of operating into 1000-ohm load.
    b. Digital Signal:
        1) Pulse output for flow totalization.
        2) HART protocol.

5. Digital Display: Digital display of alphanumerical characters. The meter shall display flow rate, flow totalization, percent of range, and current output.
6. Body and Flanges:
    a. Material: Type 316L stainless steel.
    b. Connection: ASME B16.5, Class 150 flange.
    c. Enclosure:
        1) Polyurethane-painted cast aluminum.
        2) Removable screw-on cover.
        3) NEMA 250, Type 4X.
        4) Electrical Connection: Screw terminals.
        5) Conduit Connection: 1/2-inchtrade size.

2.7 LIQUID FLOW SENSORS (PRIMARY ELEMENTS)

A. Averaging Pitot Tubes:
1. Standards: ASME MFC-12M.
2. Description:
    a. Sensor shall include isolation valves and connections that are suitable for connecting to a remote pressure instrument.
    b. Sensor shall consist of high- and low-pressure plenums and be able to accommodate an integral RTD.
    c. Sensor's cross-sectional tee shape shall allow flow separation at a fixed point independent of flow rate, pressure, or temperature with a stable flow coefficient maintained over a wide range of Reynolds numbers.
    d. Sensor shape shall promote less-turbulent zones on the backside of the sensor. Individual sensing ports shall be located in this less-turbulent region to measure low pressure. Number of sensing ports shall be a function of the pipe size.
    e. High pressure shall be measured by a frontal slot design extending full length of sensor. Number of slots shall be a function of pipe size.
    f. Manufacturer shall submit on request independent testing documentation (product test reports), demonstrating compliance with specified performance.
3. Performance:
    a. Discharge Coefficient Factor: Within 0.75 percent of flow rate.
    b. Repeatability: Within 0.1 percent.
    c. Flow Turndown: 10:1.
    d. Sensor Size for Pipe Size NPS 2 through NPS 8: Minimum rod Reynolds number of 6000; probe width of 0.59 inch.
    e. Sensor Size for Pipe Size NPS 6 through NPS 36: Minimum rod Reynolds number of 12500; probe width of 1.060 inch.
    f. Sensor Size for Pipe Size NPS 12 through NPS 72: Minimum rod Reynolds number of 25000; probe width of 1.953 inches.
    g. Process Temperature Limit: 500 deg F.
    h. Process Pressure Limit: Equal to flange rating.
4. Construction:
    a. Sensor Surface Finish: Front surface textured for high-Reynolds-number applications to create a more turbulent boundary layer on front surface of sensor and produce a more predictable and repeatable separation of flow at edge of sensor.
    b. Sensor Material: Type 316 stainless steel.
    c. Packing Gland:
        1) Wetted Parts: Type 316 stainless steel.
        2) Packing Material: Graphite.

d. Isolation Valve: Type 316 stainless-steel full port ball valve configured to remove sensor while isolating process.
e. Flanged In-line Pipe Spool:
1) Mount sensor in a flanged section of pipe.
2) Pipe material to match adjacent pipe.
3) Flanges to match adjacent pipe.

B. Venturis:
1. On request, submit independent testing documentation (product test reports), demonstrating compliance with specified performance.
2. Standard: ASME MFC-3M.
3. Performance:
a. Accuracy within 0.5 percent of measured flow throughout flow range from design to 10 percent of design flow.
b. Accuracy with five pipe diameters of straight pipe upstream and two pipe diameters downstream.
c. Size and beta ratio shall be matched with transmitter to provide accuracy of entire assembly within 1 percent of design flow rate, when the flow rate is allowed to vary between 10 to 100 percent of the design.
4. Construction:
a. One-piece bronze or brass construction with threaded connections for pipe sizes NPS 1/2 through NPS 2.
b. One-piece plated cast steel with flanged connections for pipe sizes NPS 2-1/2 through NPS 8, and fabricated steel with flanged connections for larger sizes.
c. Sensing Taps: Two, accurately located built-in sensing taps, nipples, shut-off valves, and quick connect coupling.
d. Identification Tag: Attached to each venturi with a chain and label indicating pipe size, venturi series, station identification, and meter reading at flow rate and pressure differential.
e. Use venturi with pressure differential transmitter.

C. Portable Meter Package for Liquid Flow Sensors:
1. Metal-reinforced-plastic carrying case.
2. Waterproof meter with nominal 6-inch round dial face.
3. Meter with dual rupture-proof liquid-filled bellows having integral temperature compensation.
4. Meter with external range and zero adjustment.
5. Multiple meters in package, if required to accommodate venturis with a wide range of pressure signals.
6. Two connecting hoses, 10-feet long, with quick connect couplings compatible with venturi couplings.
7. Two brass blowdown valves with Buna-N seals and blowdown hoses.
8. Instruction book with flow versus differential curves.
9. Suitable for working pressure of 200 psig at 200 deg F.
10. Portable meter package to connect to flow sensor without disturbing connection to pressure differential transmitter. Provide isolation valves at connections.
11. Turn over to Owner at Project completion.

2.8 LIQUID FLOW SWITCHES

A. Liquid Flow Switch (Bellows Type):
1. Description:
a. Field-adjustable four-vane combinations.
b. Field-adjustable set-point adjustment screw.
c. Suitable for pipe sizes NPS 1 through NPS 8.

d. Switch mounted vertically in horizontal pipe.

2. Performance:
   a. Flow Rate Actuation and De-actuation: Varies with vane combination and set-point adjustment.
   b. Pressure Limit: 145 psig.
   c. Temperature Limit: 230 deg F.
   d. Electrical Rating: 10 A resistive, 3 A conductive at 250-V ac.
   e. Switch Type: SPDT snap switch.
3. Wetted Parts Construction:
   a. Bellows: Tin-bronze.
   b. Vanes: Stainless steel.
   c. Body: Forged brass.
   d. Process Connection: NPS 1.
4. Enclosure:
   a. Die-cast aluminum alloy.
   b. NEMA 250, Type 4.
   c. Electrical Connection: Cable gland with attached wire leads.

B. Liquid Flow Switch (Magnetic Type):
1. Description:
   a. Field-adjustable five-vane combinations.
   b. Suitable for pipe sizes NPS 1-1/2 through NPS 20.
   c. Mounting Suitable for Application: Switch vertically mounted in horizontal pipe, or switch horizontally mounted in vertical pipe with flow up.
   d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous-environment Class I, Groups C and D; Class II, Groups E, F, and G.
2. Performance:
   a. Flow Rate Actuation and De-actuation: Varies with vane combination.
   b. Pressure Limit: 1000 psig for brass body, 2000 psig for Type 316 stainless-steel body.
   c. Temperature Range: Minus 4 to plus 275 deg F.
   d. Electrical Rating: 10 A at 125/250-V ac.
   e. Switch Type: SPDT snap switch.
3. Wetted Parts Construction:
   a. Vanes: Type 316 stainless steel.
   b. Body: Type 316 stainless steel.
   c. Magnetic Keeper: Type 316 stainless steel.
   d. Process Connection: NPS 1-1/2.
4. Enclosure:
   a. Die-cast aluminum alloy.
   b. Threaded cover.
   c. NEMA 250, Type 4.
   d. Electrical Connection: Terminal block.
   e. Conduit Connection: 3/4-inch trade size.

2.9 LIQUID FLOW TRANSMITTERS

A. Liquid Pressure Differential Transmitter for Flow Measurement:
1. Performance:
   a. Range: Approximately 2 times the set point.
   b. Span: Adjustable plus or minus 1 mA, non-interactive.
   c. Accuracy: Within 0.25 percent of full scale.
   d. Maximum Operating Pressure: 2.5 times range.

e. Temperature Limits: Zero to 175 deg F.
f. Compensate Temperature Limits: 30 to 150 deg F.
g. Thermal Effects: 0.02 percent of full scale per degree F.
h. Response Time: 30 to 50 ms.
i. Shock and vibration shall not harm the transmitter.

2. Analog Output Current Signal:
   a. Two wire, 4- to 20-mA dc current source.
   b. Signal capable of operating into 1000-ohm load.
3. Operator Interface:
   a. Zero and span adjustments located behind cover.
   b. Bleed screws on side of body, two screws on low-pressure side and one screw on high-pressure side, for air in line and pressure cavity.
4. Construction:
   a. Aluminum and stainless-steel enclosure with removable cover.
   b. Wetted parts of transmitter constructed of 17-4 PH or 300 series stainless steel.
   c. NPS 1/4 process connections on side of instrument enclosure.
   d. Knock out for 1/2-inch trade size conduit connection on side of instrument enclosure.
   e. Screw terminal block for wire connections.
   f. NEMA 250, Type 4X.
   g. Mounting bracket shall be suitable for installation.
5. Transmitter shall have three-valve manifold. Construct manifold of brass, bronze, or stainless steel. Manifold shall have NPS 1/4 process connections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
D. Provide the services of an independent inspection agency to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
   1. Indicate dimensioned locations with mounting height for all surface-mounted products to walls and ceilings on shop drawings.
   2. Do not begin installation without submittal approval of mounting location.
E. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.
F. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTRUMENT APPLICATIONS

A. Select from instrument types to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
B. Duct-Mounted Airflow Sensors:
   1. Measured Velocities 500 fpm and Less: Thermal airflow station.
   2. Measured Velocities Greater than 500 fpm: Pitot-tube airflow sensor station or Thermal airflow station.
C. Damper-Mounted Airflow Sensors:
   1. Measured Velocities 400 fpm and Less: Thermal airflow station.
   2. Measured Velocities Greater than 500 fpm: Pitot-tube airflow sensor station or Thermal airflow station.

D. Fan-Mounted Airflow Sensors:
   1. Measured Velocities 500 fpm and Less: Thermal airflow station.
   2. Measured Velocities Greater than 500 fpm: Pitot-tube fan inlet airflow sensor station, Piezometer ring fan inlet airflow sensor or Thermal airflow station.

E. Airflow Switches:
   1. Measured Velocities 400 fpm and Less: Polymer film sail switch.
   2. Measured Velocities Greater than 400 fpm: Stainless-steel single-vane switch.

F. Airflow Transmitters for Use with Pitot-Tube-Type Sensors:
   1. Exhaust Air Airflow: Pressure differential transmitter for airflow measurement.
   2. Outdoor Air Airflow: Pressure differential transmitter for airflow measurement.
   3. Return Air Airflow: Pressure differential transmitter for airflow measurement.
   4. Supply Air Airflow: Pressure differential transmitter for airflow measurement.

G. Liquid Flow Sensors (Primary Elements):
   1. Hydronic System, Chilled and Heating Hot Water: Averaging pitot tubes or Venturis.

H. Liquid Flow Meters:
   1. Hydronic System, Chilled and Heating Hot Water: Insertion turbine flow meter or Electromagnetic flow meter.

I. Liquid Flow Switches:
   1. Hydronic System, Chilled and Heating Hot Water: Bellows type or Magnetic type.

J. Liquid Flow Transmitters:
   1. Hydronic System, Chilled and Heating Hot Water: Liquid pressure differential transmitter.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a 50 lb force.

D. Install ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.5 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:
   1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
   2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.

3. Install liquid and steam flow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
6. Install instruments in steam, liquid, and liquid-sealed-piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
7. Install instruments in dry gas and non-condensable-vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

B. Mounting Height:
1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
   a. Make every effort to mount at 60 inches.

C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

3.6 FLOW INSTRUMENTS INSTALLATION

A. Airflow Sensors:
1. Install sensors in straight sections of duct with manufacturer-recommended straight duct upstream and downstream of sensor.
2. Installed sensors shall be accessible for visual inspection and service. Install access door(s) in duct or equipment located upstream of sensor, to allow service personnel to hand clean sensors.

B. Liquid Sensors:
1. Install sensors in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
2. Alert manufacturer where installation cannot accommodate recommended clearance, and solicit recommendations for field modifications to installation, such as flow straighteners, to improve condition.
3. Install pipe reducers for in-line sensors smaller than line size. Position reducers at distance from sensor to avoid interference and impact on accuracy.
4. Install in-line sensors with flanges or unions to provide drop-in and -out installation.

C. Liquid Flow Meters:
1. Install meters in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
2. Install pipe reducers for in-line meters smaller than line size. Install reducers at distance from meter to avoid interference and impact on accuracy.
3. Install in-line meters with flanges or unions to provide drop-in and -out installation.
4. Insertion Meters:
   a. Install system process connections full size of meter connection, but not less than NPS 1. Provide stainless-steel bushing if required to mate to system connection.
   b. Install meter in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.

c. In applications where top-dead-center location is not possible due to field constraints, install meter at location along top half of pipe if acceptable by manufacturer for mounting orientation.

D. Liquid Switches:
1. Install system process connection full size of switch connection, but not less than NPS 1. Install stainless-steel bushing if required to mate switch to system connection.
2. Install switch in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
3. In applications where top-dead-center location is not possible due to field constraints, install switch at location along top half of pipe if switch is acceptable by manufacturer for mounting orientation.

E. Transmitters:
1. Install airflow transmitters serving an air system in a single location adjacent to or within system control panel.
2. Install liquid flow transmitters, not integral to sensors, in vicinity of sensor. Where multiple flow transmitters serving same system are located in same room, co-locate transmitters by system to provide service personnel a single and convenient location for inspection and service.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification.

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.9 CHECKOUT PROCEDURES

A. Description:
1. Check out installed products before continuity tests, leak tests, and calibration.
2. Check instruments for proper location and accessibility.
3. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

B. Flow Instrument Checkout:
1. Verify that sensors are installed correctly with respect to flow direction.
2. Verify that sensor attachment is properly secured and sealed.
3. Verify that processing tubing attachment is secure and isolation valves have been provided.
4. Inspect instrument tag against approved submittal.
5. Verify that recommended upstream and downstream distances have been maintained.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:
1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after-calibration-indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:
1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

C. Digital Signals:
1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:
1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record videos on DVD disks.

D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

SECTION 23 0923.23
PRESSURE INSTRUMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Air-pressure sensors.
   2. Air-pressure switches.
   3. Air-pressure transmitters.
   4. Liquid-pressure switches.
   5. Liquid-pressure transmitters.

B. Related Requirements:
   1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
   2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.23.

1.03 DEFINITIONS

A. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a control, asset management, safety, or other system using any control platform.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
   3. Product description with complete technical data, performance curves, and product specification sheets.
   4. Installation instructions, including factors affecting performance.

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
    a. If instrument alone cannot comply with requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated and cooled, filtered, and ventilated as required by instrument and application.
2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument-installed location shall dictate following NEMA 250 enclosure requirements:
    a. Outdoors, Protected: Type 12.
    b. Outdoors, Unprotected: Type 4.
    c. Indoors, Heated with Filtered Ventilation: Type 2.
    d. Indoors, Heated with Nonfiltered Ventilation: Type 12.
    e. Indoors, Heated and Air-Conditioned: Type 1.
    f. Mechanical Equipment Rooms:
        1) Chiller and Boiler Rooms: Type 4.
        2) Air-Moving Equipment Rooms: Type 12.
    g. Localized Areas Exposed to Washdown: Type 4.
    h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 12.
    i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.

2.02 AIR-PRESSURE SENSORS

A. Duct Insertion Static Pressure Sensor:
1. Insertion length shall be at 8 inches.
2. Sensor with four radial holes of 0.04-inch diameter.
3. stainless-steel construction.
4. Sensor with threaded end support, sealing washers and nuts.
5. Connection: NPS 1/4 compression fitting.
6. Suitable for flat oval, rectangular, and round duct configurations.

B. Duct Insertion Static Pressure Sensor:
1. Sensor probe with two opposing orifices designed to reduce error-associated air velocity.
2. Sensor insertion length shall be 8 inches.
3. Construct sensor of 6061-T6 aluminum alloy or Type 304 stainless steel.
4. Connection: Threaded, NPS 1/8 swivel fitting for connection to copper tubing or NPS 1/4 barbed fitting for connection to polyethylene tubing.
5. Sensor probe attached to a mounting flange with neoprene gasket and two holes for fasteners.
6. Mounting flange shall suitable for flat oval, rectangular, and round duct configurations.
7. Pressure Rating: 10 psig.

C. Duct Traverse Static Pressure Sensor:
1. Sensor shall traverse the duct cross section and have at least one pickup point every 6 inches along length of sensor.
2. Construct sensor of 18-gage Type T6063-T5 extruded and anodized aluminum.
3. Sensor supported with threaded rod, sealing washer, and nut at one end and a mounting plate with gasket at other end.
4. Mounting plate with threaded, NPS 3/8 compression fitting for connection to tubing.
5. Accuracy within 1 percent of actual operating static pressure.

6. Dual offset static sensor design shall provide accurate sensing of duct static pressure in the presence of turbulent and rotational airflows with a maximum 30 degree yaw and pitch.
7. Suitable for velocities of 100 to 10000 fpm and temperatures of up to 200 deg F.
8. Sensor air resistance shall be less than 0.1 times the velocity pressure at probe-operating velocity.
9. Suitable for flat oval, rectangular, and round duct configurations.

D. Outdoor Static Pressure Sensor:
1. Provides average outdoor pressure signal.
2. Sensor with no moving parts.
3. NEMA 250, Type 4X enclosure.
4. Pressure Connection: Brass barbed fitting for NPS 1/4tubing.
5. Conduit fitting around pressure fitting for sensor support and protection to pressure connection.

E. Space Static Pressure Sensor for Wall Mounting:
1. White ABS plastic wall plate with integral sensing port to sense static pressure.
2. Wall plate provided with matching colored screws and sized to fit standard single-gang electrical box.
3. Back of sensor plate fitted with brass union fitting for tubing connection.
4. Pressure rating: 10 psig.

F. Space Static Pressure Sensor for Recessed Ceiling Mounting:
1. Stainless-steel round plate with perforated center arranged to sense space static pressure. Exposed surfaces provided with brush finish.
2. Sensor intended for flush mount on face of ceiling with pressure chamber recessed in ceiling plenum.
3. Back of sensor plate fitted with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 0.125-inch fitting for concealed tubing connection.
4. Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm from a 360-degree radial source.

G. Space Static Pressure Sensor for Exposed or Suspended Mounting:
1. Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm from a 360-degree radial source.
2. Stainless steel with perforations arranged to sense space static pressure. Exposed surfaces provided with brush finish.
3. Sensor fitted with multiple sensing ports, pressure impulse suppression chamber, and airflow shielding.
4. Surface-mounted sensor provided with solid mounting plate intended for mount to ceiling with pressure chamber exposed to view.
5. Surface-mounted sensor with 0.125-inch fitting for exposed tubing connection.
6. Suspended sensor intended for pendent mount with pressure chamber exposed to view.
7. Suspended sensor with NPS 1/2 fitting for exposed pipe or tubing connection.

2.03 AIR-PRESSURE SWITCHES

A. Air-Pressure Differential Switch:
1. Diaphragm operated to actuate an SPDT snap switch.
   a. Fan safety shutdown applications: Switch with manual reset.
2. Electrical Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
3. Enclosure Conduit Connection: Knock out or threaded connection.
4. User Interface: Screw-type set-point adjustment located inside removable enclosure cover.
5. High and Low Process Connections: Threaded, NPS 1/8.

6. Enclosure:
    a. Dry Indoor Installations: NEMA 250, Type 1.
    b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
    c. Hazardous Environments: Explosion proof.
7. Operating Data:
    a. Electrical Rating: 15 A at 120- to 480-V ac.
    b. Pressure Limits:
        1) Continuous: 45 inches wg.
        2) Surge: 10 psig.
    c. Temperature Limits: Minus 30 to 180 deg F.
    d. Operating Range: Approximately 2 times set point.
    e. Repeatability: Within 3 percent.
    f. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.04 AIR-PRESSURE TRANSMITTERS

A. Air-Pressure Differential Transmitter:
1. Performance:
    a. Range: Approximately 2 times set point.
    b. Accuracy: Within 0.5 percent of the full-scale range.
    c. Hysteresis: Within 0.10 percent of full scale.
    d. Repeatability: Within 0.05 percent of full scale.
    e. Stability: Within 1 percent of span per year.
    f. Overpressure: 10 psig.
    g. Temperature Limits: Zero to 150 deg F.
    h. Compensate Temperature Limits: 40 to 150 deg F.
    i. Thermal Effects: 0.033 percent of full scale per degree F.
    j. Shock and vibration shall not harm the transmitter.
2. Output Signals:
    a. Analog Current Signal:
        1) Two-wire, 4- to 20-mA dc current source.
        2) Signal capable of operating into 800-ohm load.
    b. Analog Voltage Signal:
        1) Three wire, zero to 10 V.
        2) Minimum Load Resistance: 1000 ohms.
3. Display: Four-digit digital display with minimum 0.4-inch-high numeric characters.
4. Operator Interface: Zero and span adjustments located behind cover.
5. Construction:
    a. Plastic casing with removable plastic cover.
    b. Threaded, NPS 1/4 swivel fittings for connection to copper tubing or NPS 3/16 barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.
    c. Screw terminal block for wire connections.
    d. Vertical plane mounting.
    e. NEMA 250, Type 4.
    f. Provide mounting bracket suitable for installation.

2.05 LIQUID-PRESSURE SWITCHES

A. Liquid Gage Pressure Switch-Diaphragm Operated:
1. Diaphragm operated to actuate a SPDT or DPDT snap switch.
2. Electrical Connections: Screw terminal.
3. Enclosure Conduit Connection: Knock out or threaded connection.

4. User Interface: Internal hex nut set-point adjustment with enclosed set-point indicator and scale.
    a. Process Connection: Threaded, NPS 1/4 or NPS 1/2.
5. Enclosure:
    a. Dry Indoor Installations: NEMA 250, Type 1, 12.
    b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4X with drain.
    c. Hazardous Environments: Explosion proof.
6. Operating Data:
    a. Electrical Rating: 15 A at 120-, 240-, and 480-V ac.
    b. Pressure Limits: 1200 psig.
    c. Ambient Temperature Limits: Minus 30 to 180 deg F.
    d. Process Temperature Limits: Minus 4 to 167 deg F.
    e. Adjustable Operating Range: 10 to 150 psig.
    f. Deadband: Adjustable.
7. Pressure Chamber Material: Aluminum or brass or stainless steel.
8. Diaphragm Material: Buna-N or fluorocarbon.

B. Liquid-Pressure Differential Switch:
1. Description:
    a. Type 316 stainless-steel double opposing bellows operate to actuate an SPDT snap switch.
    b. Wetted materials: Type 316 stainless steel.
    c. Seal: Buna-N or Viton.
    d. Electrical Connections: Screw terminal.
    e. Enclosure Conduit Connection: Knock out or threaded connection.
    f. User Interface: Thumbscrew set-point adjustment with enclosed set-point indicator and scale.
    g. High and Low Process Connections: Threaded, NPS 1/4.
    h. Enclosure: NEMA 250, Type 4 or 4X.
    i. Operating Data:
        1) Electrical Rating: 10 A at 120- to 240-V ac.
        2) Pressure Limits: Zero to 500 psig
        3) Ambient Temperature Limits: Minus 20 to 150 deg F.
        4) Process Temperature Limits: 20 to 300 deg F.
        5) Operating Range: 2 times set point, unless otherwise required by application.
        6) Deadband: Adjustable or fixed as required by application.
    j. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.06 LIQUID-PRESSURE TRANSMITTERS

A. Liquid-Pressure Differential Transmitter:
1. Performance:
    a. Range: Approximately 2 times the set point.
    b. Span: Adjustable plus or minus one milliamp, noninteractive.
    c. Accuracy: Within 0.25 percent of full scale.
    d. Hysteresis: Within 0.1 percent of full scale.
    e. Repeatability: Within 0.05 percent of full scale.
    f. Maximum Working Pressure: 250 psig.
    g. Temperature Limits: Zero to 175 deg F.
    h. Compensate Temperature Limits: 30 to 150 deg F.
    i. Thermal Effects: 0.02 percent of full scale per degree F.
    j. Response Time: 30 to 50 ms.

k. Shock and vibration shall not harm the transmitter.

2. Analog Output Current Signal:
   a. Two-wire, 4- to 20-mA dc current source.
   b. Signal capable of operating into 1000-ohm load.
3. Analog Output Voltage Signal:
   a. Three wire, zero to 10 V.
   b. Minimum Load Resistance: 1000 ohms.
4. Operator Interface:
   a. Zero and span adjustments located behind cover.
   b. Bleed screws on side of body, two screws on low-pressure side, and one screw on high-pressure side, for air in line and pressure cavity.
5. Construction:
   a. Aluminum and stainless-steel enclosure with removable cover.
   b. Wetted parts of transmitter constructed of 17-4 PH or 300 Series stainless steel.
   c. Threaded, NPS 1/4 process connections on side of instrument enclosure.
   d. Knock out for 1/2-inch nominal conduit connection on side of instrument enclosure.
   e. Screw terminal block for wire connections.
   f. NEMA 250, Type 4.
   g. Mounting Bracket: Appropriate for installation.
6. Provide transmitter with three-valve manifold. Construct manifold of brass, bronze, or stainless steel. Provide manifold with NPS 1/4 NPT process connections.

2.07 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled pressure instruments, as indicated by instrument requirements. Affix standards organization's certification and label.

B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PRESSURE INSTRUMENT APPLICATIONS

A. Duct-Mounted Static Pressure Sensors:
   1. Air-Handling System, Supply, Return, Exhaust and/or Outside Air: Duct insertion static pressure sensor Duct traverse static pressure sensor.

B. Space Static Pressure Sensors:
   1. Air-Handling System, Supply, Return, Exhaust and/or Outside Air: Space static pressure sensor for wall mounting Space static pressure sensor for recessed ceiling mounting Space static pressure sensor for exposed or suspended mounting.

C. Air-Pressure Differential Switches:
   1. Air-Handling System, Supply, Return, Exhaust and/or Outside Air: Air-pressure differential switch with dual scale adjustable set point.

D. Air-Pressure Differential Transmitters:
   1. Air-Handling System, Supply, Return, Exhaust and/or Outside Air: Air-pressure differential transmitter.

E. Liquid Gage Pressure Switches:

1. Hydronic System, Chilled and Heating Hot Water: Liquid gage pressure switch, diaphragm operated, low pressure Liquid gage pressure switch, diaphragm operated.

F. Liquid-Pressure Differential Switches:
   1. Hydronic System, Chilled and Heating Hot Water: Liquid-pressure differential switch.

G. Liquid-Pressure Differential Transmitters:
   1. Hydronic System, Chilled and Heating Hot Water: Liquid-pressure differential transmitter with field-selectable range.

3.03 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to a 50lb force.

C. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

D. Fastening Hardware:
   1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
   2. Tighten bolts and nuts firmly and uniformly. Do not to overstress threads by using excessive force or oversized wrenches.
   3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

F. Corrosive Environments:
   1. Use products that are suitable for environment to which they are subjected.
   2. If possible, avoid or limit use of materials in corrosive environments.
   3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
   4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.04 ELECTRICAL POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.05 PRESSURE INSTRUMENT INSTALLATION

A. Mounting Location:
   1. Rough-in: Outline instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.
   2. Install switches and transmitters for air and liquid pressure associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.

3. Install liquid and steam pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install air-pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
6. Install instruments (except pressure gages) in steam, liquid, and liquid-sealed piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
7. Install instruments in dry gas and non-condensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

C. Duct Pressure Sensors:
1. Install sensors using manufacturer's recommended upstream and downstream distances.
2. Unless indicated on Drawings, locate sensors approximately 50 percent of distance of longest hydraulic run. Location of sensors shall be submitted and approved before installation.
3. Install mounting hardware and gaskets to make sensor installation airtight.
4. Route tubing from the sensor to transmitter.
5. Use compression fittings at terminations.
6. Install sensor in accordance with manufacturer's instructions.
7. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.

D. Outdoor Pressure Sensors:
1. Install roof-mounted sensor in least-noticeable location and as far away from exterior walls as possible.
2. Locate wall-mounted sensor in an inconspicuous location.
3. Submit sensor location for approval before installation.
4. Verify signal from sensor is stable and consistent to all connected transmitters. Modify installation to achieve proper signal.
5. Route outdoor signal pipe full size of sensor connection to transmitters. Install branch connection of size required to match to transmitter.
6. Install sensor signal pipe with dirt leg and drain valve below roof penetration.
7. Insulate signal pipe with flexible elastomeric insulation as required to prevent condensation.
8. Connect roof-mounted signal pipe exposed to outdoors to building grounding system.

E. Air-Pressure Differential Switches:
1. Install air-pressure sensor in system for each switch connection. Install sensor in an accessible location for inspection and replacement.
2. A single sensor may be used to share a common signal to multiple pressure instruments.
3. Install access door in duct and equipment to access sensors that cannot be inspected and replaced from outside.
4. Route NPS 3/8 tubing from sensor to switch connection.
5. Do not mount switches on rotating equipment.

6. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
7. Install switches in an easily accessible location serviceable from floor.
8. Install switches adjacent to system control panel if within 50 feet; otherwise, locate switch in vicinity of system connection.

F. Liquid-Pressure Differential Switches:
1. Where process connections are located in mechanical equipment room, install switch in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate switch near system control panel.
3. Where multiple switches serving same system are installed in same room, install switches by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection shall be full size of switch connection, but not less than NPS 3/4. Install stainless-steel bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to switch.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each switch connection.
8. Do not mount switches on rotating equipment.
9. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
10. Install switches in an easily accessible location serviceable from floor.

G. Liquid-Pressure Transmitters:
1. Where process connections are installed in mechanical equipment room, install transmitter in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate transmitter near system control panel.
3. Where multiple transmitters serving same system are installed in same room, install transmitters by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection shall be full size of switch connection, but not less than NPS 3/4. Install stainless-steel bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to transmitter.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each transmitter connection.
8. Do not mount transmitters on equipment.
9. Install in a location free from vibration, heat, moisture, or adverse effects, which could damage and hinder accurate operation.

3.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification.

3.07 CHECKOUT PROCEDURES

A. Check out installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.

3.08 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:
   1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
   2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
   3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
   4. Equipment and procedures used for calibration shall comply with instrument manufacturer's recommendations.
   5. Provide diagnostic and test equipment for calibration and adjustment.
   6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
   7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
   8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
   9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:
   1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
   2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.

C. Digital Signals:
   1. Check digital signals using a jumper wire.
   2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:
   1. Check and calibrate transmitters at zero, 50, and 100 percent of project design values.

3.09 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate pressure instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record videos on DVD disks.

D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

SECTION 23 0923.27
TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Air temperature sensors.
   2. Combination air temperature sensors and switches.
   3. Air temperature switches.
   4. Air temperature RTD transmitters.
   5. Liquid temperature sensors.
   6. High-end, commercial-grade, liquid temperature sensors.
   7. Liquid temperature switches.

B. Related Requirements:
   1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
   2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.27.

1.03 DEFINITIONS

A. HART (Highway Addressable Remote Transducer) Protocol: The global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bidirectional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from a technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.

B. RTD: Resistance temperature detector.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
   3. Product description with complete technical data, performance curves, and product specification sheets.
   4. Installation operation and maintenance instructions, including factors affecting performance.

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

C. Samples: For each exposed product installed in finished space.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
    a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated and cooled, filtered, and ventilated as required by instrument and application.
2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument's installed location shall dictate following NEMA 250 enclosure requirements:
    a. Outdoors, Protected: Type 1.
    b. Outdoors, Unprotected: Type 4.
    c. Indoors, Heated with Filtered Ventilation: Type 2.
    d. Indoors, Heated with Non-Filtered Ventilation: Type 1.
    e. Indoors, Heated and Air Conditioned: Type 1.
    f. Mechanical Equipment Rooms:
        1) Chiller and Boiler Rooms: Type 4.
        2) Air-Moving Equipment Rooms: Type 1.
    g. Localized Areas Exposed to Washdown: Type 4.
    h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 1.
    i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.

2.02 AIR TEMPERATURE SENSORS

A. Platinum RTDs: Common Requirements:

1. 100 or 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
3. Performance Characteristics:
    a. Range: Minus 50 to 275 deg F.
    b. Interchangeable Accuracy: At 32 deg F within 0.5 deg F.
    c. Repeatability: Within 0.5 deg F.
    d. Self-Heating: Negligible.
4. Transmitter Requirements:
    a. Transmitter required for each 100-ohm RTD.
    b. Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.

B. Platinum RTD, Single-Point Air Temperature Duct Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 275 deg F
3. Probe: Single-point sensor with a stainless-steel sheath.
4. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches.
5. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
6. Gasket for attachment to duct or equipment to seal penetration airtight.

7. Conduit Connection: 1/2-inch

C. Platinum RTD, Air Temperature Averaging Sensors:
   1. 100 or 1000 ohms.
   2. Temperature Range: Minus 50 to 275 deg F
   3. Multiple sensors to provide average temperature across entire length of sensor.
   4. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
   5. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch radius.
   6. Length: As required by application to cover entire cross section of air tunnel.
   7. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
   8. Gasket for attachment to duct or equipment to seal penetration airtight.
   9. Conduit Connection: 1/2-inch

D. Platinum RTD Outdoor Air Temperature Sensors:
   1. 100 or 1000 ohms.
   2. Temperature Range: Minus 50 to 275 deg F
   3. Probe: Single-point sensor with a stainless-steel sheath.
   4. Solar Shield: Stainless steel.
   5. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
   6. Conduit Connection: 1/2-inch trade size.

E. Platinum RTD Space Air Temperature Sensors:
   1. 100 or 1000 ohms.
   2. Temperature Range: Minus 50 to 212 deg F
   3. Sensor assembly shall include a temperature sensing element mounted under a bright white, non-yellowing, plastic cover.
   4. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
   5. Concealed wiring connection.

F. Thermal Resistors (Thermistors): Common Requirements:
   1. 10,000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C.
   2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
   3. Performance Characteristics:
      a. Range: Minus 50 to 275 deg F.
      b. Interchangeable Accuracy: At 77 deg F within 0.5 deg F.
      c. Repeatability: Within 0.5 deg F.
      d. Drift: Within 0.5 deg F over 10 years.
      e. Self-Heating: Negligible.
   4. Transmitter optional, contingent on compliance with end-to-end control accuracy.

G. Thermistor, Single-Point Duct Air Temperature Sensors:
   1. Temperature Range: Minus 50 to 275 deg F
   2. Probe: Single-point sensor with a stainless-steel sheath.
   3. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches.
   4. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
   5. Gasket for attachment to duct or equipment to seal penetration airtight.
   6. Conduit Connection: 1/2- inch trade size.

H. Thermistor Averaging Air Temperature Sensors:
   1. Temperature Range: Minus 50 to 275 deg F
   2. Multiple sensors to provide average temperature across entire length of sensor.

3. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
4. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch radius.
5. Length: As required by application to cover entire cross section of air tunnel.
6. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
7. Gasket for attachment to duct or equipment to seal penetration airtight.
8. Conduit Connection: 1/2-inch trade size.

I. Thermistor Outdoor Air Temperature Sensors:
1. Temperature Range: Minus 50 to 275 deg F
2. Probe: Single-point sensor with a stainless-steel sheath.
3. Solar Shield: Stainless steel.
4. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
5. Conduit Connection: 1/2-inch trade size.

J. Thermistor Space Air Temperature Sensors:
1. Temperature Range: Minus 50 to 212 deg F
2. Sensor assembly shall include a temperature sensing element mounted under a bright white, non-yellowing, plastic cover.
3. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
4. Concealed wiring connection.

K. Space Air Temperature Sensors for Use with DDC Controllers Controlling Terminal Units:
1. 100- or 1000-ohm platinum RTD or thermistor.
2. Thermistor:
   a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.
   b. Thermistor drift shall be less than plus or minus 0.5 deg F over 10 years.
3. Temperature Transmitter Requirements:
   a. Mating transmitter required with each 100-ohm RTD.
   b. Mating transmitters optional for 1000-ohm RTD and thermistor, contingent on compliance with end-to-end control accuracy.
4. Provide discrete communicating sensor to combine temperature, humidity, and C02 sensing in blank-face enclosure.

2.03 COMBINATION AIR TEMPERATURE SENSOR AND SWITCH

A. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.

B. Combination temperature sensor and switch in same instrument.

C. Air Temperature Switch:
1. Factory preset set point of 38 deg F. Field-adjustable set point from 30 to 44 deg F.
2. Responsive to coldest 12-inch section of sensor length.
3. DPST latching relay rated at 25 A and 120-V ac, with powered controller, coil, and manual rest at panel. Wire one leg to fan start circuit and other leg to signal a remote alarm.

D. Air Temperature Sensor:
1. Temperature-averaging type over sensor length. Length to be determined by installing trade to provide uniform coverage over air tunnel. Consult manufacturer for recommendations.
2. Platinum RTD with a value of 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
3. Accuracy: Within 0.9 deg F.

4. Output Signal: 4 to 20 mA for connection to remote monitoring.
5. Encase RTDs in a flexible nominal 0.375-inch-diameter sheath constructed of brass.
6. Lead wires shall be 18-gage AWG copper.
7. Enclosure: NEMA 250, Type 4.

2.04 AIR TEMPERATURE SWITCHES

A. Thermostat and Switch for Low Temperature Control in Duct Applications:
   1. Description:
      a. Two-position control.
      b. Field-adjustable set point.
      c. Manual reset.
      d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Performance:
      a. Operating Temperature Range: 15 to 55 deg F.
      b. Temperature Differential: 5 deg F, non-adjustable and additive.
      c. Enclosure Ambient Temperature: Minus 20 to 140 deg F.
      d. Sensing Element Maximum Temperature: 250 deg F.
      e. Voltage: 120-V ac.
      f. Current: 16 FLA.
      g. Switch Type: Two SPDT snap switches operate on coldest 12-inchsection along element length.
   3. Construction:
      a. Vapor-Filled Sensing Element: Nominal 20 feetlong.
      b. Dual Temperature Scale: Fahrenheit and Celsius visible on face.
      c. Set-Point Adjustment: Screw.
      d. Enclosure: Painted metal, NEMA 250, Type 1.
      e. Electrical Connections: Screw terminals.
      f. Conduit Connection: 1/2-inch trade size.

B. Thermostat and Switch for High Temperature Control in Duct Applications:
   1. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.
   2. Description:
      a. Two-position control.
      b. Field-adjustable set point.
      c. Manual reset.
      d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   3. Performance:
      a. Temperature Range: 100 to 160 deg F.
      b. Temperature Differential: 5 deg F.
      c. Ambient Temperature: Zero to 260 deg F.
      d. Voltage: 120-V ac.
      e. Current: 16 FLA.
      f. Switch Type: SPDT snap switch.
   4. Construction:
      a. Sensing Element: Helical bimetal.
      b. Enclosure: Metal, NEMA 250, Type 1.
      c. Electrical Connections: Screw terminals.
      d. Conduit Connection: 1/2-inch trade size.

2.05 AIR TEMPERATURE RTD TRANSMITTERS

A. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.

B. House electronics in NEMA 250 enclosure.
   1. Duct: Type 2.
   2. Outdoor: Type 4.
   3. Space: Type 1.

C. Conduit Connection: 1/2-inch

D. Functional Characteristics:
   1. Input:
      a. 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
      b. 1000-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
   2. Span (Adjustable):
      a. Space: 40 to 90 deg F.
      b. Supply Air Cooling and Heating: 40 to 120 deg F.
      c. Supply Air Cooling Only: 40 to 90 deg F.
      d. Supply Air Heating Only: 40 to 120 deg F.
      e. Exhaust Air: 50 to 100 deg F.
      f. Return Air: 50 to 100 deg F.
      g. Mixed Air: Minus 40 to 140 deg F.
      h. Outdoor: Minus 40 to 140 deg F.
   3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc .
   4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F.
   5. Match sensor with temperature transmitter and factory calibrate together.

E. Performance Characteristics:
   1. Calibration Accuracy: Within 0.1 percent of the span.
   2. Stability: Within 0.2 percent of the span for at least 6 months.
   3. Combined Accuracy: Within 0.5 percent.

2.06 LIQUID TEMPERATURE SENSORS, COMMERCIAL GRADE

A. RTD:
   1. Description:
      a. Platinum with a value of 100 or 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
      b. Encase RTD in a stainless-steel sheath with a 0.25-inch OD.
      c. Sensor Length: 4, 6, or 8 inches as required by application.
      d. Process Connection: Threaded, NPS 1/2
      e. Two-stranded copper lead wires.
      f. Powder-coated steel enclosure, NEMA 250, Type 4.
      g. Conduit Connection: 1/2-inch
      h. Performance Characteristics:
         1) Range: Minus 40 to 210 deg F.
         2) Interchangeable Accuracy: Within 0.54 deg F at 32 deg F.

B. Thermowells:
   1. Stem: Straight or stepped shank formed from solid bar stock.
   2. Material: Brass or stainless steel.
   3. Process Connection: Threaded, NPS 3/4.
   4. Sensor Connection: Threaded, NPS 1/2.

5. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
6. Furnish thermowells installed in insulated pipes and equipment with an extended neck.
7. Length: 4, 6, or 8 inchesas required by application.
8. Thermowells furnished with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

2.07 LIQUID TEMPERATURE SWITCHES

A. Thermostat and Switch for Temperature Control in Pipe Applications:
   1. Description:
      a. Two-position control.
      b. Field-adjustable set point.
      c. Manual reset.
      d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Performance:
      a. Operating Temperature Range: 65 to 200 deg F.
      b. Temperature Differential Deadband: 5 to 30 deg F, adjustable.
      c. Enclosure Ambient Temperature: 150 deg F.
      d. Sensing Element Pressure Rating: 200 psig.
      e. Voltage: 120-V ac.
      f. Current: 8 FLA.
      g. Switch Type: SPDT snap switch.
   3. Construction:
      a. Vapor-Filled Immersion Element: Copper, nominal 3 incheslong.
      b. Temperature Scale: Fahrenheit, visible on face.
      c. Set-Point Adjustment: Screw.
      d. Enclosure: Painted metal, NEMA 250, Type 1.
      e. Electrical Connections: Screw terminals.
      f. Conduit Connection: 3/4-inch.

2.08 LIQUID AND STEAM TEMPERATURE TRANSMITTERS, COMMERCIAL GRADE

A. House electronics in NEMA 250, Type 4 enclosure.
B. Enclosure Connection: 1/2-inch trade size.
C. Functional Characteristics:
   1. Input: 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two- or three-wire sensors.
   2. Default Span (Adjustable):
      a. Chilled Water: Zero to 100 deg F.
      b. Condenser Water: Zero to 120 deg F.
      c. Heating Hot Water: 32 to 212 deg F.
      d. Heat Recovery: Zero to 120 deg F.
   3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.
   4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F.
   5. Match sensor with temperature transmitter and factory calibrate together. Each matched sensor and transmitter set shall include factory calibration data traceable to NIST.
D. Performance Characteristics:
   1. Calibration Accuracy: Within 0.1 percent of the span.
   2. Stability: Within 0.2 percent of the span for at least 6 months.
   3. Combined Accuracy: Within 0.5 percent.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 TEMPERATURE INSTRUMENT APPLICATIONS

A. Air Temperature Sensors:

1. Duct, Air-Handling Systems: Thermistor or 100-ohm platinum RTD.
2. Outdoor, Air-Handling Systems: Thermistor or 100-ohm platinum RTD.
3. Space, Air-Handling Systems: Thermistor or 100-ohm platinum RTD.

B. Air Temperature Transmitters:

1. Duct, Air-Handling Systems: Air temperature RTD transmitter.
2. Outdoor, Air-Handling Systems: Air temperature RTD transmitter.
3. Space, Air-Handling Systems: Air temperature RTD transmitter.

C. Liquid and Steam Temperature Sensors:

1. Hydronic System, Chilled and Heating Hot Water: Liquid and steam temperature sensor, commercial grade.

D. Liquid and Temperature Transmitters:

1. Hydronic System, Chilled and Heating Hot Water: Liquid and steam temperature transmitter, commercial grade.

3.03 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a 50lb force.

C. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

E. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.04 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.05 TEMPERATURE INSTRUMENT INSTALLATIONS

A. Mounting Location:

1. Roughing In:
    a. Outline instrument mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
    b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
        1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
        2) Do not begin installation without submittal approval of mounting location.
    c. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.
2. Install switches and transmitters for air and liquid temperature associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install air temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Special Mounting Requirements:

1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.
2. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.

C. Mounting Height:

1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
    a. Make every effort to mount at 60 inches.

D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

E. Space Temperature Sensor Installation:

1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
3. In finished areas, recess electrical box within wall.
4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

F. Outdoor Air Temperature Sensor Installation:
1. Mount sensor in a discrete location facing north.
2. Protect installed sensor from solar radiation and other influences that could impact performance.
3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.

G. Single-Point Duct Temperature Sensor Installation:
1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches in sensor length.
2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
3. Rigidly support sensor to duct and seal penetration airtight.
4. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.

H. Averaging Duct Temperature Sensor Installation:
1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. and larger.
2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
4. If required to have transmitter, mount transmitter in an accessible and serviceable location.

I. Low-Limit Air Temperature Switch Installation:
1. Install multiple low-limit switches to maintain coverage over entire cross-sectional area of air tunnel.
2. Fasten and support sensing element with manufacturer-furnished clips to keep element taut throughout entire length.
3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.
4. Install on entering side of cooling coil unless otherwise indicated on Drawings.

J. Liquid Temperature Sensor Installation:
1. Assembly shall include sensor, thermowell and connection head.
2. For pipe NPS 4 and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.
3. For pipe smaller than NPS 4:
    a. Install reducers to increase pipe size to NPS 4at point of thermowell installation.

b. For pipe sizes NPS 2-1/2 and NPS 3, thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
c. Minimum insertion depth shall be 2-1/2 inches.

4. Install matching thermowell.
5. Fill thermowell with heat-transfer fluid before inserting sensor.
6. Tip of spring-loaded sensors shall contact inside of thermowell.
7. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.
8. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.
9. For applications with transmitters, mount transmitter remote from sensor in an accessible and serviceable location from floor, service platform or catwalk.

3.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification.

3.07 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.08 CHECK-OUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check temperature instruments for proper location and accessibility.

C. Verify sensing element type and proper material.

D. Verify location and length.

E. Verify that wiring is correct and secure.

3.09 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.

9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:
   1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
   2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
   3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:
   1. Check digital signals using a jumper wire.
   2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:
   1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
   2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.10 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.

B. Provide a complete set of instructional videos covering each product specified and installed and showing the following:
   1. Software programming.
   2. Calibration and test procedures.
   3. Operation and maintenance requirements and procedures.
   4. Troubleshooting procedures.

C. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

D. Record videos on DVD disks.

E. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

SECTION 23 0993.11.309
SEQUENCE OF OPERATIONS FOR HVAC DDC

PART 1 - **GENERA**L

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes control sequences for DDC for HVAC systems, subsystems, and equipment.

B. Related Requirements:

1. Section 230923 "DDC Systems for HVAC" for control equipment.

1.03 DEFINITIONS

A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).

B. Binary Output: On/off output signal or contact closure.

C. DDC: Direct digital control.

D. Digital Output: Data output that must be interpreted digitally.

1.04 ACTION SUBMITTALS

A. Product Data:

1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.

B. Shop Drawings:

1. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

1.05 CHILLED WATER SYSTEM VARIABLE PRIMARY PUMPING CONTROL SEQUENCE:

A. Chilled Water System Description – The chilled water system is a nominal 60 ton system. The system is comprised of one (1) 60 ton air-cooled modulating chiller with factory mounted pumps, indoor plate and frame heat exchanger, glycol make up unit, and a linked three way bypass valve. The system is designed such that the chiller side of the heat exchanger contains 30% glycol and the building side of the heat exchanger only contain water.

B. Start/Stop of the chilled water system shall be initiated by the Peoria Park District Facilities Personnel Through the BAS.

1. Once Initiated the system shall read building flow, Supply water temperature, and Return water temperature and shall send those points though BACknet to the chiller for chiller staging.
2. On Call for Cooling:
   a. BAS shall command the existing building pumps motor starters to start and shall monitor building flow rate 150 GPM (adjustable).
   b. System shall modulate the linked three-way bypass valves to close the building flow though port A and open the building flow though port B sending building flow though the heat exchanger. Once the heat exchanger flow rate matches the

building flow rate (152 GPM Adjustable) the enable shall be sent to the chiller though BACnet and the chiller shall begin its factory start sequence.

1) Chiller shall automatically control its pumps and modulate its stages to maintain its programed supply water temperature set point 44 Deg F (Adjustable) operating at its designed 10 Deg F Delta T.

2) If the heat exchanger Chiller side or building side differential pressure spikes beyond normal operating pressures the chiller shall be commanded to shut down and the pumps shall continue to operate for the chillers minimum shutdown duration then turn off. An alarm shall be sent though the BAS to PPD Facilities Personnel. [Heat Exchanger Clogged OR Check Strainer]

3) If the Building flow stops the chiller shall be commanded to shut down and an alarm shall be sent though the BAS to PPD Facilities Personnel. [Building Flow Stopped – Chiller Shut Down]

3. If outside air temperatures are below 50 Deg F (Adjustable) the chiller shall be off.

4. If the existing boiler is enabled (BAS shall monitor power to the burner) the chiller shall be locked out and off.

C. Operator interface - The chilled water control system shall include the following operator interface elements:
   1. Operational status screen to include:
      a. Chiller System Status (Off/Soft Start/Normal/Ambient Lockout/Shutdown in Progress)
      b. Chiller Supply Water Set-point
      c. Chilled Water System Supply Water Temperature
      d. Chilled Water System Return Water Temperature
      e. Chiller Failure Reset (Push Button)
   2. Screen that allows editing of the following data (to be performed without entering program code editor):
      a. Supply Water Setpoint
      b. System Soft Loading Parameters
      c. Ambient Lockout Parameters
      d. Alarm Handling Setup
      e. Security Setup
   3. Chiller Graphic(s) to include all data listed on the supplementary Chiller System Point List, including:
      a. Chiller Name
      b. Chiller Operating Mode
      c. Chilled Water Setpoint
      d. Chiller RLA %
      e. Entering Chiller Water Temperature
      f. Leaving Chilled Water Temperature
      g. Evaporator Flow Status

D. System Start/Stop - The chilled water system shall start in response to a binary signal from an external source such as the building automation system. The intent is for the chilled water system to be initiated automatically by the building automation system.
   1. Upon the start of the chilled water system the chiller plant control system shall automatically start Trend Log Reports to include:
      a. Hourly logging of system shall include the following points:
      b. Outside Air Dry Bulb
      c. System Chilled Water Set-point
      d. System Chilled Water Supply
      e. System Chilled Water Return Temperature
      f. Operating Status of the chiller
      g. Operating Status of pumps

E. Sequencing - The chiller control system will start and stop its factory chilled water pump(s) and chiller based upon system load.
   1. When the chilled water system is enabled the chiller plant control system shall:
      a. Send an Enable signal to the chiller.
      b. Upon receiving the enable signal the chiller shall verify minimum chilled water flow is achieved.
      c. Upon confirmation of evaporator water flow the chiller shall continue its pre-start sequence and start its compressor(s).
      d. Upon the start of each chiller the Chiller Plant Control system shall automatically start chiller specific Trend Log Reports to include:
         1) Hourly logging of chiller
         2) Unit Chilled Water set-point
         3) Compressor(s) RLA
         4) Evaporator Entering Water Temp
         5) Evaporator Leaving Water Temp
         6) Evaporator Approach Temp
         7) Five-minute logging of chiller:
         8) Unit Chilled Water set-point
         9) Compressor(s) RLA
         10) Evaporator Entering Water Temp
         11) Evaporator Leaving Water Temp
   2. The factory chiller controls shall stage its compressors as required to maintain a constant chiller leaving water temperature, system set point of [42] degrees F (adjustable).
   3. The chiller shall start the factory controlled shut down sequence after receiving the shut down command from the BAS when chiller determines it is safe to do so.
   4. Upon sensing a chiller failure the chiller plant control system shall shut down the failed chiller immediately and send an alert email / text message to facilities personnel.

F. System Soft Start - The chiller control system will initiate a “soft start” mode whenever the system chilled water temperature exceeds the specified chilled water system set-point by [20] degrees F at system start-up. The chiller control application will add cooling capacity during soft start mode only if return water temperature is not declining at a rate of at least [0.5] degrees F per minute. This prevents the unnecessary operation of chiller and limits system electrical demand during chilled water loop pull down.

G. Diagnostics/Protection - the Building Automation System shall be able to alarm from all sensed points and diagnostic alarms monitored by the chiller controller.

H. CHILLED WATER SYSTEM CONTROL POINTS LIST:
   1. Digital Outputs
      a. CH-1 Enable / Disable

b. (E)P-1 Start/Stop (DDC to Pneumatics)
c. (E)P-2 Start/Stop (DDC to Pneumatics)

2. Digital Inputs
   a. CH-1 Status/Alarm
   b. CH-1 Pumps Status/Alarm
3. Analog Inputs
   a. Outside Air Temperature (Deg F)
   b. CH-1 Evaporator Entering Temperature
   c. CH-1 Evaporator Leaving Temperature
   d. Differential Pressure Sensor 1 – Chiller Side of Heat Exchanger
   e. Differential Pressure Sensor 2 – Building Side of Heat Exchanger
   f. Heat Exchanger Chiller Side Flow (GPM)
   g. Heat Exchanger Building Side Flow (GPM)
   h. Building System Flow (GPM)
   i. Heat Exchanger Chiller Side EWT (Deg F)
   j. Heat Exchanger Chiller Side LWT (Deg F)
   k. Heat Exchanger Building Side EWT (Deg F)
   l. Heat Exchanger Building Side LWT (Deg F)
   m. Building System Supply Water Temperature (Deg F)
   n. Building System Return Water Temperature (Deg F)
   o. Heat Exchanger Chiller Side Inlet Pressure (PSI)
   p. Heat Exchanger Chiller Side Outlet Pressure (PSI)
   q. Heat Exchanger Building Side Inlet Pressure (PSI)
   r. Heat Exchanger Building Side Outlet Pressure (PSI)
   s. Chiller Side of Heat Exchanger GMU Make Up Water Meter (Totaling)
   t. Chilled Water System Linked Three Way Valve Position (Feedback)
4. Analog Outputs
   a. Chilled Water System Linked Three Way Valves Command (Position)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 23 2113
HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:
   1. Copper tube and fittings.
   2. Steel pipe and fittings.
   3. Plastic pipe and fittings.
   4. Joining materials.
   5. Transition fittings.
   6. Dielectric fittings.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe.
   2. Fittings.
   3. Joining materials.
   4. Bypass chemical feeder.

1.04 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
   2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Hot-Water Heating Piping: 100 psig at 200 deg F.
   2. Chilled-Water Piping: 150 psig at 73 deg F.
   3. Dual-Temperature Heating and Cooling Water Piping: 100 psig at 200 deg F.
   4. Makeup-Water Piping: 80 psig at 73 deg F.
   5. Condensate-Drain Piping: 150 deg F.
   6. Blowdown-Drain Piping: 180 deg F.
   7. Air-Vent Piping: 180 deg F.
   8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.02 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
C. DWV Copper Tubing: ASTM B 306, Type DWV.
D. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.
   1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
   2. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, pre-lubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
E. Copper or Bronze Pressure-Seal Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Viega Pro-Press System
   2. Housing: Copper.
   3. O-Rings and Pipe Stops: EPDM.
   4. Tools: Manufacturer's special tools.
   5. Minimum 200-psig working-pressure rating at 250 deg F.
F. Wrought-Copper Unions: ASME B16.22.

2.03 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.
C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.
E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.
H. Grooved Mechanical-Joint Fittings and Couplings:
   1. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
   2. Couplings: Ductile- or malleable-iron housing and EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.04 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic Pipe: ASTM F 441/F 441M, with wall thickness as indicated in "Piping Applications" Article.
   1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
B. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.

1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

2.05 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise 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.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for CPVC Piping: ASTM F 493.
   1. Solvent cement shall have a VOC content of 490 g/L or less.

H. Solvent Cements for PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   1. Solvent cement shall have a VOC content of 490 g/L or less.

2.06 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:
   1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:
   1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.07 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
   1. Description:
      a. Standard: ASSE 1079.
      b. Pressure Rating: 150 psig minimum at 210 deg F.
      c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Description:
      a. Standard: ASSE 1079.
      b. Factory-fabricated, bolted, companion-flange assembly.
      c. Pressure Rating: 150 psig minimum at 210 deg F.
      d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
   1. Description:
      a. Nonconducting materials for field assembly of companion flanges.
      b. Pressure Rating: 150 psig minimum at 210 deg F.
      c. Gasket: Neoprene or phenolic.
      d. Bolt Sleeves: Phenolic or polyethylene.
      e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:
1. Description:
a. Standard: IAPMO PS 66.
b. Electroplated steel nipple, complying with ASTM F 1545.
c. Pressure Rating: 150 psig minimum at 210 deg F.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
2. Schedule 40, Grade B steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. Hot-water heating piping installed belowground and within slabs shall be either of the following:
1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

D. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

E. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

F. Chilled-water piping installed belowground and within slabs shall be either of the following:
1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

G. Dual-temperature heating and cooling water piping, aboveground, NPS 2 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

H. Dual-temperature heating and cooling water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

I. Dual-temperature heating and cooling water piping installed belowground and within slabs shall be either of the following:
   1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
   2. RTRP and RTRF with adhesive or flanged joints.

J. Glycol cooling-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
   1. Type L Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
   2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

K. Glycol cooling-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
   2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

L. Glycol cooling-water piping installed belowground and within slabs shall be either of the following:
   1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

M. Makeup-water piping installed aboveground shall be either of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

N. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

O. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

P. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

Q. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.02 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
O. Install branch connections to mains usingtee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
P. Install valves according to the following:
    1. Section 230523.12 "Ball Valves for HVAC Piping."
    2. Section 230523.13 "Butterfly Valves for HVAC Piping."
    3. Section 230523.14 "Check Valves for HVAC Piping."
Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
S. Install shutoff valve immediately upstream of each dielectric fitting.
T. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

3.03 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.04 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
C. Install the following pipe attachments:
    1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
    2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
    3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
    4. Spring hangers to support vertical runs.
    5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
    6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
    1. NPS 3/4: Maximum span, 7 feet.
    2. NPS 1: Maximum span, 7 feet.
    3. NPS 1-1/2: Maximum span, 9 feet.
    4. NPS 2: Maximum span, 10 feet.
    5. NPS 2-1/2: Maximum span, 11 feet.
    6. NPS 3 and Larger: Maximum span, 12 feet.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.05 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. 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 ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
   4. PVC Nonpressure Piping: Join according to ASTM D 2855.

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

I. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.06 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.07 CHEMICAL TREATMENT

A. Comply with requirements in Section 232513 "Water Treatment for Closed-Loop Hydronic Systems".

B. Install side-stream filters to provide service as chemical feeders in each hydronic system where indicated.
   1. Install in upright position with top of funnel not more than 48 inches above the floor.
   2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
   3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.

C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.08 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Isolate expansion tanks and determine that hydronic system is full of water.
   4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
   5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
   6. Prepare written report of testing.

C. Perform the following before operating the system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
   3. Set makeup pressure-reducing valves for required system pressure.
   4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 23 2116
HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Hydronic specialty valves.
   2. Air-control devices.
   3. Strainers.
   4. Connectors.

B. Related Requirements:
   1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for expansion fittings and loops.
   2. Section 230523.12 "Ball Valves for HVAC Piping" for specification and installation requirements for ball valves common to most piping systems.
   3. Section 230523.13 "Butterfly Valves for HVAC Piping" for specification and installation requirements for butterfly valves common to most piping systems.
   4. Section 230523.14 "Check Valves for HVAC Piping" for specification and installation requirements for check valves common to most piping systems.
   5. Section 230923.11 "Control Valves" for automatic control valve and sensor specifications, installation requirements, and locations.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product:
   1. Include construction details and material descriptions for hydronic piping specialties.
   2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
   3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.06 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. Safety Valves and Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong Pumps, Inc.
      b. Bell & Gossett; a Xylem brand.
      c. Flow Design, Inc.
      d. Griswold Controls.

e. HCI; Hydronics Components Inc.
f. Nexus Valve, Inc.
g. NIBCO INC.

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong Pumps, Inc.
b. Bell & Gossett; a Xylem brand.
c. Flow Design, Inc.
d. Griswold Controls.
e. HCI; Hydronics Components Inc.
f. Nexus Valve, Inc.
g. NIBCO INC.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AMTROL, Inc.
b. Apollo Flow Controls; Conbraco Industries, Inc.
c. Armstrong Pumps, Inc.
d. Bell & Gossett; a Xylem brand.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

D. Diaphragm-Operated Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. AMTROL, Inc.
    b. Apollo Flow Controls; Conbraco Industries, Inc.
    c. Armstrong Pumps, Inc.
    d. Bell & Gossett; a Xylem brand.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Automatic Flow-Control Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Caleffi.
    b. Flow Design, Inc.
    c. Griswold Controls.
    d. HCI; Hydronics Components Inc.
    e. Nexus Valve, Inc.
    f. NIBCO INC.
2. Body: Brass or ferrous metal.
3. Flow Control Assembly, provide either of the following:
    a. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
    b. Elastomeric Diaphragm and Polyphenylsulfone Orifice Plate: Operating ranges within 2- to 80-psig differential pressure.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow within plus or minus 10 percent, regardless of system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 200 deg F.

2.02 AIR-CONTROL DEVICES

A. Manual Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. AMTROL, Inc.
    b. Apollo Flow Controls; Conbraco Industries, Inc.
    c. Armstrong Pumps, Inc.
    d. Bell & Gossett; a Xylem brand.
    e. HCI; Hydronics Components Inc.
    f. Nexus Valve, Inc.
2. Body: Bronze.
3. Internal Parts: Nonferrous.

4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett; a Xylem brand.
   d. Nexus Valve, Inc.
   e. NuTech Hydronic Specialty Products.
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

C. Chilled Water Buffer Tank with Baffel:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett; a Xylem brand.
   d. American Wheatley
   e. Wessels
2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Bladder-Type ASME Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett; a Xylem brand.
   d. American Wheatley
2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. Coalescing-Type Air and Dirt Separators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Spiro-Therm – Spirovent Air/Dirt Separator
   b. SUBSTITIONS WILL NOT BE ACCEPTED.

2. Tank: Two-piece cast iron body with an integral copper core tube with continuously wound copper wire medium constructed to suppress turbulence and maximize air separation.
3. Omitted Addendum #2.
4. Maximum Working Pressure: Up to 175 psig.
5. ASME Rated.
6. Maximum Operating Temperature: Up to 300 deg F.

2.03 STRAINERS

A. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 60-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

B. Basket Strainers:
1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. T-Pattern Strainers:
1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

2.04 CONNECTORS

A. Spherical, Rubber, Flexible Connectors:
1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.01 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
C. Install check valves at each pump discharge and elsewhere as required to control flow direction.
D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.02 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

E. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
   1. Install tank fittings that are shipped loose.
   2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION

SECTION 23 2123
HYDRONIC PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Close-coupled, in-line centrifugal pumps.
   2. Separately coupled, horizontally mounted, in-line centrifugal pumps.
   3. Separately coupled, base-mounted, end-suction centrifugal pumps.
   4. Automatic condensate pump units.

1.03 DEFINITIONS

A. Buna-N: Nitrile rubber.
B. EPT: Ethylene propylene terpolymer.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
B. Shop Drawings: For each pump.
   1. Show pump layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   3. Include diagrams for power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

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. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.01 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Pumps, Inc.
   2. Aurora Pump; Pentair Ltd.
   3. ITT Corporation.
B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.
C. Pump Construction:
   1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
   3. Pump Shaft: Stainless steel.
   4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

5. Pump Bearings: Oil lubricated; bronze-journal or thrust type.

D. Motor: Single speed and rigidly mounted to pump casing.
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      a. Enclosure: Totally enclosed, fan cooled.
      b. Enclosure Materials: Cast iron.
      c. Motor Bearings: Grease-lubricated ball bearings.
      d. Efficiency: Premium efficient.
      e. NEMA Design: B.
      f. Service Factor: 1.15.

2.02 SEPARATELY COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Pumps, Inc.
   2. Aurora Pump; Pentair Ltd.
   3. ITT Corporation.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

C. Pump Construction:
   1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps not frequency-drive controlled, 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. Include water slinger on shaft between motor and seal.
   5. Pump Bearings: Oil lubricated; bronze-journal or thrust type.

D. Shaft Coupling: Molded-rubber insert with interlocking spider capable of absorbing vibration.

E. Motor: Single speed and resiliently mounted to pump casing.
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      a. Enclosure: Totally enclosed, fan cooled.
      b. Enclosure Materials: Cast iron.
      c. Motor Bearings: Grease-lubricated ball bearings.
      d. Efficiency: Premium efficient.
      e. NEMA Design: B.
      f. Service Factor: 1.15.

2.03 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Pumps, Inc.
   2. Aurora Pump; Pentair Ltd.
   3. ITT Corporation.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Pump Construction:
   1. Casing: Radially 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 flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
   3. Pump Shaft: Stainless steel.
   4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
   5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

D. Shaft Coupling: 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.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, secured to mounting frame, with adjustable alignment.
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      a. Enclosure: Totally enclosed, fan cooled.
      b. Enclosure Materials: Cast iron.
      c. Motor Bearings: Grease-lubricated ball bearings.
      d. Efficiency: Premium efficient.
      e. NEMA Design: B.
      f. Service Factor: 1.15.

2.04 AUTOMATIC CONDENSATE PUMP UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Beckett Corporation.
   2. Franklin Electric Co.
   3. Hartell Pumps; Milton Roy.

B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch-minimum, electrical power cord with plug.

2.05 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:
   1. Angle pattern.
   2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
   3. Bronze startup and bronze or stainless-steel permanent strainers.
   4. Bronze or stainless-steel straightening vanes.
   5. Drain plug.
   6. Factory-fabricated support.

B. Triple-Duty Valve:
   1. Angle or straight pattern.
   2. 175-psig pressure rating, cast-iron body, pump-discharge fitting.
   3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
   4. Brass gage 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 the 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 PUMP INSTALLATION

A. Comply with HI 1.4 and HI 2.4.

B. Install pumps to provide access for periodic maintenance including removing 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. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

E. Equipment Mounting:
   1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers of size required to support weight of in-line pumps.

3.03 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.04 CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install triple-duty valve on discharge side of pumps.
E. Install suction diffuser and shutoff valve on suction side of pumps.
F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
G. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
H. Install check valve and gate or ball valve on each condensate pump unit discharge.
I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.05 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.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Perform the following startup checks for each pump before starting:
      a. Verify bearing lubrication.
      b. 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.
      c. Verify that pump is rotating in the correct direction.
   5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
   6. Start motor.
   7. Open discharge valve slowly.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION

SECTION 23 5700
HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes shell-and-tube and plate heat exchangers.

1.03 DEFINITIONS

A. TEMA: Tubular Exchanger Manufacturers Association.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Design Calculations: Calculate requirements for selecting seismic restraints and for designing bases.
   2. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Tube-removal space.
   2. Structural members to which heat exchangers will be attached.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of domestic-water heat exchangers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including heat exchanger, storage tank, and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Periods: From date of Substantial Completion.
      a. Plate, Heat Exchangers:
         1) Plate-and-Frame Type: One year(s).

PART 2 - PRODUCTS

2.01 GASKETED-PLATE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Alfa Laval Inc.
   2. API Heat Transfer Inc.
   3. APV; SPX Corporation.
   4. Armstrong Pumps, Inc.
   5. Flo Fab Inc.
   6. ITT Corporation.
   7. TACO Comfort Solutions, Inc.

B. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets.
C. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.
D. Frame:
1. Capacity to accommodate 20 percent additional plates.
2. Painted carbon steel with provisions for anchoring to support.
E. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.
1. Fabricate attachment of heat-exchanger carrying and guide bars with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger carrying and guide bars are anchored to building structure.
F. End-Plate Material: Painted carbon steel.
G. Tie Rods and Nuts: Steel or stainless steel.
H. Plate Material: 0.039 inch thick before stamping; Type 304 stainless steel.
I. Gasket Materials: EPDM rubber.
1. Glue: Chlorine free.
J. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
1. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
2. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
K. Enclose plates in solid stainless-steel removable shroud.

2.02 ACCESSORIES

A. Hangers and Supports:
1. Custom, steel supports cradles for mounting on structural steel.
a. Minimum Number of Cradles: Three (3).
2. Field-fabricated steel supports or cradles to ensure both horizontal and vertical support of heat exchanger. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
B. Shroud: Steel sheet.
C. Miscellaneous Components for High-Temperature Hot-Water Unit: Control valve, valves, and piping.
D. Pressure Relief Valves: Bronze, ASME rated and stamped.
1. Pressure relief valve setting: 50 psig.

2.03 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect heat exchangers according to ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1. Affix ASME label.
B. Hydrostatically test heat exchangers to minimum of one and one-half times pressure rating before shipment.
C. Heat exchangers will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.
B. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections before equipment installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 GASKETED-PLATE HEAT-EXCHANGER INSTALLATION

A. Install gasketed-plate heat exchanger on custom-designed wall supports anchored to structure as indicated on Drawings.

B. Install metal shroud over installed gasketed-plate heat exchanger according to manufacturer's written instructions.

3.03 CONNECTIONS

A. Comply with requirements for piping specified in other Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.

C. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.

D. Install shutoff valves at heat-exchanger inlet and outlet connections.

E. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

F. Install hose end valve to drain shell.

G. Install thermometer on heat-exchanger and inlet and outlet piping, and install thermometer on heating-fluid inlet and outlet piping. Comply with requirements for thermometers specified in Section 230519 "Meters and Gages for HVAC Piping."

H. Install pressure gages on heat-exchanger and heating-fluid piping. Comply with requirements for pressure gages specified in Section 230519 "Meters and Gages for HVAC Piping."

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Heat exchanger will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.05 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.06 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers.

END OF SECTION

SECTION 23 6423.13
AIR-COOLED, SCROLL WATER CHILLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes packaged, air-cooled, electric-motor-driven, scroll water chillers.

1.03 DEFINITIONS

A. BAS: Building automation system.

B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

C. DDC: Direct digital control.

D. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in Btu/h to the total power input given in watts at any given set of rating conditions.

E. GFI: Ground fault interrupt.

F. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.

G. I/O: Input/output.

H. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

I. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.

J. SCCR: Short-circuit current rating.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include refrigerant, rated capacities, operating characteristics, and furnished specialties and accessories.
2. Performance at AHRI standard conditions and at conditions indicated.
3. Performance at AHRI standard unloading conditions.
4. Minimum evaporator flow rate.
5. Refrigerant capacity of water chiller.
6. Oil capacity of water chiller.
7. Fluid capacity of evaporator.
8. Characteristics of safety relief valves.
9. Force and moment capacity of each piping connection.

B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Size and location of piping and wiring connections.
5. Diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   a. Structural supports.
   b. Piping roughing-in requirements.

c. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
d. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

2. Coordination drawings showing plan, section and elevation views, drawn to.
3. Each view to show screened background with the following:
   a. Column grids, beams, columns, and concrete housekeeping pads.
   b. Layout with walls, floors, and roofs, including each room name and number.
   c. Equipment and products of other trades that are located in vicinity of chillers and part of final installation, such as plumbing systems.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.

B. Spare Parts List: Recommended spare parts list with quantity for each.

C. Touchup Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.

D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Tool kit to include the following:
1. A tool kit specially designed by chiller manufacturer for use in servicing chiller(s) furnished.
2. Special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Chiller Tool Kit." Text size shall be at least 1 inch high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least 1/2 inch high.

B. Touchup Paint: 32 oz. container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.

1.08 QUALITY ASSURANCE

A. AHRI Certification: Certify chiller according to AHRI 590 certification program.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

B. Package water chiller for export shipping.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified warranty period.
1. Extended warranties include, but are not limited to, the following:
   a. Complete chiller including refrigerant and oil charge.
   b. Complete compressor and drive assembly including refrigerant and oil charge.
   c. Refrigerant and oil charge.
      1) Loss of refrigerant charge for any reason due to manufacturer's product defect and product installation.
   d. Parts only and labor.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

B. Performance Tolerance: Comply with the following in lieu of AHRI 550/590:
   1. Allowable Capacity Tolerance: Zero percent.
   2. Allowable Full-Load Energy Efficiency Tolerance: Zero percent.
   3. Allowable Part-Load Energy Efficiency Tolerance: Zero percent.

C. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.

D. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.

G. Comply with NFPA 70.

H. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.

I. Operation Following Loss of Normal Power:
   1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
   2. See drawings for equipment served by backup power systems.
   3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

J. Outdoor Installations:
   1. Chiller shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a 25-year period with minimal degradation due to exposure to outdoor ambient conditions.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. JCI/York.
   2. Daikin Applied
   3. Carrier
   4. Trane

2.03 MANUFACTURED UNITS

A. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser with fans, electrical power, controls, and indicated accessories.

B. Fabricate water chiller mounting base with reinforcement strong enough to resist water chiller movement during a seismic event when water chiller is anchored to field support structure.

C. Security Package: Security grilles with fasteners for additional protection of compressors, evaporator, and condenser coils. Grilles shall be coated for corrosion resistance and shall be removable for service access.

2.04 CABINET

A. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.

B. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
C. Casing: Galvanized steel, all exterior piping shall be concealed within unit casing.
D. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.

2.05 COMPRESSOR-DRIVE ASSEMBLIES

A. Compressors:
1. Description: Positive-displacement direct drive with hermetically sealed casing.
2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.
3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
4. Capacity Control: On-off compressor cycling.
a. Digital compressor unloading is an acceptable alternative to achieve capacity control.
5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.
a. Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.
6. Vibration Isolation: Mount individual compressors on vibration isolators.
a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.
B. Compressor Motors:
1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
C. Compressor Motor Controllers:
1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

2.06 REFRIGERATION

A. Refrigerant: A2L R454B. Classified as Safety Group A1 according to ASHRAE 34.
B. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
C. Refrigerant Circuit: Each circuit shall include an electronic or a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
D. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.
1. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in each circuit in lieu of each compressor.
E. Pressure Relief Device:
1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
3. ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger.

2.07 EVAPORATOR

A. Brazed Plate:

1. Direct-expansion, single-pass, brazed-plate design.
2. Type 304 or 316 stainless-steel construction.
3. Code Compliance: Tested according to ASME Boiler and Pressure Vessel Code.
4. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping. Furnish flange adapters to mate to flanged piping.
5. Inlet Strainer: Factory-furnished, 40-mesh strainer for field installation in supply piping to evaporator. Manufacturer has option to factory install strainer.

B. Flow Switch: Factory-furnished and -installed, thermal-type flow switch wired to chiller operating controls.

C. Remote-Mounting Kit: Designed for remote field mounting where indicated. Provide kit for field installation.

2.08 AIR-COOLED CONDENSER

A. Coil(s) with integral subcooling on each circuit.

B. Copper Tube with Plate Fin Coils:
1. Construct coils of copper tubes mechanically bonded to aluminum with precoated epoxy-phenolic fins.

C. Aluminum Microchannel Coils:
1. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
2. Single- or multiple-pass arrangement.
3. Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.

D. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

E. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

F. Fan Motors: TENV or TEAO enclosure, with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
1. Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.

G. Fan Guards: Removable steel safety guards with corrosion-resistant PVC coating.

2.09 INSULATION

A. Closed-cell, flexible, elastomeric thermal insulation complying with ASTM C 534/C 534M, Type I for tubular materials and Type II for sheet materials.
1. Thickness: 1-1/2 inches.

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
1. Apply adhesive to 100 percent of insulation contact surface.
2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
3. Seal seams and joints to provide a vapor barrier.
4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
5. Manufacturer has option to factory or field insulate chiller components to reduce potential for damage during installation.
6. Field-Applied Insulation:
   a. Components that are not factory insulated shall be field insulated to comply with requirements indicated.

b. Manufacturer shall be responsible for chiller insulation whether factory or field installed to ensure that manufacturer is the single point of responsibility for chillers.
c. Manufacturer's factory-authorized service representative shall instruct and supervise installation of field-applied insulation.
d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

2.10 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.
B. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
C. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
D. Wiring shall be numbered and color-coded to match wiring diagram.
E. Factory wiring shall be located outside of an enclosure in a metal raceway. Terminal connections shall be made with not more than a 24-inch length of liquidtight or flexible metallic conduit.
F. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system, but not less than 65,000 A.
G. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
2. NEMA KS 1, heavy-duty, non-fusible switch.
3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
H. Each motor shall have overcurrent protection.
I. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
J. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
K. Power Factor Correction: Capacitors to correct power factor to 0.90 at full load.
L. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
M. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.
N. Service Receptacle:
1. Unit-mounted, 120-V GFI duplex receptacle.
2. Power receptacle from chiller internal electrical power wiring.
O. Indicate the following for water chiller electrical power supply:
1. Current, phase to phase, for all three phases.
2. Voltage, phase to phase and phase to neutral for all three phases.
3. Three-phase real power (kilowatts).
4. Three-phase reactive power (kilovolt amperes reactive).
5. Power factor.
6. Running log of total power versus time (kilowatt hours).
7. Fault log, with time and date of each.

2.11 CONTROLS

A. Factory installed and wired, and functionally tested at factory before shipment.
B. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

C. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.

D. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, digital display. Display the following:
   1. Date and time.
   2. Operating or alarm status.
   3. Operating hours.
   4. Outside-air temperature if required for chilled-water reset.
   5. Temperature and pressure of operating set points.
   6. Chilled-water entering and leaving temperatures.
   7. Refrigerant pressures in evaporator and condenser.
   8. Saturation temperature in evaporator and condenser.
   9. No cooling load condition.
   10. Elapsed time meter (compressor run status).
   11. Pump status.
   12. Antirecycling timer status.
   13. Percent of maximum motor amperage.
   14. Current-limit set point.
   15. Number of compressor starts.
   16. Alarm history with retention of operational data before unit shutdown.
   17. Superheat.

E. Control Functions:
   1. Manual or automatic startup and shutdown time schedule.
   2. Capacity control based on evaporator leaving-fluid temperature.
   3. Capacity control compensated by rate of change of evaporator entering-fluid temperature.
   4. Chilled-water entering and leaving temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water temperature.
   5. Current limit and demand limit.
   6. Condenser-water temperature.
   7. External water chiller emergency stop.
   8. Antirecycling timer.
   9. Automatic lead-lag switching.

F. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
   1. Low evaporator pressure or high condenser pressure.
   2. Low chilled-water temperature.
   3. Refrigerant high pressure.
   4. High or low oil pressure.
   5. High oil temperature.
   6. Loss of chilled-water flow.
   7. Loss of condenser-water flow.
   8. Control device failure.

G. BAS System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.
   1. Hardwired I/O Points:
      a. Monitoring: On/off status, common trouble alarm.
      b. Control: On/off operation, chilled-water discharge temperature set-point adjustment.
   2. Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control and monitor the water chiller from an

operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through DDC system for HVAC.

H. Factory-installed wiring outside of enclosures shall be in NFPA 70-complaint raceway. Make terminal connections with liquidtight or flexible metallic conduit.

2.12 ACCESSORIES

A. Factory-furnished spring isolators for field installation.
   1. Spring Deflection: 2 inches.

2.13 SOURCE QUALITY CONTROL

A. Perform functional test of water chillers before shipping.

B. Factory performance test water chillers, before shipping, according to AHRI 550/590.
   1. Test the following conditions:
      a. Design conditions indicated.
      b. AHRI 550/590 part-load points.
   2. Allow Owner access to place where water chillers are being tested. Notify Owner 14 days in advance of testing.

C. Factory test and inspect evaporator and water-cooled condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

D. For water chillers located outdoors, rate sound power level according to AHRI 370 procedure.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
   1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WATER CHILLER INSTALLATION

A. Coordinate sizes and locations of bases with actual equipment provided. Cast anchor-bolt inserts into concrete bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.

C. Install water chillers on support structure indicated.

D. Equipment Mounting:
   1. Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Maintain clearances required by governing code.

G. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

H. Install separate devices furnished by manufacturer and not factory installed.
   1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.03 PIPING CONNECTIONS

A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Where installing piping adjacent to chillers, allow space for service and maintenance.

D. Evaporator Fluid Connections:

1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
3. Make connections to water chiller with a union flange or mechanical coupling.

E. Connect each drain connection with a drain valve, full size of drain connection. Connect drain pipe to drain valve with union and extend drain pipe to terminate over floor drain.

F. Connect each chiller vent connection with an automatic or a manual vent, full size of vent connection.

3.04 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.05 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and DDC system for remote monitoring and control of chillers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup 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 gages are installed.
4. Operate water chiller for run-in period.
5. Check bearing lubrication and oil levels.
6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
9. Verify and record performance of chilled-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. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

E. Prepare a written startup report that records results of tests and inspections.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers.
   1. Instructor shall be factory trained and certified.
   2. Provide not less than eight hours of training.
   3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
   4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
   5. Obtain Owner sign-off that training is complete.
   6. Owner training shall be held at Project site.

END OF SECTION

SECTION 26 0500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Electrical equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Grout.
   4. Common electrical installation requirements.

1.03 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.04 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables and wireways will be clear of obstructions and of the working and access space of other equipment.
B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
D. Coordinate sleeve selection and application with selection and application of firestopping.

PART 2 - PRODUCTS

2.01 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.02 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.
B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
E. Right of Way: Give to piping systems installed at a required slope.

3.02 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables and wireways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations with core-drilled holes.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.03 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly.

END OF SECTION

SECTION 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.03 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Qualification Data: For testing agency.
C. Field quality-control test reports.

1.05 QUALITY ASSURANCE

A. 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.
B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Alcan Products Corporation; Alcan Cable Division.
   2. American Insulated Wire Corp.; a Leviton Company.
   3. General Cable Corporation.
   4. Senator Wire & Cable Company.
   5. Southwire Company.
C. Copper Conductors: Comply with NEMA WC 70.
D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.
E. Multiconductor Cable: Not permitted.

2.02 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Hubbell Power Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
   5. Tyco Electronics Corp.
C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Stranded for all conductors.

B. Branch Circuits: Copper. Stranded for all conductors.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

C. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway. Metal-clad cable, Type MC cable is not allowed.

E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

F. Class 1 Control Circuits: Type THHN-THWN, in raceway.

G. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

3.04 CONNECTIONS

A. 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 and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 26 0523
CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Low-voltage control cabling.
   2. Control-circuit conductors.
   3. Identification products.

1.03 DEFINITIONS

A. EMI: Electromagnetic interference.
B. IDC: Insulation displacement connector.
C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
D. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

1.04 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each low voltage cable for open and short circuits.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.01 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
B. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.
   1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.02 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. Size and configuration as recommended by the manufacturer.
   2. PVC insulation.
   3. PVC jacket.
   4. Flame Resistance: Comply with NFPA 262.
   5. All cabling shall be furnished and installed per equipment manufacturer’s recommendations.

2.03 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway or power-limited cable, concealed in building finishes, complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.04 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation.
2. HellermannTyton.
3. Kroy LLC.
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.01 INSTALLATION OF PATHWAYS

A. Install manufactured conduit sweeps and long-radius elbows if possible.

B. Pathway Installation in Equipment Rooms:

1. Secure conduits to backboard if entering room from overhead.
2. Extend conduits 3 inches above finished floor.
3. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.02 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets and terminals.
2. Cables may not be spliced. Secure and support cables at intervals not exceeding 60 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
3. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii.
4. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
5. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Separation from EMI Sources:

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
4. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
5. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.03 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:
1. Class 1 remote-control and signal circuits, No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.
4. Minimum sizes may be modified if manufacturer's recommendations are different.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Tests and Inspections:
1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and labeling of all components.
C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

END OF SECTION

SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at ground rings and grounding connections for separately derived systems based on NETA MTS and NFPA 70B.
    a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
    b. Include recommended testing intervals.

1.04 QUALITY ASSURANCE

A. 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.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

PART 3 - EXECUTION

3.01 APPLICATIONS

A. Conductors: Install stranded conductors unless otherwise indicated.

3.02 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase and three-phase motor and appliance branch circuits.
5. Flexible raceway runs.

END OF SECTION

SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.04 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.05 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.

1.06 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with NFPA 70.

1.07 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
   3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.
2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with two-bolt conduit clamps, single-bolt conduit clamps, or single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69, or Spring-tension clamps.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 26 0533
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. FMC: Flexible metal conduit.
C. IMC: Intermediate metal conduit.
D. LFMC: Liquidtight flexible metal conduit.

1.04 QUALITY ASSURANCE

A. 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.
B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 METAL CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Allied Tube & Conduit; a Tyco International Ltd. Co.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. Electri-Flex Co.
   6. Manhattan/CDT/Cole-Flex.
   7. Maverick Tube Corporation.
   8. O-Z Gedney; a unit of General Signal.
   9. Wheatland Tube Company.
C. Rigid Steel Conduit: ANSI C80.1.
D. IMC: ANSI C80.6.
E. EMT: ANSI C80.3.
F. FMC: Zinc-coated steel or aluminum.
G. LFMC: Flexible steel conduit with PVC jacket.
H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
   2. Fittings for EMT: Steel, set-screw or compression type.

2.02 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.
   2. Hoffman.
   3. Square D; Schneider Electric.

C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
E. Wireway Covers: Screw-cover type unless specifically noted otherwise on the drawings.
F. Finish: Manufacturer's standard enamel finish.

2.03 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
   3. Erickson Electrical Equipment Company.
   4. Hoffman.
   5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
   6. O-Z/Gedney; a unit of General Signal.
   7. RACO; a Hubbell Company.
   8. Robroy Industries, Inc.; Enclosure Division.
   9. Scott Fetzer Co.; Adalet Division.
   10. Spring City Electrical Manufacturing Company.
   11. Thomas & Betts Corporation.
   12. Walker Systems, Inc.; Wiremold Company (The).
   13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
C. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
E. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed Conduit: Rigid steel or IMC conduit.
   2. Concealed Conduit, Aboveground: RNC, Type EPC-40-PVC.
   3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
B. Comply with the following indoor applications, unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   5. Damp or Wet Locations: Rigid steel conduit or IMC.
   6. Raceways for Communications Cable in Spaces Used for Environmental Air: EMT.
   7. Raceways for Concealed General Purpose Distribution of Low-Voltage and Communications Cable: EMT.
   8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.
D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.02 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
C. Complete raceway installation before starting conductor installation.
D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
E. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
F. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
G. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
H. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
I. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in all exposed applications in this scope of work where the conduit is exposed.

3.03 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Identification for raceway.
   2. Identification for conductors and communication and control cable.
   3. Equipment identification labels.
   4. Miscellaneous identification products.

1.03 QUALITY ASSURANCE

A. Comply with NFPA 70.
B. Comply with 29 CFR 1910.145.

1.04 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
C. Coordinate installation of identifying devices with location of access panels and doors.
D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.02 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength: 50 lb, minimum.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black, except where used for color-coding.
B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 APPLICATION

A. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
   1. Fire Alarm System: Red.
B. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape marker tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.
D. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control

panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
    a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
    b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
2. Equipment to Be Labeled:
    a. Panelboards, electrical cabinets, and enclosures.
    b. Remote-controlled switches, dimmer modules, and control devices.

3.02 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
2. Colors for 208/120-V Circuits:
    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.
3. Colors for 480/277-V Circuits:
    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.
4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

END OF SECTION

SECTION 26 2816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Molded-case circuit breakers (MCCBs).
   4. Enclosures.

1.02 DEFINITIONS

A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.03 SUBMITTALS

A. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.
B. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Comply with NFPA 70.

1.05 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.
B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Construction Manager's written permission.
   4. Comply with NFPA 70E.

1.06 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.07 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

A. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   3. Lugs: Mechanical type, suitable for number, size, and conductor material.
   4. Service-Rated Switches: Labeled for use as service equipment.

2.02 NONFUSIBLE SWITCHES

A. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.03 MOLDED-CASE CIRCUIT BREAKERS

A. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

B. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

C. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and I^2t response.

E. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.04 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
   4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.03 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.05 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION

SECTION 262923
VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. BAS: Building automation system.
B. CPT: Control power transformer.
C. EMI: Electromagnetic interference.
D. IGBT: Insulated-gate bipolar transistor.
E. LAN: Local area network.
F. LED: Light-emitting diode.
G. NC: Normally closed.
H. NO: Normally open.
I. OCPD: Overcurrent protective device.
J. PID: Control action, proportional plus integral plus derivative.
K. PWM: Pulse-width modulated.
L. RFI: Radio-frequency interference.
M. TDD: Total demand (harmonic current) distortion.
N. THD(V): Total harmonic voltage demand.
O. VFC: Variable-frequency motor controller.

1.4 SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.
B. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
    1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
        a. Each installed unit's type and details.
        b. Factory-installed devices.
        c. Enclosure types and details.
        d. Nameplate legends.
        e. Short-circuit current (withstand) rating of enclosed unit.
        f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
        g. Specified modifications.
    2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.
C. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
    1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
    2. Manufacturer's written instructions for setting field-adjustable overload relays.
    3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.

4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 14 deg F and not exceeding 104 deg F.
2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F
3. Humidity: Less than 95 percent (noncondensing).
4. Altitude: Not exceeding 3300 feet.

B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical systems.
2. Indicate method of providing temporary electrical service.
3. Do not proceed with interruption of electrical systems without Owner's written permission.
4. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.8 COORDINATION

A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:

1. Torque, speed, and horsepower requirements of the load.
2. Ratings and characteristics of supply circuit and required control sequence.
3. Ambient and environmental conditions of installation location.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.10 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. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Basis-of-Design Product: Square D, ABB, Toshiba, Eaton

B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2.

C. Application: variable torque.

D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

G. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 3 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   4. Minimum Efficiency: 97 percent at 60 Hz, full load.
   5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
   6. Minimum Short-Circuit Current (Withstand) Rating: 10 kA.
   7. Ambient Temperature Rating: Not less than 14 deg F and not exceeding 104 deg F.
   8. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
   9. Humidity Rating: Less than 95 percent (noncondensing).
   10. Altitude Rating: Not exceeding 3300 feet.
   11. Vibration Withstand: Comply with IEC 60068-2-6.
   12. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
   13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
   14. Speed Regulation: Plus or minus 5 percent.
   15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
   16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, 16 or 32 bit, isolated from all power circuits.

I. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
   1. Signal: Electrical.

J. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 0.1 to 999.9 seconds.
   4. Deceleration: 0.1 to 999.9 seconds.
   5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   3. Under- and overvoltage trips.
   4. Inverter overcurrent trips.
   5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
   6. Critical frequency rejection, with three selectable, adjustable deadbands.
   7. Instantaneous line-to-line and line-to-ground overcurrent trips.
   8. Loss-of-phase protection.
   9. Reverse-phase protection.
   10. Short-circuit protection.
   11. Motor overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.
   1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
   2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
   3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
   4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
   5. NC and NO alarm contact that operates only when circuit breaker has tripped.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.

4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
      a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (V dc).
   9. Set point frequency (Hz).
   10. Motor output voltage (V ac).

E. Control Signal Interfaces:
   1. Electric Input Signal Interface:
      a. A minimum of two programmable analog inputs: 0- to 10-V dc 4- to 20-mA dc Operator-selectable "x"- to "y"-mA dc.
      b. A minimum of six multifunction programmable digital inputs.
   2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
      a. 0- to 10-V dc.
      b. 4- to 20-mA dc.
      c. Potentiometer using up/down digital inputs.
      d. Fixed frequencies using digital inputs.
   3. Output Signal Interface: A minimum of two programmable analog output signal(s) (0- to 10-V dc 4- to 20-mA dc operator-selectable "x"- to "y"-mA dc), which can be configured for any of the following:
      a. Output frequency (Hz).
      b. Output current (load).
      c. DC-link voltage (V dc).
      d. Motor torque (percent).
      e. Motor speed (rpm).
      f. Set point frequency (Hz).

4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    a. Motor running.
    b. Set point speed reached.
    c. Fault and warning indication (overtemperature or overcurrent).
    d. PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
1. Number of Loops: One.

G. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
1. Network Communications Ports: Ethernet and RS-422/485.
2. Embedded BAS Protocols for Network Communications: Interface with the submitted DDC system for this project; protocols accessible via the communications ports.

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Provide input filtering, as required, to limit TDD at input terminals of all VFCs to less than 5 percent and THD(V) to 3 percent.

2.4 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
1. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.5 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
    a. Push Buttons: Covered types;.
    b. Pilot Lights: LED types;.
    c. Selector Switches: Rotary type.
    d. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

D. Supplemental Digital Meters:
1. Elapsed-time meter.
2. Kilowatt meter.
3. Kilowatt-hour meter.

E. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 72 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

C. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. VFCs will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges.

3.7 PROTECTION

A. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION

ATTACHMENT A.6
INSURANCE REQUIREMENTS
ROUTINE CONSTRUCTION, MAINTENANCE AND REPAIR PROJECTS

Contractor shall obtain insurance of the types and in the amounts listed below.

A. COMMERCIAL GENERAL AND UMBRELLA LIABILITY INSURANCE

Contractor shall maintain commercial general liability (CGL) and, if necessary, commercial umbrella insurance with a limit of not less than $1,000,000 each occurrence. If such CGL insurance contains a general aggregate limit, it shall apply separately to this project/location.

CGL insurance shall be written on Insurance Services Office (ISO) occurrence form CG 00 01 10 93, or a substitute form providing equivalent coverage, and shall cover liability arising from premises, operations, independent contractors, products-completed operations, personal injury and advertising injury, and liability assumed under an insured contract (including the tort liability of another assumed in a business contract).

Owner shall be included as an insured under the CGL, using ISO additional insured endorsement CG 20 10 or a substitute providing equivalent coverage, and under the commercial umbrella, if any. This insurance shall apply as primary insurance with respect to any other insurance or self-insurance afforded to Owner.

There shall be no endorsement or modification of the CGL limiting the scope of coverage for liability arising from pollution, explosion, collapse, or underground property damage.

B. CONTINUING COMPLETED OPERATIONS LIABILITY INSURANCE

Contractor shall maintain commercial general liability (CGL) and, if necessary, commercial umbrella liability insurance with a limit of not less than $1,000,000 each occurrence for at least one (1) year following substantial completion of the work.

Continuing CGL insurance shall be written on ISO occurrence form CG 00 01 10 93, or substitute form providing equivalent coverage, and shall, at minimum, cover liability arising from products-completed operations and liability assumed under an insured contract.

Continuing CGL insurance shall have a products-completed operations aggregate of at least two times its each occurrence limit.

Continuing commercial umbrella coverage, if any, shall include liability coverage for damage to the insured's completed work equivalent to that provided under ISO form CG 00 01.

C. BUSINESS AUTO AND UMBRELLA LIABILITY INSURANCE

Contractor shall maintain business auto liability and, if necessary, commercial umbrella liability insurance with a limit of not less than $1,000,000 each accident. Such insurance shall cover liability arising out of any auto including owned, hired and non-owned autos.

Business auto insurance shall be written on Insurance Services Office (ISO) form CA 00 01, CA 00 05, CA 00 12, CA 00 20, or a substitute form providing equivalent liability coverage. If necessary, the policy shall be endorsed to provide contractual liability coverage equivalent to that provided in the 1990 and later editions of CA 00 01.

D. WORKERS COMPENSATION INSURANCE

Contractor shall maintain workers compensation as required by statute and employers liability insurance. The commercial umbrella and/or employers liability limits shall not be less than $1,000,000 each accident for bodily injury by accident or $1,000,000 each employee for bodily injury by disease.

If Owner has not been included as an insured under the CGL using ISO additional insured endorsement CG 20 10 under the Commercial General and Umbrella Liability Insurance required in this Contract, the Contractor waives all rights against Owner and its officers, officials, employees, volunteers and agents for recovery of damages arising out of or incident to the Contractor's work.

E. GENERAL INSURANCE PROVISIONS

1. Evidence of Insurance. Prior to beginning work, Contractor shall furnish Owner with a certificate(s) of insurance and applicable policy endorsement(s), executed by a duly authorized representative of each insurer, showing compliance with the insurance requirements set forth above.

All certificates shall provide for 30 days written notice to Owner prior to the cancellation or material change of any insurance referred to therein. Written notice to Owner shall be by certified mail, return receipt requested.

Failure of Owner to demand such certificate, endorsement or other evidence of full compliance with these insurance requirements or failure of Owner to identify a deficiency from evidence that is provided shall not be construed as a waiver of Contractor's obligation to maintain such insurance.

Owner shall have the right, but not the obligation, of prohibiting Contractor or any subcontractor from entering the project site until such certificates or other evidence that insurance has been placed in complete compliance with these requirements is received and approved by Owner.

Failure to maintain the required insurance may result in termination of this Contract at Owner's option.

With respect to insurance maintained after final payment in compliance with a requirement above, an additional certificate(s) evidencing such coverage shall be promptly provided to Owner whenever requested.

Contractor shall provide certified copies of all insurance policies required above within 10 days of Owner's written request for said copies.

2. Acceptability of Insurers. For insurance companies which obtain a rating from A.M. Best, that rating should be no less than A VII using the most recent edition of the A.M. Best's Key Rating Guide. If the Best's rating is less than A VII or a Best's rating is not obtained, the Owner has the right to reject insurance written by an insurer it deems unacceptable.

3. Cross-Liability Coverage. If Contractor's liability policies do not contain the standard ISO separation of insureds provision, or a substantially similar clause, they shall be endorsed to provide cross-liability coverage.

4. Deductibles and Self-Insured Retentions. Any deductibles or self-insured retentions must be declared to the Owner. At the option of the Owner, the Contractor may be asked to eliminate such deductibles or self insured retentions as respects the Owner, its officers, officials, employees, volunteers and agents or required to procure a bond guaranteeing payment of losses and other related costs including but not limited to investigations, claim administration and defense expenses.

5. Subcontractors. Contractor shall cause each subcontractor employed by Contractor to purchase and maintain insurance of the type specified above. When requested by the Owner, Contractor shall furnish copies of certificates of insurance evidencing coverage for each subcontractor.

F. INDEMNIFICATION

To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner and the Architect and their officers, officials, employees, volunteers and agents from and against all claims, damages, losses and expenses including but not limited legal fees (attorney's and paralegal's fees and court costs), arising

out of or resulting from the performance of the Contractor's work, provided that any such claim, damage, loss or expense (1) is attributable to bodily injury, sickness, disease or death, or injury to or destruction of tangible property, other than the work itself, including the loss of use resulting therefrom and (2) is caused in whole or I part by any wrongful or negligent act or omission of the Contractor, any Subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, except to the extent it is caused in part by a party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or otherwise reduce any other right or obligation of indemnity which would otherwise exist as to any party or person described in this Paragraph. Contractor shall similarly protect, indemnify and hold and save harmless the Owner, its officers, officials, employees, volunteers and agents against and from any and all claims, costs, causes, actions and expenses including but not limited to legal fees, incurred by reason of Contractor's breach of any of its obligations under, or Contractor's default of, any provision of the Contract.

SAMPLE LIABILITY INSURANCE ENDORSEMENT

The following spaces preceded by an asterisk (*) need not be completed if this endorsement and policy have the same inception date.

ATTACHED TO AND FORMING PART OF POLICY NUMBER	*EFFECTIVE DATE OF ENDORSEMENT	*ISSUED TO

This endorsement changes the policy. Please read it carefully.

AUTOMATIC ADDITIONAL INSUREDS

The following provision is added to (SECTION II), Who Is An Insured.

5. Any entity you are required in a written contract (hereinafter called Additional Insured) to name as an insured is an insured but only with respect to liability arising out of your premises, "your work" for the Additional Insured, or acts or omissions of the Additional Insured in connection with the general supervision of "your work" to the extent set forth below.

a. The Limits of Insurance provided on behalf of the Additional Insured are not greater than those required by such contract.

b. The coverage provided to the Additional Insured(s) is not greater than that customarily provided by the policy forms specified in and required by the contract.

c. All insuring agreements, exclusions and conditions of this policy apply.

d. In no event shall the coverages or Limits of Insurance in this Coverage Form be increased by such contract.

Except when required otherwise by contract, this insurance does not apply to:

1) "Bodily injury" or "property damage" occurring after

a) All work on the project (other than service, maintenance or repairs) to be performed by or on behalf of the Additional Insured(s) at the site of the covered operations has been completed; or

b) That portion of "your work" out of which the injury or damage arises has been put to its intended use by any person or organization other than another contractor or subcontractor engaged in performing operations for a principal as a part of the same project.

2) "Bodily injury" or "property damage" arising out of any act or omission of the Additional Insured(s) or any of their employees, other than the general supervision of work performed for the Additional Insured(s) by you.

3) "Property damage" to

a) Property owned, used or occupied by or rented to the Additional Insured(s);

b) Property in the care, custody or control of the Additional Insured(s) or over which the Additional Insured(s) is for any purpose exercising physical control; or

c) “Your work” for the Additional Insured(s).

With respect to Additional Insureds who are architects, engineers or surveyors, this insurance does not apply “bodily injury”, “property damage”, “personal injury” or “advertising injury” arising out of the rendering of or the failure to render any professional services by or for you, including:

a) The preparing, approving, or failing to prepare or approve maps, drawings, opinions, reports, surveys, change orders, designs or specifications; and

b) Supervisory, inspection or engineering services.

Any coverages provided hereunder shall be excess over any other valid and collectible insurance available to the Additional Insured(s) whether primary, excess, contingent or on any other basis unless a contract specifically requires that this insurance be primary or you request that it apply on a primary basis.

No person or organization is an Additional Insured with respect to the conduct of any current or past partnership or joint venture that is not shown as a Named Insured in the Declarations.

END OF ATTACHMENT A.6

SECTION III BUSINESS

5.00 SOLICITATION AND HIRING FOR QUALIFYING CONSTRUCTION CONTRACTS

.01 OBJECTIVE

The Peoria Park District Staff and Board believe that diversity and equity are central to our mission. Diversity of race, color, gender, disability, age, and culture in our employees and those we work with is important to fairly represent the same diversity in our community. The differing perspectives available from a diverse workforce are important to solving the complex problems of our community.

As one of the four pillars of the **Peoria Park District's 4-Pronged Approach to Equity** document, **Pillar #3** is to **Actively Promote and Encourage the Diversity, Equity and Inclusiveness of Peoria Park District funded Contractors and Suppliers**.

The Peoria Park District actively promotes and encourages maximum participation of minorities and women on Peoria Park District construction, procurement, and maintenance contracts to ensure that those we serve and those we work with look like the residents of our community.

This goal is established with the following objectives in mind:

(A) To ensure that construction contracts are awarded and administered in a nondiscriminatory manner;

(B) To meet the goals and requirements of the Illinois Human Rights Act ("Act") which requires that every party to a public contract and every eligible bidder shall refrain from unlawful discrimination and undertake affirmative action to assure equality of employment opportunity and eliminate the effects of past discrimination (775 ILCS 5/2-105(A)(1) and of the Illinois Administrative Code ("Code") which requires public contractors and subcontractors to determine if minority persons or women are underutilized in any job classification and, if such underutilization exists, to take appropriate affirmative action to rectify underutilization (44 Ill Admin Code 750.110 and 750.120);

(C) To promote the District's use of Minority-Owned and Women-Owned Businesses by removing barriers and encouraging a level playing field on which such businesses can compete fairly for construction contracts;

(D) To strive to increase capacity and participation of minority and women labor as well as Minority- Owned and Women-Owned Businesses for Peoria Park District construction projects; and

(E) To ensure that goals for Minority-Owned and Women-Owned Businesses are narrowly tailored in accordance with applicable law.

The Park Board recognizes that it is required to comply with applicable bidding laws, federal and state constitutions, statutes, and rules and regulations, as well as any applicable local ordinances.

.02 DEFINITIONS

For the purpose of this Policy, the terms set forth below shall have the following definitions:

"Minority Person" shall mean a person who is a citizen or lawful permanent resident of the United States and who is any of the following: (a) American Indian or Alaska Native (a person having origins in any of the original peoples of North and South America, including Central America, and who maintains tribal affiliation or community attachment); (b) Asian (a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent, including, but not limited to, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam); (c) Black or African American (a person having origins in any of the black racial groups of Africa); (d) Hispanic or Latino (a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race); and (e) Native Hawaiian or Other Pacific Islander (a person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands).

"Woman" shall mean a person who is a citizen or lawful permanent resident of the United States and who is of the female gender.

"Minority-Owned Business" means a business which is at least 51% owned by one or more minority persons, or in the case of a corporation, at least 51% of the stock in which is owned by one or more minority persons; and the management and daily operations of which are controlled by one or more of the minority individuals who own it.

"Women-Owned Business" means a business which is at least 51% owned by one or more women, or in the case of a corporation, at least 51% of the stock in which is owned by one or more women; and the management and daily operations of which are controlled by one or more of the women who own it.

"Qualifying Construction Contract"or "Qualifying Construction Contracts" means any any or all construction projects with an estimated total base cost of $50,000 or more.

"Responsible Bidder" means a person who has the capability in all respects to perform fully the contract requirements and who has the integrity and reliability that will assure good faith performance. Past performance may be considered as a part of this analysis. This further requires that the bidder is in compliance with the Act and Code.

"Responsive Bidder" means a person who has submitted a bid that conforms in all material respects to the invitation for bids.

"Subcontractor" includes any sub-subcontractors or any more remote contractors on the job.

Any definition above or herein that is not consistent with existing or subsequently added or amended provisions of the Act or Code shall be deemed modified to be consistent with the Act or Code. Any term used herein but not explicitly defined shall have the same meaning as in the Act or Code.

.03 PARTICIPATION GOALS AND AFFIRMATIVE STEPS

(A) Goals:

It is a goal of the Peoria Park District to ensure that the goals and provisions of the Act and Code are met and to encourage participation of minorities and women on Park District Qualifying Construction Projects.

Peoria Park District shall as permitted by law:

(1) endeavor to award not less than 20% of the total dollar amount of the Park District's Qualifying Construction Contracts to Minority-owned Businesses and not less than 5% of the total dollar amount of the Park District's Qualifying Construction Contracts to Women-owned Businesses ("Participation Goals"); and

(2) endeavor to ensure that a minimum of 20% of the total hours worked on any Qualifying Construction Contract are performed by Minority Persons and a minimum of 5% of the total hours worked are performed by Women ("Workforce Goals").

(B) Affirmative Steps:

Peoria Park District shall take the following affirmative steps to ensure that the aforesaid goals are met in respect to Qualifying Construction Projects:

1) Require that all contractors and subcontractors, as a part of their bid submission documents, provide information demonstrating that the contractor or subcontractor has examined all of its job classifications to determine if minority persons or women are underutilized in any classification, and if so, what affirmative action was taken to rectify that underutilization. (44 Ill Admin Code 750.110 (b) and 750.120);

2) Require that if a contractor or subcontractor hires additional employees in order to perform the contract or portion of the contract, it will determine the availability of minorities and women in the areas from which it might reasonably recruit and will hire for each job classification in a way that minorities and women are not underutilized (44 Ill Admin Code 750.110(c) and 120);

3) Include as a part of all contracts, and require as a part of all subcontracts, the Equal Opportunity Clause set forth in Appendix A of 44 Ill Admin Code 750;

4) Place qualified Minority-Owned and Women-Owned Businesses on solicitation lists;

5) Require that Minority-Owned and Women-Owned Businesses are solicited whenever they are potential sources, at varying sizes of projects;

6) Include in all advertisements for bid (legal notice in the Peoria Journal Star), "Bidders are also advised that contract documents for this project include the non-discrimination, equal opportunity and affirmative action provisions in the Human Rights Act and rules and regulations of

the Department of Human Rights. The Peoria Park District is an EEO organization and encourages participation by minority and female-owned firms."

7) Notify applicable plan rooms and diverse agencies which have specific outreach and contacts with local Minority-Owned Businesses or Women-Owned Businesses of current projects out for bid to encourage the broadest notification to Minority-Owned Businesses and Women-Owned Businesses;

8) Include in all bid documents, a current list of Minority-Owned and Women-Owned Businesses for general contractors to be able to contact;

9) Provide access to a website for free download ability of bid documents for all contractors, including Minority-Owned Businesses and Women-Owned Business;

10) When economically feasible and legally permissible, divide construction projects into smaller tasks or quantities to permit maximum participation by Minority-Owned and Women-Owned Businesses;

11) Establish project and delivery schedules, when feasible, that encourage participation by Minority-Owned and Women-Owned Businesses;

12) Provide the following documentation in staff recommendations to the Park Board: all contractors and agencies notified of the work, all contractors known to download the bid documents, all contractors that bid on the work, which contractors and subcontractors are minority or women owned; the racial, ethnic, and gender breakdown of the contractor and subcontractor workforce on the form provided by PPD; and whether the contractor or subcontractor has violated any law or ordinance, failed to follow any PPD policies, or breached any contract with the PPD in the past;

13) Track final statistics of Peoria Park District construction projects for Minority-Owned Businesses and Women-Owned Businesses and workforce participation numbers quarterly and annually;

14) Require the general contractor on Qualifying Construction Contracts, if subcontracts are to be let, to follow the Good Faith Effort requirements defined below.

Good Faith Effort is defined as follows:

A good faith effort means the contractor actively and aggressively sought participation by Minority-Owned and Women-Owned Businesses and/or employment of Minority Persons and Women and to meet all requirements of the Act and Code.

Evidence of good faith effort includes, as appropriate:

- Meeting the requirements of the Act and Code as set forth above on an ongoing basis .
- Based on the trades and availability of contractors required to complete the project, a

minimum of three minority/women owned firms must be contacted. The Park District's list of minority/women owned firms will be included in all bid documents.

- The bidder shall negotiate in good faith with the potential minority/women owned firms by not imposing any conditions which are not similarly imposed on all other subcontractors and suppliers, or by denying benefits ordinarily conferred on subcontractors or suppliers for the type of work for which bids were solicited. Minority and women owned businesses must be notified at least 3 business days prior to bid opening to allow adequate time to review and provide bid.

- On all Qualifying Construction Contracts, the bidder must complete and include in the bid, the **Minority/Women Owned Contact Sheet** form. This form will include name of companies contacted, the time and date companies were contacted, the method by which the companies were contacted, the response by the companies contacted, the area of work the companies were contacted about, and bid amounts received from the companies along with other comments.

- The low bidder shall provide to the Park District upon request, copies of all correspondence including without limitation, faxes, letters, text messages, and emails sent to minority/women owned firms.

- Assisting interested Minority-owned and Women-owned Businesses in obtaining bonding, lines of credit and insurance;

- Seeking services from available minority and women community organizations, contractors' groups, business assistance offices and other organizations, as appropriate, to provide assistance in recruiting Minority owned and Women-owned Businesses;

- Providing payroll records or other evidence showing the percentage of Minority Persons and Women employees;

- If a Minority-owned or Women-owned Business is rejected, providing sound reasons for rejection;

- Assisting interested Minority-owned and Women-owned Businesses in obtaining necessary equipment, supplies or materials;

- Placing qualified Minority-Owned and Women-Owned Businesses on solicitation lists;

- Ensuring that Minority-Owned and Women-Owned Businesses are solicited whenever they are potential sources, at varying sizes of projects; and

- When economically feasible and legally permissible, dividing construction projects into smaller tasks or quantities to permit maximum participation by Minority-Owned and Women-Owned Businesses

- All other good faith efforts or evidence of due diligence to meet the Park District's Workforce Goals;

.04 CONTRACT BID DOCUMENTS AND AWARD

The Park District shall include within the bid documents for each Qualifying Construction Contract:

(A) A copy of this policy (Section 5.00);

(B) An identification of what documents are required to be submitted as a part of the bid under this policy;

(C) Such documents as will assist in determining compliance with this policy (including without limitation, Company Ownership Form, EEO Form, Workforce Profile, Minority/Women Owned Contact Sheet, Contractor/Subcontractor Workforce Plan);

(D) A requirement that the contractor meet the Park District's Workforce Goals or provide evidence of a good faith effort toward meeting the goals;

(E) Appendix A of 44 Ill Admin Code 750;

(F) Notice that all subcontracts must make reference to and incorporate the provisions of this policy. To the extent a subcontract does not reference and incorporate the provisions of this policy, the contractor will be deemed in breach of contract and in violation of this policy, and shall be subject to the provisions of Section .05. below; and

(G) Such other documents as deemed appropriate.

Contracts will be awarded to the lowest Responsible and Responsive Bidder. Bids or proposals submitted without the required documentation identified in this policy are considered unresponsive and will be rejected.

.05 PROGRAM ADMINISTRATION

(A) The Executive Director or designee shall administer and enforce the provisions of this policy;

(B) The Park District Board, prior to voting on an applicable contract award, shall be provided information showing the bidder's compliance with this policy;

(C) The Executive Director or designee shall monitor, track, and report contractors' compliance with this policy over the contract duration to ensure compliance with this policy, including prompt reporting of potential violations to the DEIA Committee and Park District Board. The Park District Board, after five (5) days' notice to the contractor and allowing the

contractor to make a presentation to the Park District Board, shall make a final determination of whether a violation has occurred and what penalty or remedy should be imposed for such violation. Potential penalties or remedies include, but are not limited to, termination of any contract or subcontract, corrective action steps, PPD's contractual remedies, or that the PPD will not consider that contractor to be a responsible bidder, in accordance with Section 8-1(c) of the Park District Code, 70 ILCS 1205/8-1(c), until that contractor provides evidence of making a good faith effort toward meeting these goals, or any combination of penalties and remedies that the Board deems appropriate. The decision of the Park Board is final. The Park Board shall promptly report its decision to the DEIA Committee.

(D) The Executive Director or designee shall submit a quarterly report with statistics of Peoria Park District construction projects for Minority- Owned Businesses and Women-Owned Businesses and workforce participation numbers to DEIA Committee and to the Park Board for review; and

(E) The Executive Director or designee shall submit an annual report to the DEIA Committee and Park Board of final statistics of Peoria Park District construction projects for Minority-Owned Businesses and Women-Owned Businesses and workforce participation numbers.

SUMMARY SHEET
SOLICITATION AND HIRING FOR QUALIFYING CONSTRUCTION CONTRACTS
(Construction Projects of $50,000.00 or more)

1. **Goals**
   Bidder must meet Park District's goals stated below or provide evidence of good faith effort toward meeting the goals to be considered a Responsible and Responsive Bidder.

   - Not less than 20% of the total dollar amount of the Contract awarded to go to Minority-owned Businesses
   - Not less than 5% of the total dollar amount of the Contract awarded to go to Women-owned Businesses

   - Not less than 20% of total hours worked on the job to be by Minority Persons
   - Not less than 5% of total hours worked on the job to be by Women

   Prior to award, Bidder may be asked to attend a Park Board meeting to review goals and good faith efforts.

2. **Required bid documents**
   The following forms are required with each bid submission. Failing to submit the forms may result in the bid being non-responsive.

   - Bid Form
   - Subcontractors List
   - Certification of Compliance of Listed Provisions and Laws
   - W-9
   - Bid Bond
   - Company Ownership Certification
   - Certificate of Equal Employment Opportunity Compliance for Contractors and Vendors
   - Workforce Profile
   - Minority/Women Owned Contact Sheet
   - Contractor/Subcontractor Workforce Plan

3. **Required project administrative documents**
   - Signed Agreement Between Owner & Contractor
   - Labor & Material Bond and Performance Bond
   - Insurance
   - Proof of Certified Payroll submitted to IDOL
   - Lien Waivers
   - Contractor Affidavit
   - Contractor/Subcontractor Workforce Plan

4. **Notice to Subcontractors**
   All subcontracts must make reference to and incorporate the provisions of this Qualifying Construction Contracts Policy. To the extent a subcontract does not reference and incorporate the provisions of the policy, the contractor will be deemed in breach of contract and in violation of this policy, and shall be subject to penalties or remedies stated below.

5. **Violation & Penalties**
   During construction, not meeting self-stated goals listed on "Contractor/Subcontractor Workforce Plan" or "Minority/Women Owned Contact Sheet" shall appear to be a violation. This will result in the following:
   - Staff will notify contractor and request additional information and corrective action steps

- Staff will give notice to the Diversity, Equity, Inclusion, & Accessibility (DEIA) Committee and the Park District Board
- The Park District Board, after 5 days' notice to the contractor and allowing the contractor to make a presentation to the Park District Board, shall make a final determination of whether a violation has occurred and what penalty or remedy should be imposed for such violations
- Potential penalties or remedies include:
    - Corrective action steps
    - Termination of any contract or subcontract
    - PPD's contractual remedies
    - PPD will not consider that contractor to be a responsible bidder on future projects until contractor provides evidence of making a good faith effort toward meeting these goals, or any combination of penalties and remedies that the Board deems appropriate.

The decision of the Park Board is final.

Peoria Park District

Certificate of Equal Employment Opportunity Compliance for Contractors & Vendors

The Peoria Park District is an Equal Opportunity Employer and it agrees with each of the provisions below and requires that all suppliers, contractors, subcontractors, and vendors doing business with the Park District be Certified Equal Employment Opportunity Employers in compliance with the Illinois Human Rights Act and such regulations promulgated thereunder, and, that any and all suppliers, contractors, subcontractors or vendors who are found to be in non-compliance with the Illinois Human Rights Act or said regulations may be declared ineligible for future contracts with this Park District; and, that each and every supplier, contractor, subcontractor or vendor does at all times in connection with any dealings with this Park District agree as follows:

1) That it will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, marital status, order of protection status, national origin or ancestry, citizenship status, age, physical or mental disability unrelated to ability, military status or an unfavorable discharge from military service; and,

_____ ***Initial*** **further, that it will examine all job classifications to determine if minority persons or women are underutilized and will take appropriate affirmative action to rectify any underutilization [44 Ill Admin Code 750.110(b)].**

2) That, if it hires additional employees in order to perform this contract or any portion of this contract, it will determine the availability (in accordance with the Illinois Department of Human Rights Rules and Regulations) of minorities and women in the areas from which it may reasonably recruit and it will hire for each job classification for which employees are hired in a way that minorities and women are not underutilized.

3) That, in all solicitations or advertisements for employees placed by it or on its behalf, it will state that all applicants will be afforded equal opportunity without discrimination because of race, color, religion, sex, sexual orientation, marital status, order of protection status, national origin or ancestry, citizenship status, age, physical or mental disability unrelated to ability, military status or an unfavorable discharge from military service.

4) That it will send to each labor organization or representative of workers with which it has or is bound by a collective bargaining or other agreement or understanding, a notice advising the labor organization or representative of the contractor's obligations under the Illinois Human Rights Act and the Department's Rules and Regulations. If any labor organization or representative fails or refuses to cooperate with the contractor in its efforts to comply with such Act and Rules and Regulations, the contractor will promptly notify the Peoria Park District and will recruit employees from other sources when necessary to fulfill its obligations under the contract.

5) That it will submit reports as required by the Department's Rules and Regulations, furnish all relevant information as may from time to time be requested by the Department or the Peoria Park District, and in all respects comply with the Illinois Human Rights Act and the Department's Rules and Regulations.

6) That it will permit access to all relevant books, records, accounts and work sites by personnel of the Peoria Park District and the Department for purposes of investigation to ascertain compliance with the Illinois Human Rights Act and the Department's Rules and Regulations.

7) That it will include verbatim or by reference the provisions of this clause in every subcontract awarded under which any portion of the contract obligations are undertaken or assumed, so that the provisions will be binding upon the subcontractor. In the same manner as with other provisions of this contract, the contractor will be liable for compliance with applicable provisions of this clause by subcontractors; and further it will promptly notify the Peoria Park District and the Department in the event any subcontractor fails or refuses to comply with the provisions. In addition, the contractor will not utilize any subcontractor declared by the Illinois Human Rights Commission to be ineligible for contracts or subcontracts with the State of Illinois or any of its political subdivisions or municipal corporations.

Failure to properly complete and sign this form, certifying that the Company will agree to the above provisions of the Illinois Human Rights Act as well as the items below will result in it being returned unprocessed thereby resulting in a delay or denial of eligibility to be awarded work with the Peoria Park District.

The Company certifies that it has a written sexual harassment policy meeting the Illinois Human Rights Act and Illinois Department of Human Rights requirements.

Company Name	Company Address
Signature of Company Official	Name / Title
Telephone Number & Fax Number	Email Address

WORKFORCE PROFILE

IMPORTANT: Please complete the company workforce analysis below. Employment data must include ALL full-time company employees who were employed as of the most recent payroll period.

Job Classifications	Black Employees		White Employees		Hispanic Employees		Native American Employees		Asian Employees		Other Employees		TOTAL EMPLOYEES	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1. Officials, Managers, Supervisors														
2. Professionals														
3. Technicians														
4. Sales														
5. Office/Clerical														
6. White Collar Trainees:														
7. Skilled Crafts:														
8. Apprentices:														
9. On-the-job Trainees:														
10. Semi-skilled														
11. Service Workers														
12. Unskilled														
TOTALS														

Company Name: _____

05/2025

WORKFORCE PROFILE INSTRUCTIONS

RACE/ETHNIC IDENTIFICATION

WHITE (not of Hispanic origin): All persons having origins in any of the original peoples of Europe, North Africa, or the Middle East.

BLACK (not of Hispanic origin): All persons having origins in any of the Black racial groups of Africa.

HISPANIC: All persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race.

ASIAN or PACIFIC ISLANDER: All persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands. This area includes, for example, China, India, Japan, Korea, the Philippine Islands, and Samoa.

NATIVE AMERICAN or ALASKAN NATIVE: All persons having origins in any of the original peoples of North America, and who maintain cultural identification through tribal affiliation or community recognition.

DESCRIPTION OF JOB CLASSIFICATIONS

OFFICIALS, MANAGERS, AND SUPERVISORS - Occupations requiring administrative personnel who set broad policies, and exercise over-all responsibility for the execution of these policies, and direct individual departments or special phases of a firm's operations. Includes: officials, executives, middle management, plant managers, department managers/superintendents, salaried foremen who are members of management, purchasing agents and buyers, and kindred workers.

PROFESSIONALS - Occupations requiring either college graduation or experience of such kind and amount as to provide a comparable background. Includes: accountants/auditors, airplane pilots and navigators, architects, artists, chemists, designers, dietitians, editors, engineers, lawyers, librarians, mathematicians, natural scientists, personnel and labor relations workers, physical scientists, physicians, social scientists, teachers, and kindred workers.

TECHNICIANS - Occupations requiring combination of basic scientific knowledge and manual skill which can be obtained through about 2 years of post high school education, such as is offered in many technical institutes and junior colleges, or through equivalent on-the-job training. Includes: drafters, engineering aids, junior engineers, scientific assistants, surveyors, technical illustrators, technicians (medical, dental, electronic physical sciences), and kindred workers.

SALES WORKERS - Occupations engaging wholly or primarily in direct selling. Includes: advertising agents/salespersons, insurance agents/brokers, real estate agents/brokers, stock and bond salespersons, demonstrators, salespersons and sales clerks, and kindred workers.

OFFICE AND CLERICAL WORKERS - Includes all clerical type work regardless of level of difficulty, where the activities are predominantly non-manual though some manual work not directly involved with altering or transporting the products is included. Includes: bookkeepers, cashiers, collectors (bills and accounts), messengers and office couriers, office machine operators, shipping and receiving clerks, stenographers, typist and secretaries, telegraph and telephone operators, and kindred workers.

WHITE COLLAR TRAINEES - Persons engaged in formal training for official, managerial, professional, technical, sales, office and clerical occupations.

SKILLED CRAFTS - Manual worker of relatively high skill level having a thorough and comprehensive knowledge of the processes involved in their work. Exercise considerable independent judgement and usually receive an extensive period of training. Includes: the building trades hourly paid foremen and leadmen who are not members of management, mechanics and repairmen, skilled machining occupations, compositors and typesetters, electricians, engravers, job setters (metal), motion picture projectionists, pattern and model makers, stationary engineers, tailors and tailoresses, and kindred workers.

APPRENTICES - Persons employed in a program including work training and related instruction to learn a trade or craft which is traditionally considered an apprenticeship, regardless of whether the program is registered with a Federal or State agency.

ON-THE-JOB TRAINEES - Persons engaged in formal training for craftsmen when not trained under apprentice programs; semi-skilled, unskilled and service occupations.

SEMI-SKILLED WORKERS - Workers who operate machine or processing equipment or perform other factory-type duties of intermediate skill level which can be mastered in a few weeks and require only limited training.

SERVICE WORKERS - Workers in both protective and non-protective service occupations. Includes: attendants (hospital and other institution, professional and personal service), barbers, charwomen and cleaners, cooks (except household), counter and fountain workers, elevator operators, fire fighters, guards, watchmen and doorkeepers, stewards, janitors, police officers and detectives, porters, waiters and waitresses, and kindred workers.

UNSKILLED WORKERS - Workers in manual occupations which generally require no special training. Perform elementary duties that may be learned in a few days and require the application of little or no independent judgement. Includes: garage laborers, car washers and greasers, gardeners (except farm) and groundskeepers, longshoremen and stevedores, lumbermen, craftsmen and wood choppers, laborers performing lifting, digging, mixing loading and pulling operations, and kindred workers.

PEORIA PARK DISTRICT

Company Ownership Certification

In compliance with Illinois Public Act 102-265, and Peoria Park District policy, disclosure of the information requested in this form is required by the Peoria Park District. Failure to properly complete and sign this form will result in it being returned unprocessed thereby resulting in a delay or denial of Company's eligibility to transact business with Peoria Park District.

Please answer all questions. Note, Company may answer "Yes" to more than one category.

- **Is the Company a Minority Owned Business?** ____ YES ____ NO
  Check One:
  ____ Company holds Certification for this classification, or
  ____ Company is self-certifying
- **Is the Company a Woman Owned Business?** ____ YES ____ NO
  Check One:
  ____ Company holds Certification for this classification, or
  ____ Company is self-certifying
- **Is the Company a Disability-Owned Business?** ____ YES ____ NO
  Check One:
  ____ Company holds Certification for this classification, or
  ____ Company is self-certifying
- **Is the Company a Veteran Owned Business?** ____ YES ____ NO
  Check One:
  ____ Company holds Certification for this classification, or
  ____ Company is self-certifying
- **Is the Company a Service Disabled Veteran Owned Business?** ____ YES ____ NO
  Check One:
  ____ Company holds Certification for this classification, or
  ____ Company is self-certifying

Does Company qualify as a small business under federal Small Business Administration? ____ YES ____ NO
https://www.sba.gov/document/support-table-size-standards

Please list the name(s) of the Company majority owner(s):_____

Does Company have any parent and/or subsidiary companies? ____ YES ____ NO

If yes, please list all companies: _____

_____

By signing this form, the Company and the individual signing below attest that the above questions have been answered truthfully, to the best of their knowledge.

_____ Company Name

_____ Company Address

_____ Signature of Company Official

_____ Name / Title

_____ Telephone Number & Fax Number

_____ Email Address

Rev. 5/2022

PEORIA PARK DISTRICT

Definitions for Company Ownership Certification

- Selected Classification of Owned Business means a business which is at least 51% owned by one or more persons of the selected ownership classification (i.e. minority, women, veteran, etc.), or in the case of a corporation, at least 51% of the stock in which is owned by one or more persons of the selected ownership classification; and the management and daily operations of which are controlled by one or more of the selected ownership classification individuals who own it.
- Control means the exclusive or ultimate and sole control of the business including, but not limited to, capital investment and all other financial matters, property, acquisitions, contract negotiations, legal matters, officer-director-employee selection and comprehensive hiring, operating responsibilities, cost-control matters, income and dividend matters, financial transactions and rights of other shareholders or joint partners. Control shall be real, substantial and continuing, no pro forma. Control shall include the power to direct or cause the direction of the management and policies of the business and to make the day-to-day as well as major decisions in matters of policy, management and operations. Control shall be exemplified by possessing the requisite knowledge and expertise to run the particular business and control shall not include simple majority or absentee ownership.
- Minority person shall mean a person who is a citizen or lawful permanent resident of the United States and who is any of the following:
  a) American Indian or Alaska Native (a person having origins in any of the original peoples of North and South America, including Central America, and who maintains tribal affiliation or community attachment).
  b) Asian (a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent, including, but not limited to, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam).
  c) Black or African American (a person having origins in any of the black racial groups of Africa).
  d) Hispanic or Latino (a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race).
  e) Native Hawaiian or Other Pacific Islander (a person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands).
- Woman shall mean a person who is a citizen or lawful permanent resident of the United States and who is of the female gender.
- Veteran means a person who (i) has been a member of the armed forces of the United States or, while a citizen of the United States, was a member of the armed forces of allies of the United States in time of hostilities with a foreign country and (ii) has served under one or more of the following conditions: (a) the veteran served a total of at least 6 months; (b) the veteran served for the duration of hostilities regardless of the length of the engagement; (c) the veteran was discharged on the basis of hardship; or (d) the veteran was released from active duty because of a service connected disability and was discharged under honorable conditions.
- Service-Disabled Veteran means a veteran who has been found to have 10% or more service-connected disability by the United States Department of Veterans Affairs or the United States Department of Defense.
- A Person with a Disability means a person who is a citizen or lawful resident of the United States and is a person qualifying as being disabled, meaning a person with a severe physical or mental disability that:
  a) results from: amputation, arthritis, autism, blindness, burn injury, cancer, cerebral palsy, Crohn's disease, cystic fibrosis, deafness, head injury, heart disease, hemiplegia, hemophilia, respiratory or pulmonary dysfunction, an intellectual disability, mental illness, multiple sclerosis, muscular dystrophy, musculoskeletal disorders, neurological disorders, including stroke and epilepsy, paraplegia, quadriplegia and other spinal cord conditions, sickle cell anemia, ulcerative colitis, specific learning disabilities, or end stage renal failure disease; and
  b) substantially limits one or more of the person's major life activities.

  Another disability or combination of disabilities may also be considered as a severe disability for the purposes of item (a) of this subdivision if it is determined by an evaluation of the rehabilitation potential to cause a comparable degree of substantial functional limitation similar to the specific list of disabilities listed in item (a) of this subdivision.
- Certification means a determination made by the Business Enterprise Council for Minorities, Women, and Persons with Disabilities, or by one delegated authority from the Council to make certifications, or by a State agency with statutory authority to make such a certification, that a business entity is a business owned by a minority, woman, or person with a disability for whatever purpose.

Minority/Women Owned Contact Sheet

Proof of Contact Efforts by General Contractor of MBE/WBE firms for the project

MBE/WBE Company Name	Minority Owned or Woman Owned?	Individual Contacted at MBE/WBE also date/time	Method of Contact & Information: Phone #, Fax #, Email	Response: (Provided Bid or No Bid?)	Area of Work	Comments: If Bid accepted, give $ amount. If Bid not accepted, give justification.

Company Name _____

Contractor/Subcontractor Workforce Plan

Initial Bid/Estimating Date: _____ Progress Reporting Date: _____

Check appropriate status:

_____ Contractor

_____ Subcontractor

Company Name: _____

Address: _____

Contact Person: _____ Phone: _____

Project: _____

Date Work Started: _____ Percent Complete: _____ %

Job Categories (by Trade)	Total Est. Hrs. (Bid)	# Crew (Head Ct.)	# Minority (Head Ct.)	# Female (Head Ct.)	Planned Minority Hrs.	Planned Female Hrs.	Actual Minority Hrs. to date	Actual Female Hrs. to date
Example: Carpenter	1,000	4	1	0	250	0		
Example: Painter	300	3	1	1	100	100		
Total								

Document Purpose:

This document is a tool to estimate the number and areas of work concerning minority and female labor hours anticipated on this job.

The apparent low bidder and their subcontractors listed on the bid documents shall submit this form within one week after bid opening to the Peoria Park District.

This tool is also a means of tracking the minority and female hours on this job. This document shall be attached to each invoice to show actual minority and female hours on this job.

Job Categories (by Trade)	*List of Workers Trade Name*
Total Est. Hrs. (Bid)	*Total hours of each of the trade listed*
# Crew (Head Ct.)	*Total crew head count of each of the trade listed*
# Minority (Head Ct.)	*Total Minority head count (it is subset of Total Crew #)*
# Females (Head Ct.)	*Total Female head count (it is subset of Total Crew #)*
Planned Minority Hrs.	*Planned Minority hours of each of the trade listed*
Planned Female Hrs.	*Planned Female hours of each of the trade listed*

Contractor/Subcontractor Workforce Plan (pg 2)
Anticipated Minority & Female Hours on the Job
Implementation Outline

Initial Bid/Estimating Date: _____

Job Categories (by Trade)	Month #1 or Payment #1	Month #2 or Payment #2	Month #3 or Payment #3	Month #4 or Payment #4	Month #5 or Payment #5	Month #6 or Payment #6	Month #7 or Payment #7
Example: Carpenter			XXXXXXXXX	XXXXXXXXX	XXXXXXXXX		
Example: Painter						XXXXXXXXX	XXXXXXXXX

Document Purpose:
This document is a tool to help the Park District anticipate when minority and women hours can be expected on the project to help ensure compliance of good faith efforts.

APPENDIX A OF 44 IL ADMIN CODE 750
EQUAL EMPLOYMENT OPPORTUNITY

In the event of the contractor's non-compliance with the provisions of this Equal Employment Opportunity Clause or the Act, the contractor may be declared ineligible for future contracts or subcontracts with the State of Illinois or any of its political subdivisions or municipal corporations, and the contract may be cancelled or voided in whole or in part, and other sanctions or penalties may be imposed or remedies invoked as provided by statute or regulation. During the performance of this contract, the contractor agrees as follows:

1) That he or she will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, marital status, order of protection status, national origin or ancestry, citizenship status, age, physical or mental disability unrelated to ability, military status or an unfavorable discharge from military service; and, further, that he or she will examine all job classifications to determine if minority persons or women are underutilized and will take appropriate affirmative action to rectify any underutilization.

2) That, if he or she hires additional employees in order to perform this contract or any portion of this contract, he or she will determine the availability (in accordance with this Part) of minorities and women in the areas from which he or she may reasonably recruit and he or she will hire for each job classification for which employees are hired in a way that minorities and women are not underutilized.

3) That, in all solicitations or advertisements for employees placed by him or her or on his or her behalf, he or she will state that all applicants will be afforded equal opportunity without discrimination because of race, color, religion, sex, sexual orientation, marital status, order of protection status, national origin or ancestry, citizenship status, age, physical or mental disability unrelated to ability, military status or an unfavorable discharge from military service.

4) That he or she will send to each labor organization or representative of workers with which he or she has or is bound by a collective bargaining or other agreement or understanding, a notice advising the labor organization or representative of the contractor's obligations under the Act and this Part. If any labor organization or representative fails or refuses to cooperate with the contractor in his or her efforts to comply

with the Act and this Part, the contractor will promptly notify the Department and the contracting agency and will recruit employees from other sources when necessary to fulfill its obligations under the contract.

5) That he or she will submit reports as required by this Part, furnish all relevant information as may from time to time be requested by the Department or the contracting agency, and in all respects comply with the Act and this Part.

6) That he or she will permit access to all relevant books, records, accounts and work sites by personnel of the contracting agency and the Department for purposes of investigation to ascertain compliance with the Act and the Department's Rules and Regulations.

7) That he or she will include verbatim or by reference the provisions of this clause in every subcontract awarded under which any portion of the contract obligations are undertaken or assumed, so that the provisions will be binding upon the subcontractor. In the same manner as with other provisions of this contract, the contractor will be liable for compliance with applicable provisions of this clause by subcontractors; and further it will promptly notify the contracting agency and the Department in the event any subcontractor fails or refuses to comply with the provisions. In addition, the contractor will not utilize any subcontractor declared by the Illinois Human Rights Commission to be ineligible for contracts or subcontracts with the State of Illinois or any of its political subdivisions or municipal corporations.

Directory of Minority & Women Owned Business Enterprises
Peoria Park District

MBE-Minority Owned Business Enterprise • WBE-Women Owned Business Enterprise • DOB-Persons with Disability Owned Business Enterprise
VOB-Veteran Owned Business Enterprise • SDV-Service Disabled Veteran Owned Business Enterprise

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3 Keys Construction (MBE) Tray Keys	Construction Management 2314 Lehman Rd, Peoria, IL 61604	309-472-2721 traykeys@gmail.com
4th Distribution LLC, The (MBE) Samuel Stidwell	Commercial Building Materials 206 N Randolph St, 2nd Floor, Champaign, Illinois 61822	217-655-4174 info@the4thdistribution.com
A. Lucas & Sons Steel (WBE) Margaret Hanley	Structural Steel Fabrication 1328 SW Washington, Peoria, IL 61602	309-673-8547 Margaret@alucasiron.com
Ace In The Hole (WBE) Willa Warnkes-Sipp	Asphalt 15820 McDonald Rd, Hanna City, IL 61536	309-231-4556 patchem1@yahoo.com
AFE Construction LLC (MBE/WBE) Tommy and Monica Arbuckle	General Contractor 2216 W Altorfer Dr, Suite #2, Peoria, IL 61615	309-473-8688 309-208-3092 Cell admin@afeconstruction.net tommy@afeconstruction.net
Agile Supply Company (MBE)	Commercial Building Materials 706 West Bradley Ave, Urbana, IL 61801	217-729-2686 sales@agilesupplycompany.com
Alexander Brothers Construction Co (MBE) Arielle Alexander	Concrete, Demolition, Excavation, Landscaping PO Box 1508, Peoria, IL 61605 alexanderbrothers1997@gmail.com	309-713-3010
Alexander & Sons Construction (MBE) Leonard Alexander	Driveways, Curbs, Foundations, Layouts, Sidewalks, etc. 2415 N. Linn Street, Peoria, IL 61604 Leonardalexander1467@yahoo.com	773-628-9064 Cell
Allworld Project Management LLC (MBE) Ronnie Foster Jr	Highway, Street & Bridge Construction, Water & Sewer Line and Related Construction, Landscaping, Civil Engineering 415 South Front Street, Suite 121, Memphis, TN 38103	901-881-2985 info@allworldmail.com
Architectural Design Group, Inc (WBE) Deborah Jean Baker	Architect Services 800 SW Adams St, Peoria, IL 61602	309-672-6498 dbaker@archdesigngrp.com
Bautista Electric Enterprises Inc (MBE)	Electrical 1204 W Eads St, Urbana, IL 61801	217-637-0659 Bautistaelectricinc@gmail.com
Ben Hendricks Trucking Inc (WBE) Miranda Hendricks	Trucking, Freight 460 W Vine St, Canton, IL 61520 benhendrickstrucking@gmail.com	815-289-7994 309-647-6878
Black Squirrel Contracting (MBE) Joshua Wessels	Concrete, Painting 2037 N Aspen Road, Peoria, IL 61604	309-369-7817 blacksquirrel@yahoo.com
BMI Contractors & Assoc (MBE) Sammy Hobson	Excavation, Concrete, Demolition 1123 MacQueen, Peoria, IL 61604	309-657-4469 bmicontractors@yahoo.com
BOWA Group, The (MBE) Lee Fantroy	General 7050 S Stony Island Ave, Chicago, IL 60649	312-238-9899 lfantroy@thebowagroup.com
BPI Testing LLC (WBE)	HVAC Building Testing Services 2911 Gill Street, Ste 1A, Bloomington, IL 61704	309-663-1500 bpi@bpitestingllc.com
Buddy's Grounds Maintenance Inc (MBE) Dexter Davis	Landscaping PO Box 1125, Bloomington, IL 61702	309-824-9211 Dexterdavis2@aol.com
Built United (MBE) John Sutherland	General Contractor, Carpentry 921 S. Bosch Rd, Unit B, Peoria, IL 61607	309-699-9191 john@builtunited.com
Burnside Brothers Construction (MBE) Terry Burnside	Landscaping, General Construction 3563 SW Adams, Peoria, IL 61605	309-922-9390 terryburnside@hotmail.com
C Lindsay Sealcoating (MBE)	Paving & Asphalt Serving Peoria & Surrounding Areas	309-291-9352 309-453-8162 clindsay44@yahoo.com

C & G Concrete Construction Co Inc (WBE) Patricia Slusher	Concrete East Peoria, IL 61611	309-699-0384 309-208-4601 Cell Rodney@cngconcrete.com tricia@cngconcrete.com
CAD Construction (WBE) Kerry Keller	General Contractor 150 S Baer Rd, Tremont, IL 61568 admin@cadconstructioninc.com	309-925-2092
Central IL Consulting (WBE) Jessica Youngman	Land Surveying 531 Parkside Drive, Washburn, IL 61570	309-383-3156 youngman@mtco.com
Central Landscaping (WBE) Donna Brandenburg	Seeding, Landscaping 12512 Mendell Rd, Princeville, IL 61559	309-385-4832 cntrland@frontier.com
CJL Landscaping Inc (WBE) Rebecca Kelch	Landscaping 10902 W US Highway 150, Brimfield, IL 61517	309-691-9200 Meinders_81@yahoo.com jrdoering@att.net
Clevenger Contractors Inc (WBE) Verlee Clevenger, Misty L. Daham	Guardrail, Bridge Rail, Seeding, Fencing 355 Naples Rd, PO Box 19, Bluffs, IL 62621	217-754-3411 clever@irtc.net
CNS Forestry & Landscaping (WBE)	Forestry & Landscaping 1813 1000th St, Lincoln, IL 62656	217-792-3808
Concrete to Perfection (MBE/WBE) Elonda Whitfield	Concrete (Repair, Design, Protect, Patching) and Counter Tops 3510 N Kingston Dr Unit 21, Peoria, IL 61604 concretetoperfection@gmail.com	309-681-9508 309-472-0215 Cell
Cook Fasser (WBE)	Roofing Supplies 5835 N Galena Road, #201, Peoria, IL 61614	309-682-1600 manderson@cookfasser.com
Cordova Construction (WBE) Tina Christopher	Landscaping, Dirt Work, Concrete Removal, Curb & Gutter Removal, Sidewalk Removal 2424 N Ellory Road, Peoria, IL 61615	309-208-3448 Cell tinac18827@yahoo.com
Cranford Plumbing (WBE)	Plumbing PO Box 755, Dunlap, IL 61525	309-697-3484
Cronkhite Painting & Decorating Inc (WBE) Amy Cronkhite	Painting 1925 Woodland Knolls Rd, Metamora, IL 61548	309-208-6237 amy@cronkhitepainting.com
CSS (Construction Specialties & Services) (MBE) Dave Suzuki	Building Specialties, Design, Engineering, Estimating PO Box 120703, Peoria, IL 61614	309-685-8453 css@sai-x.com cssco@sai-x.com
Custom Underground Inc (WBE) Diane Feuchter	Directional Boring, Fiber Optic Splicing, Utility Construction 9907 W US Highway 150, Edwards, IL 61528	309-683-3677 mail@customug.com
CWG Inc (WBE) Teresa Gustafson	Demolition, Excavation, Trucking 24635 Cooper Rd, Morton, IL 61550	309-208-5461 Cell 309-208-8899 Cell
Dashco, Inc (WBE)	Insulation, siding, windows, soffits, gutters, rain/gutter guard 4901 S Becker Dr, Bartonville, Il 61607	309-633-1383 debbie@dashco.site
DECA Realty & DECA Properties (MBE) Eddie J. Washington	Real Estate Broker, Appraiser & Properties 417 W Main, Peoria, IL 61606	309-637-3322 washingtoned48@gmail.com
Design Air Inc (MBE) Christopher Eston	Commercial Air Duct Cleaning 6625 N Big Hollow Rd # 312,Peoria, IL 61615	309-693-8632 cle@designair-inc.com
Drummond Construction LLC (MBE) Charles Drummond	Sewage and stormwater treatment works or nonpoint source projects 1609 S Griswold, Peoria IL 61605	309-643-2757 drummondcharles9@gmail.com
Earth Care Unlimited Inc (WBE) Monica Thornley	Landscaping, Seeding, Sodding 3108 Panther Grove Rd, Ashland, IL 62612 earthcareunlimited@yahoo.com	217-452-7370 217-414-4321
EB Home Improvement LLC (MBE) Elbert Billups	Painting Peoria, IL	309-420-2846 billupselbert@gmail.com
Elite Armour Roofing (MBE)	Roofing, Siding, Gutters, Fascia, Soffits Dunlap, IL	800-327-4987 elitearmourroofing@gmail.com
Foster-Jacob Electric (WBE) Emily Rudesill	Electrical 826 W Main St, Peoria, IL 61606	309-674-8129 emilyj@fosterjacob.com

Fosters Custom Painting (WBE)	Painter Peoria, IL fosterscustompainting@yahoo.com	309-208-7538
Fritch Heating & Cooling (WBE)	HVAC 1004 NE Adams, Peoria, IL 61603	309-671-5360
G.A. Rich & Sons (WBE)	Mechanical and Utility Contractor, Commercial Plumbing 204 S Perry, Deer Creek, IL 61733	309-447-6231 info@garich.com
Garza Heating & Cooling (MBE)	HVAC 1304 S Western Ave, Peoria, IL 61605	309-645-6294 carlosngarza@gmail.com
Horowitz Concrete (WBE)	Concrete 128 Legion Lane, East Peoria, IL 61611	309-208-4757
Ronald A. Givens & Associates (MBE) Ronald A. Givens	Insurance & Investments 2616 N Lehman, Peoria, IL 61602	309-685-4588
GIVSCO Construction (MBE) Ronald Givens	General Contractor 2323 Lakeshore Dr, Suite B, Pekin, IL 61554	309-620-9127 info@givsco.com
Gutters & More (WBE) Kris Rainey	Gutters 157 Thunderbird Ln, East Peoria, IL 61611	309-694-4000 ksr@gutters-more.com
H & S Mechanical Inc (WBE) Tara Howard	Mechanical, Structural Steel and Electrical Contractor 5607 S Washington St, Bartonville, IL 61607	309-696-7066 tara@hsmechanicalinc.com
Hanley Industrial Services (VOB) Jim Hanley	Drafting & Design, Metal Supplies (Incl. Fabricated Steel), Highway Products, Consulting 8811 N. Industrial Road, Suite A, Peoria, IL 61615 jim@hanleyindustrialservices.com	309-261-9941
Hermann & Associates (WBE) Alisha Hermann	Consultant Engineering 4603 N Galena Rd, Peoria Heights, IL 61616 ahermann@hermannassoc.com	309-687-5566
Illinois Mechanical Service & Design (WBE) Beth Ward	HVAC PO Box 10494, Peoria, IL 61612	309-713-3640 309-713-2995 Fax service@illmsd.com
Infrastructure Engineering (MBE)	Civil Engineering 456 Fulton St, Suite 256, Peoria, IL 61602 eandrews@infrastructure-eng.com	309-637-9200 309-637-9210
Intech Innovations (SDV) John McCrary	Audio/Video Design and Integration Washington, IL 61571 jmccrary@intechinnovations.com	309-481-4361
Interlock Brick Paving (WBE) Chris Joos	Hardscaping, Landscaping, Excavating PO Box 6, Morton, IL 61550	309-696-9264
JC Construction (MBE) Frank Coates	General 1810 Stever, Peoria, IL 61605	309-303-3919 Cell
JD Traffic Inc (WBE)	Traffic Control Equipment 4200 S Ricketts Ave, Bartonville, IL	309-966-4494 Jordan@JD-Traffic.com
JM Industrial Supply (MBE/VOB) Ron Given	Maintenance Items, Tools, Soaps 2323 Lakeshore, Pekin, IL 61554	309-346-5796 sales@jmindsupply.com
Jones Electrical Contractors Inc (MBE/VOB) Ronald Jones	Electrical 5611 W Rachael Dr, Peoria, IL 61615	309-339-7690
Kadilex Construction Inc (MBE)	Rebar Installation P.O. Box 348 Wood River, IL 62095	618-216-2621 info@kadilexconstruction.com
Kelley Ironworks (WBE) Tania Hoerr	Fencing, Railings and Ironwork 4303 N Main St, East Peoria, IL 61611	309-697-9870 309-208-5207 Cell tania@kelleyiron.com
Kemper Construction (WBE)	General Contractor 423 Enterprise Dr, Canton, IL 61520	309-647-3836

Kerry Brown Trucking (MBE) Leo K. Brown	Tandem, Semi Dump, General Hauling Peoria, IL	309-251-6089 Cell leok.brown1957@gmail.com
Kreiling Roofing Co (WBE)	Residential & Commercial single ply, BUR, coatings, metal roofing, shingles, tile, slate, wood shake, with custom sheet metal details and copper work 2335 W Altorfer Dr, Peoria, IL 61615	309-673-3649 kdimler@kreiling.com
Lewis Michael Construction (MBE/WBE) Andre McKnight	Janitorial & Construction Clean-Up 2000 W Pioneer Parkway, Ste 7, Peoria, IL61615	309-686-7107 lmcm2@comcast.net
LIZZ Trucking & Hauling (MBE) Brandon Hines	Trucking/Hauling Peoria, IL 61604	309-208-5942 lizztrucking@yahoo.com
Los Amigos Concrete Construction (MBE)	Concrete Peoria, IL	309-863-6495 Eddievega599@yahoo.com
LNR Construction (MBE) Lavael Randle Sr	General Construction 2200 N Linsley St, Peoria, IL 61605	309-678-3314 Cell
M & A Plumbing (MBE) Michael Abner	Plumbing 6216 N Devonshire Avenue, Peoria, IL 61615	309-689-0133 mabner1953@icloud.com
McGinnis Transportation (WBE) Beth McGinnis	Trucking, Tandem, 24" Box Truck 336 Riverview Drive, Creve Coeur, IL 61610	309-369-4465
Millennia Professional Services of IL (MBE) Thomas Ngo	Civil Engineering, Surveying, Materials Testing 850 N Main St., Morton, IL 61550	309-321-8141 tngo@millennia.pro
Molleck Electric (WBE)	Electrical 14926 W Winchester Dr, Brimfield, IL 61517	309-446-3483 dmolleck@yahoo.com
Montefusco HVAC (WBE) Lisa Rhoades	HVAC 2400 W Park 74 Drive, Peoria, IL 61615	309-691-7400 309-208-6233 lisa@montefuscohvac.com
Murillo Concrete (MBE) Javier Murillo	Concrete Dunlap, IL	309-397-6852 murilloconcrete@gmail.com
Oberlander Electric (MBE) Chad Gardner	Electrical 1300 E Gardner Drive, Mossville, IL 61552	309-657-0259 309-694-1468 **cgardner@obie.biz**
Ogborn Plumbing (WBE)	Plumbing 311 Peach, Washington, IL 61571	309-745-5763
Peoria Brick Company (WBE)	Brick and Stone Supply 501 Cole Street, East Peoria, IL 61611	309-699-1116 info@peoriabrick.com
Peoria Metro Construction Inc (WBE) Courtney Meischner	General Contractor, Concrete Contractor 1925 S Darst St, Peoria, IL 61607	309-671-1466 info@peoriametro.com
Phoenix Corporation (WBE)	Trucking and Excavating 1006 Rosehill Rd. Port Byron IL 61275	309-523-3687 estimating@phoenixcorp.org
Pizano Electric Inc (MBE)	Electrical 716 24th St. Rock Island, IL 61201	309-373-7808 pizanoelectrical@gmail.com
Point Construction Company (MBE) Juan Madrigal	Roofing, Siding, Carpentry Peoria, IL 61614	309-635-9074 jjm025@gmail.com
Prairie Engineers of Illinois PC (WBE) Colleen Ayars	Civil Engineering, Surveying, Environmental Consulting 926 SW Adams Street, Suite 120, Peoria, IL 61602 www.prairieengineers.com	309-839-2642
Quick Electrical Contractors Inc (WBE) Lisa Quick	Electrical 445 Carter St, PO Box 49, Fairview, IL 61432	309-778-2000 lq@quickelectric.net
Rainforcing Roofing and Exteriors (MBE/WBE)	Roofing, Siding, Gutters 2617 N Sheridan Rd, Peoria, IL	309-989-3279 rainforcing.roof2022@gmail.com
Reign Construction (MBE/WBE) Bridget Booker	Iron Worker, Structural, Bridges, Rebar, Fabrication, Welding, Rigging, and Ornamental 801 W Main St, Suite A118, Peoria, IL 61606 bridget@reignconstructioninc.com	309-495-7284 309-750-4846 Cell

R.J. Rhodes Electric (MBE) Richard Joseph Rhodes	Electrical 4210 N Northbrook Ct, Peoria, IL 61614 Richard_rhodes2001@yahoo.com	309-989-7931
RNS Electric Inc (WBE) Regina Slonneger	Electrical 28558 Irish Lane, Washington, IL 61571	309-444-5200 gina@rnselectricinc.com ty@rnselectricinc.com
Rob Johnson Trucking (WBE) Jessica Johnson	Trucking East Peoria, IL 61611	309-251-2756 jessicamjohnson_80@yahoo.com
Rustic Oaks Lawn & Landscaping (MBE) Kameron Velasquez	Concrete, Landscape Design, Installation, and Maintenance East Peoria, IL 61611 office@rusticoakslandscaping.com	309-966-0689
Searle Trucking Inc (WBE) Debbie Searle	Trucking/Hauling, Trailors, Flat Dump PO Box 1084, Peoria, IL 61653	309-686-0708 searletrkn@comcast.net
Serenity Electric (MBE)	Electrical PO Box 6521, Peoria, IL 61601 jamesltaylor1955@yahoo.com	309-363-5067 Cell
Sheridan Road Lumber (WBE)	Lumber and Materials Provider 6600 N Sheridan Road, Peoria, IL 61614	309-691-0858 info@srlco.com
Sierra Glass Company (MBE)	Glass Supply 301 N. Neil Street Suite 400, Champaign, IL 61820 antwuan@sierraglasscompany.com	217-239-0644
Standard Heating & Cooling (WBE)	HVAC 906 SW Adams, Peoria, IL 61602	309-671-5417 bewalt@standardheat.com
Stoops Plumbing (WBE) Jennifer Stoops	Plumbing PO Box 320, Mackinaw, IL 61755	309-494-9500 jennifer@stoopsplumbing.com
Tabitha Ventures Inc (MBE) Edward O Taiwo	General Construction & Management 2217 N Woodcrest Dr #3E, Dunlap, IL 61525	309-692-1473 info@tabithainc.com
Thompson Brothers Inc (MBE) Todd Thompson	General Carpentry and Construction, Interior Finish Work, Millwork PO Box 313, Pekin, IL 61555	309-613-0254 office@tbrosinc.com
Tiles in Style LLC (MBE/WBE) **dba Taza Supplies** **dba Taza Construction**	Flooring Solutions Construction Materials General Construction 16940 Vincenness Ave, South Holland, IL	sales@tilesinstyle.com sales@tazasupplies.com sales@tazaconstruction.com 877-817-2841
Titan Industries (WBE)	Steel Fabrication 100 Prospect Dr, Deer Creek, IL 61733	309-440-1010
TSI Commercial Floor Covering (WBE)	Flooring 3611 N Staley Rd, Suite #1, Champaign, IL 61822	217-328-7321 marci.smith@tsicfcacr.com
Universal Paintings and Coatings (WBE)	Painting & Wallpapering 390 Wildwood Dr, Groveland, IL 61535	309-253-1569 universalcoatingsllc@gmail.com
Veya Inc (MBE)	Concrete, Curbs & Gutters, Excavation 601 S. Country Fair Drive, Champaign, IL 61821	217-607-1500 patrick@veyainc.com
Western Asphalt Inc (WBE)	Environmental Remediation & Restoration, Excavation, Demolition 2665 Prairie College Rd. Jacksonville, IL 62650	217-243-3822 info@workwithwestern.com
Will Heating & Cooling (MBE)	HVAC 2825 Humboldt, Peoria IL 61605	309-839-5280 dallaswilliams73@gmail.com
Willis Electric (WBE) Phyllis Willis	Electrical PO Box 545, Chillicothe, IL 61523	309-579-2926 309-208-3415 Cell

Peoria County Prevailing Wage Rates posted on 3/2/2026

						Overtime										
Trade Title	**Rg**	**Type**	**C**	**Base**	**Foreman**	**M-F**	**Sa**	**Su**	**Hol**	**H/W**	**Pension**	**Vac**	**Trng**	**Other Ins**	**Add OT 1.5x owed**	**Add OT 2.0x owed**
ASBESTOS ABT-GEN	All	BLD		36.00	37.50	1.5	1.5	2.0	2.0	8.90	23.58	0.00	0.80	0.00	2.51	5.02
ASBESTOS ABT-GEN	All	HWY		38.07	39.57	1.5	1.5	2.0	2.0	8.90	28.44	0.00	0.80	0.00	4.20	8.39
ASBESTOS ABT-MEC	All	BLD		35.18	38.00	1.5	1.5	2.0	2.0	16.44	14.75	0.00	0.92		2.43	4.84
BOILERMAKER	All	BLD		50.46	54.46	1.5	1.5	2.0	2.0	7.07	24.29	0.00	2.34	0.00	16.38	32.76
BRICK MASON	All	BLD		39.50	41.87	1.5	1.5	2.0	2.0	12.45	16.63	0.00	1.25		0.00	0.00
CARPENTER	All	BLD		39.06	41.81	1.5	1.5	2.0	2.0	9.95	23.19	0.00	0.81	0.00	16.57	33.14
CARPENTER	All	HWY		40.96	43.21	1.5	1.5	2.0	2.0	9.95	24.87	0.00	0.78	0.00	0.00	0.00
CEMENT MASON	All	BLD		35.96	38.71	1.5	1.5	2.0	2.0	9.00	24.00	0.00	0.86	0.00	0.00	0.00
CEMENT MASON	All	HWY		39.43	41.93	1.5	1.5	2.0	2.0	9.00	23.67	0.00	0.80	0.00	0.00	0.00
CERAMIC TILE FINISHER	All	BLD		36.21		1.5	1.5	2.0	2.0	12.45	16.63	0.00	1.24		0.00	0.00
ELECTRIC PWR EQMT OP	All	ALL		59.91	71.10	1.5	1.5	2.0	2.0	9.30	16.78	0.00	0.60	0.00	0.00	0.00
ELECTRIC PWR GRNDMAN	All	ALL		40.71	71.10	1.5	1.5	2.0	2.0	8.72	11.40	0.00	0.41	0.00	0.00	0.00
ELECTRIC PWR LINEMAN	All	ALL		66.69	71.10	1.5	1.5	2.0	2.0	9.50	18.67	0.00	0.67	0.00	0.00	0.00
ELECTRIC PWR TRK DRV	All	ALL		45.45	71.10	1.5	1.5	2.0	2.0	8.86	12.72	0.00	0.45	0.00	0.00	0.00
ELECTRICIAN	All	BLD		46.70	50.20	1.5	1.5	2.0	2.0	10.00	16.45	0.00	0.90	0.00	0.00	0.00
ELECTRONIC SYSTEM TECH	All	BLD		37.70	40.70	1.5	1.5	2.0	2.0	8.85	14.15	0.00	0.40	0.00	0.00	0.00
ELEVATOR CONSTRUCTOR	All	BLD		60.52	68.09	2.0	2.0	2.0	2.0	16.37	21.76	4.84	0.85		0.00	0.00
GLAZIER	All	BLD		41.24	43.24	1.5	1.5	1.5	2.0	15.87	11.51	0.00	1.40	0.00	0.00	0.00
HEAT/FROST INSULATOR	All	BLD		46.91	49.72	1.5	1.5	2.0	2.0	16.44	17.08	0.00	0.92		3.59	7.17
IRON WORKER	All	BLD		39.24	41.14	1.5	1.5	2.0	2.0	12.71	20.26	0.00	0.91	0.00	0.00	0.00
IRON WORKER	All	HWY		45.48	47.48	1.5	1.5	2.0	2.0	12.71	20.26	0.00	1.16	0.00	0.00	0.00
LABORER	All	BLD		34.00	35.50	1.5	1.5	2.0	2.0	8.90	23.58	0.00	0.80	0.00	2.51	5.02
LABORER	All	HWY		37.32	38.82	1.5	1.5	2.0	2.0	8.90	28.44	0.00	0.80	0.00	4.20	8.39
LABORER, SKILLED	All	BLD		34.40	35.90	1.5	1.5	2.0	2.0	8.90	23.58	0.00	0.80	0.00	2.51	5.02
LABORER, SKILLED	All	HWY		37.62	39.12	1.5	1.5	2.0	2.0	8.90	28.44	0.00	0.80	0.00	4.20	8.39
LATHER	All	BLD		39.06	41.81	1.5	1.5	2.0	2.0	9.95	23.19	0.00	0.81	0.00	16.57	33.14
MACHINERY MOVER	All	HWY		45.48	47.48	1.5	1.5	2.0	2.0	12.71	20.26	0.00	1.16	0.00	0.00	0.00

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MACHINIST	All	BLD		60.39	64.39	1.5	1.5	2.0	2.0	11.43	9.95	1.85	1.47	0.00	0.00	0.00
MARBLE FINISHER	All	BLD		36.21		1.5	1.5	2.0	2.0	12.45	16.63	0.00	1.24		0.00	0.00
MARBLE MASON	All	BLD		39.92	42.32	1.5	1.5	2.0	2.0	12.45	16.63	0.00	1.26		0.00	0.00
MILLWRIGHT	All	BLD		39.10	41.85	1.5	1.5	2.0	2.0	9.95	23.53	0.00	0.81	0.00	16.74	33.48
MILLWRIGHT	All	HWY		42.00	44.25	1.5	1.5	2.0	2.0	9.95	24.50	0.00	0.78	0.00	0.00	0.00
OPERATING ENGINEER	All	BLD	1	47.79	50.79	1.5	1.5	2.0	2.0	12.85	26.97	0.00	3.60		0.00	0.00
OPERATING ENGINEER	All	BLD	2	44.09		1.5	1.5	2.0	2.0	12.85	26.97	0.00	3.60		0.00	0.00
OPERATING ENGINEER	All	BLD	3	38.03		1.5	1.5	2.0	2.0	12.85	26.97	0.00	3.60		0.00	0.00
OPERATING ENGINEER	All	HWY	1	47.79	51.29	1.5	1.5	2.0	2.0	12.85	26.97	0.00	3.60		0.00	0.00
OPERATING ENGINEER	All	HWY	2	44.09		1.5	1.5	2.0	2.0	12.85	26.97	0.00	3.60		0.00	0.00
OPERATING ENGINEER	All	HWY	3	38.03		1.5	1.5	2.0	2.0	12.85	26.97	0.00	3.60		0.00	0.00
PAINTER	All	ALL		42.40	44.40	1.5	1.5	1.5	2.0	15.13	12.32	0.00	1.50	0.00	0.00	0.00
PAINTER - SIGNS	All	BLD		48.16	54.11	1.5	1.5	2.0	2.0	8.20	16.81	0.00	0.00	0.00	0.00	0.00
PILEDRIVER	All	BLD		41.06	43.81	1.5	1.5	2.0	2.0	9.95	23.19	0.00	0.81	0.00	16.57	33.14
PILEDRIVER	All	HWY		41.96	44.21	1.5	1.5	2.0	2.0	9.95	24.87	0.00	0.78	0.00	0.00	0.00
PIPEFITTER	All	BLD		46.60	51.73	1.5	1.5	2.0	2.0	9.95	17.49	0.00	1.65	0.00	0.00	0.00
PLASTERER	All	BLD		34.25	36.25	1.5	1.5	2.0	2.0	9.00	25.10	0.00	0.99		0.00	0.00
PLUMBER	All	BLD		42.70	47.40	1.5	1.5	2.0	2.0	9.95	19.33	0.00	1.70	0.00	0.00	0.00
ROOFER	All	BLD		38.05	40.90	1.5	1.5	2.0	2.0	10.75	13.26	0.00	0.50	0.00	0.00	0.00
SHEETMETAL WORKER	All	BLD		40.48	42.50	1.5	1.5	2.0	2.0	12.42	20.68	0.00	1.29	0.00	0.00	0.00
SIGN HANGER	All	HWY		45.48	47.48	1.5	1.5	2.0	2.0	12.71	20.26	0.00	1.16	0.00	0.00	0.00
SPRINKLER FITTER	All	BLD		50.51	53.76	1.5	1.5	2.0	2.0	12.40	17.31	0.00	0.54	0.00	0.00	0.00
STEEL ERECTOR	All	HWY		45.48	47.48	1.5	1.5	2.0	2.0	12.71	20.26	0.00	1.16	0.00	0.00	0.00
STONE MASON	All	BLD		39.50	41.87	1.5	1.5	2.0	2.0	12.45	16.63	0.00	1.25		0.00	0.00
TERRAZZO FINISHER	All	BLD		36.21		1.5	1.5	2.0	2.0	12.45	16.63	0.00	1.24		0.00	0.00
TERRAZZO MASON	All	BLD		39.92	42.32	1.5	1.5	2.0	2.0	12.45	16.63	0.00	1.26		0.00	0.00
TILE MASON	All	BLD		39.92	42.32	1.5	1.5	2.0	2.0	12.45	16.63	0.00	1.26		0.00	0.00
TRUCK DRIVER	All	ALL	1	45.29	49.65	1.5	1.5	2.0	2.0	17.11	8.06	0.00	0.25	0.00	0.00	0.00
TRUCK DRIVER	All	ALL	2	45.88	49.65	1.5	1.5	2.0	2.0	17.11	8.06	0.00	0.25	0.00	0.00	0.00
TRUCK DRIVER	All	ALL	3	46.15	49.65	1.5	1.5	2.0	2.0	17.11	8.06	0.00	0.25	0.00	0.00	0.00

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TRUCK DRIVER	All	ALL	4	46.54	49.65	1.5	1.5	2.0	2.0	17.11	8.06	0.00	0.25	0.00	0.00	0.00
TRUCK DRIVER	All	ALL	5	47.64	49.65	1.5	1.5	2.0	2.0	17.11	8.06	0.00	0.25	0.00	0.00	0.00
TRUCK DRIVER	All	O&C	1	36.23	39.72	1.5	1.5	2.0	2.0	17.11	8.06	0.00	0.25	0.00	0.00	0.00
TRUCK DRIVER	All	O&C	2	36.70	39.72	1.5	1.5	2.0	2.0	17.11	8.06	0.00	0.25	0.00	0.00	0.00
TRUCK DRIVER	All	O&C	3	36.92	39.72	1.5	1.5	2.0	2.0	17.11	8.06	0.00	0.25	0.00	0.00	0.00
TRUCK DRIVER	All	O&C	4	37.23	39.72	1.5	1.5	2.0	2.0	17.11	8.06	0.00	0.25	0.00	0.00	0.00
TRUCK DRIVER	All	O&C	5	38.11	39.72	1.5	1.5	2.0	2.0	17.11	8.06	0.00	0.25	0.00	0.00	0.00
TUCKPOINTER	All	BLD		39.50	41.87	1.5	1.5	2.0	2.0	12.45	16.63	0.00	1.25		0.00	0.00

Legend

Rg Region
Type Trade Type - All,Highway,Building,Floating,Oil & Chip,Rivers
C Class
Base Base Wage Rate
OT M-F Unless otherwise noted, OT pay is required for any hour greater than 8 worked each day, Mon through Fri. The number listed is the multiple of the base wage.
OT Sa Overtime pay required for every hour worked on Saturdays
OT Su Overtime pay required for every hour worked on Sundays
OT Hol Overtime pay required for every hour worked on Holidays
H/W Health/Welfare benefit
Vac Vacation
Trng Training
Other Ins Employer hourly cost for any other type(s) of insurance provided for benefit of worker.

Explanations PEORIA COUNTY

The following list is considered as those days for which holiday rates of wages for work performed apply: New Years Day, Memorial Day, Fourth of July, Labor Day, Thanksgiving Day, Christmas Day and Veterans Day in some classifications/counties. Generally, any of these holidays which fall on a Sunday is celebrated on the following Monday. This then makes work performed on that Monday payable at the appropriate overtime rate for holiday pay. Common practice in a given local may alter certain days of celebration. If in doubt, please check with IDOL.

Oil and chip resealing (O&C) means the application of road oils and liquid asphalt to coat an existing road surface, followed by application of aggregate chips or gravel to coated surface, and subsequent rolling of material to seal the surface.

EXPLANATION OF CLASSES

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ASBESTOS - GENERAL - removal of asbestos material/mold and hazardous materials from any place in a building, including mechanical systems where those mechanical systems are to be removed. This includes the removal of asbestos materials/mold and hazardous materials from ductwork or pipes in a building when the building is to be demolished at the time or at some close future date.

ASBESTOS - MECHANICAL - removal of asbestos material from mechanical systems, such as pipes, ducts, and boilers, where the mechanical systems are to remain.

CERAMIC TILE FINISHER, MARBLE FINISHER, TERRAZZO FINISHER

Assisting, helping or supporting the tile, marble and terrazzo mechanic by performing their historic and traditional work assignments required to complete the proper installation of the work covered by said crafts. The term "Ceramic" is used for naming the classification only and is in no way a limitation of the product handled. Ceramic takes into consideration most hard tiles.

ELECTRONIC SYSTEMS TECHNICIAN

Installation, service and maintenance of low-voltage systems which utilizes the transmission and/or transference of voice, sound, vision, or digital for commercial, education, security and entertainment purposes for the following: TV monitoring and surveillance, background/foreground music, intercom and telephone interconnect, field programming, inventory control systems, microwave transmission, multi-media, multiplex, radio page, school, intercom and sound burglar alarms and low voltage master clock systems.

Excluded from this classification are energy management systems, life safety systems, supervisory controls and data acquisition systems not intrinsic with the above listed systems, fire alarm systems, nurse call systems and raceways exceeding fifteen feet in length.

LABORER, SKILLED - BUILDING

The skilled laborer building (BLD) classification shall encompass the following types of work, irrespective of the site of the work: cutting & acetylene torch, gunnite nozzlemen, gunnite pump men & pots, kettlemen & carriers of men handling hot stuff, sandblaster nozzle men, sandblasting pump men & pots, setting up and using concrete burning bars, wood block setters, underpinning & shoring of existing buildings, and the unload-ing and handling of all material coated with creosote.

LABORER, SKILLED - HIGHWAY

The skilled laborer heavy & highway (HWY) classification shall encompass the following types of work,irrespective of the site of the work: jackhammer & drill operator, gunite pump & pot man, puddlers, vibrator men, wire fabric placer, sandblast pump & pot man, strike off concrete, unloading, handling & carrying of all creosoted piles, ties or timber, concrete burning bars, power wheelbarrows or buggies, asphalt raker, brickset-ters, cutting torchman (electric & acetylene), men setting lines to level forms, form setters, gunite nozzle man & sandblasting nozzle man, power man, and rip-rapping by hand.

TRUCK DRIVER - BUILDING, HEAVY AND HIGHWAY CONSTRUCTION Class 1. Drivers on 2 axle trucks hauling less than 9 ton. Air

compressor and welding machines and brooms, including those pulled by separate units, truck driver helpers, warehouse employees, mechanic helpers, greasers and tiremen, pickup trucks when hauling materials, tools, or workers to and from and on-the-job site, and fork lifts up to 6,000 lb. capacity.

Class 2. Two or three axle trucks hauling more than 9 ton but hauling less than 16 ton. A-frame winch trucks, hydrolift trucks, vactor trucks or similar equipment when used for transportation purposes. Fork lifts over 6,000 lb. capacity, winch trucks, four axle combination units, and ticket writers.

Class 3. Two, three or four axle trucks hauling 16 ton or more. Drivers on water pulls, articulated dump trucks, mechanics and working forepersons, and dispatchers. Five axle or more combination units.

Class 4. Low Boy and Oil Distributors.

Class 5. Drivers who require special protective clothing while employed on hazardous waste work.

TRUCK DRIVER - OIL AND CHIP RESEALING ONLY.

This shall encompass laborers, workers and mechanics who drive contractor or subcontractor owned, leased, or hired pickup, dump, service, or oil distributor trucks. The work includes transporting materials and equipment (including but not limited to, oils, aggregate supplies, parts, machinery and tools) to or from the job site; distributing oil or liquid asphalt and aggregate; stock piling material when in connection with the actual oil and chip contract. The Truck Driver (Oil & Chip Resealing) wage classification does not include supplier delivered materials.

OPERATING ENGINEERS - BUILDING

Class 1. Cranes; Overhead Cranes; Gradall; All Cherry Pickers; Mechanics; Central Concrete Mixing Plant Operator; Road Pavers (27E - Dual Drum - Tri Batchers); Blacktop Plant Operators and Plant Engineers; 3 Drum Hoist; Derricks; Hydro Cranes; Shovels; Skimmer Scoops; Koehring Scooper; Drag Lines; Backhoe; Derrick Boats; Pile Drivers and Skid Rigs; Clamshells; Locomotive Cranes; Dredge (all types) Motor Patrol; Power Blades - Dumore - Elevating and similar types; Tower Cranes (Crawler-Mobile) and Stationary; Crane-type Backfiller; Drott Yumbo and similar types considered as Cranes; Caisson Rigs; Dozer; Tournadozer; Work Boats; Ross Carrier; Helicopter; Tournapulls - all and similar types; Scoops (all sizes); Pushcats; Endloaders (all types); Asphalt Surfacing Machine; Slip Form Paver; Rock Crusher; Heavy Equipment Greaser; CMI, CMI Belt Placer, Auto Grade & 3 Track and similar types; Side Booms; Multiple Unit Earth Movers; Creter Crane; Trench Machine; Pump-crete-Belt Crete-Squeeze Cretes-Screw-type Pumps and Gypsum; Bulker & Pump - Operator will clean; Formless Finishing Machine; Flaherty Spreader or similar types; Screed Man on Laydown Machine; Wheel Tractors (industrial or Farm-type w/Dozer-Hoe-Endloader or other attachments); F.W.D. & Similar Types; Vermeer Concrete Saw.

Class 2. Dinkeys; Power Launches; PH One-pass Soil Cement Machine (and similar types); Pugmill with Pump; Backfillers; Euclid Loader; Forklifts; Jeeps w/Ditching Machine or other attachments; Tuneluger; Automatic Cement and Gravel Batching Plants; Mobile Drills (Soil Testing) and similar types; Gurries and Similar Types; (1) and (2) Drum Hoists (Buck Hoist and Similar Types); Chicago Boom; Boring Machine & Pipe Jacking Machine; Hydro Boom; Dewatering System; Straw Blower; Hydro Seeder; Assistant Heavy Equipment Greaser on Spread; Tractors (Track type) without Power Unit pulling Rollers; Rollers on Asphalt -- Brick

Macadem; Concrete Breakers; Concrete Spreaders; Mule Pulling Rollers; Center Stripper; Cement Finishing Machines & CMI Texture & Reel Curing Machines; Cement Finishing Machine; Barber Green or similar loaders; Vibro Tamper (All similar types) Self-propelled; Winch or Boom Truck; Mechanical Bull Floats; Mixers over 3 Bag to 27E; Tractor pulling Power Blade or Elevating Grader; Porter Rex Rail; Clary Screed; Truck Type Hoptoe Oilers; Fireman; Spray Machine on Paving; Curb Machines; Truck Crane Oilers; Oil Distributor; Truck-Mounted Saws.

Class 3. Air Compressor; Power Subgrader; Straight Tractor; Trac Air without attachments; Herman Nelson Heater, Dravo, Warner, Silent Glo, and similar types; Roller: Five (5) Ton and under on Earth or Gravel; Form Grader; Crawler Crane & Skid Rig Oilers; Freight Elevators - permanently installed; Pump; Light Plant; Generator; Conveyor (1) or (2) - Operator will clean; Welding Machine; Mixer (3) Bag and Under (Standard Capacity with skip); Bulk Cement Plant; Oiler on Central Concrete Mixing Plant.

OPERATING ENGINEERS - HEAVY AND HIGHWAY CONSTRUCTION

CLASS 1. Cranes; Hydro Cranes; Shovels; Crane Type Backfiller; Tower, Mobile, Crawler, & Stationary Cranes; Derricks; Hoists (3 Drum); Draglines; Drott Yumbo & Similar Types considered as Cranes; 360 Degree Swing Excavator (Shears, Grapples, Movacs, etc.); Back Hoe; Derrick Boats; Pile Driver and Skid Rigs; Clam Shell; Locomotive - Cranes; Road Pavers - Single Drum - Dual Drum - Tri Batcher; Motor Patrols & Power Blades - Dumore - Elevating & Similar Types; Mechanics; Central Concrete Mixing Plant Operator; Asphalt Batch Plant Operators and Plant Engineers; Gradall; Caisson Rigs; Skimmer Scoop - Koering Scooper; Dredges (all types); Hoptoe; All Cherry Pickers; Work Boat; Ross Carrier; Helicopter; Dozer; Tournadozer; Tournapulls - all and similar types; Operation of Concrete and all Recycle Machines; Multiple Unit Earth Movers; Scoops (all sizes); Pushcats; Endloaders (all types); Asphalt Surfacing Machine; Slip Form Paver; Rock Crusher; Operation of Material Crusher, Screening Plants, and Tunnel Boring Machine; Heavy Equipment Greaser (top greaser on spread); CMI, Auto Grade, CMI Belt Placer & 3 Track and Similar Types; Side Booms; Asphalt Heater & Planer Combination (used to plane streets); Wheel Tractors (with Dozer, Hoe or Endloader Attachments); CAT Earthwork Compactors and Similar Types; Blaw Knox Spreader and Similar Types; Trench Machines; Pump Crete - Belt Crete - Squeeze Crete - Screw Type Pumps and Gypsum (operator will clean); Creter Crane; Operation of Concrete Pump Truck; Formless Finishing Machines; Flaherty Spreader or Similar Types; Screed Man on Laydown Machine; Vermeer Concrete Saw; Operation of Laser Screed; Span Saw; Dredge Leverman; Dredge Engineer; Lull or Similar Type; Hydro-Boom Truck; Operation of Guard Rail Machine; and Starting Engineer on Pipeline or Construction (11 or more pieces) including: Air Compressor (Trailer Mounted), All Forced Air Heaters (regardless of Size), Water Pumps (Greater than 4-1/2" or Total Discharge Over 4-1/2"), Light Plants, Generators (Trailer Mounted - Excluding Decontamination Trailer), Welding Machines (Any Size or Mode of Power), Conveyor, Mixer (any size), Stud Welder, Power Pac, etc, and Ground Heater (Trailer Mounted).

CLASS 2. Bulker & Pump; Power Launches; Boring Machine & Pipe Jacking Machine; Dinkeys; Operation of Carts, Powered Haul Unit for a Boring Machine; P & H One Pass Soil Cement Machines and Similar Types; Wheel Tractors (Industry or Farm Type - Other); Back Fillers; Euclid Loader; Fork Lifts; Jeep w/Ditching Machine or Other Attachments; Tunneluger; Automatic Cement & Gravel Batching Plants; Mobile Drills - Soil Testing and Similar Types; Pugmill with Pump; All (1) and (2) Drum Hoists; Dewatering System; Straw Blower; Hydro-Seeder; Bump Grinders (self-propelled); Assistant Heavy Equipment Greaser; Apsco Spreader; Tractors (Track-Type) without Power Units Pulling Rollers; Rollers on Asphalt - Brick or Macadam; Concrete Breakers; Concrete Spreaders; Cement Strippers; Cement Finishing Machines & CMI Texture & Reel Curing Machines; Vibro-Tampers (All Similar Types Self-Propelled); Mechanical Bull Floats; Self-Propelled Concrete Saws; Truck Mounted Power Saws; Operation of Curb Cutters; Mixers - Over Three (3) Bags; Winch and Boom Trucks; Tractor Pulling Power Blade or Elevating Grader; Porter Rex Rail;

Clary Screed; Mule Pulling Rollers; Pugmill without Pump; Barber Greene or Similar Loaders; Track Type Tractor w/Power Unit attached (minimum); Fireman; Spray Machine on Paving; Curb Machines; Paved Ditch Machine; Power Broom; Self-Propelled Sweepers; Self-Propelled Conveyors; Power Subgrader; Oil Distributor; Straight Tractor; Truck Crane Oiler; Truck Type Oilers; Directional Boring Machine; Horizontal Directional Drill; Articulating End Dump Vehicles; Starting Engineer on Pipeline or Construction (6 -10 pieces) including: Air Compressor (Trailer Mounted), All Forced Air Heaters (regardless of Size), Water Pumps (Greater than 4-1/2" or Total Discharge Over 4-1/2"), Light Plants, Generators (Trailer Mounted - Excluding Decontamination Trailer), Welding Machines (Any Size or Mode of Power), Conveyor, Mixer (any size), Stud Welder, Power Pac, etc., and Ground Heater (Trailer Mounted).

CLASS 3. Straight Framed Truck Mounted Vac Unit (separately powered); Trac Air Machine (without attachments); Rollers - Five Ton and Under on Earth and Gravel; Form Graders; Bulk Cement Plant; Oilers; and Starting Engineer on Pipeline or Construction (3 - 5 pieces) including: Air Compressor (Trailer Mounted), All Forced Air Heaters (regardless of Size), Water Pumps (Greater than 4-1/2" or Total Discharge Over 4-1/2"), Light Plants, Generators (Trailer Mounted - Excluding Decontamination Trailer), Welding Machines (Any Size or Mode of Power), Conveyor, Mixer (any size), Stud Welder, Power Pac, etc., and Ground Heater (Trailer Mounted).

Other Classifications of Work:

For definitions of classifications not otherwise set out, the Department generally has on file such definitions which are available. If a task to be performed is not subject to one of the classifications of pay set out, the Department will upon being contacted state which neighboring county has such a classification and provide such rate, such rate being deemed to exist by reference in this document. If no neighboring county rate applies to the task, the Department shall undertake a special determination, such special determination being then deemed to have existed under this determination. If a project requires these, or any classification not listed, please contact IDOL at 217-782-1710 for wage rates or clarifications.

LANDSCAPING

Landscaping work falls under the existing classifications for laborer, operating engineer and truck driver. The work performed by landscape plantsman and landscape laborer is covered by the existing classification of laborer. The work performed by landscape operators (regardless of equipment used or its size) is covered by the classifications of operating engineer. The work performed by landscape truck drivers (regardless of size of truck driven) is covered by the classifications of truck driver.

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ABBREVIATIONS

▲T	TEMPERATURE DIFFERENCE	LB	POUND
Ø	ROUND	LB/HR	POUNDS PER HOUR
ABV	ABOVE	LD	LINEAR DIFFUSER
AC	AIR CONDITIONING	LP	LOW PRESSURE
AD	AREA DRAIN	LP	LIQUEFIED PETROLEUM GAS
ADD	ADDENDUM	LVR	LOUVER
A/E	ARCHITECT / ENGINEER	LWT	LEAVING WATER TEMPERATURE
AFF	ABOVE FINISHED FLOOR	MA	MIXED AIR
AFUE	ANNUAL FUEL UTILIZATION EFFICIENCY	MAX	MAXIMUM
ALT	ALTERNATE	MBH	ONE THOUSAND BTU PER HOUR
AP	ACCESS PANEL	M.C.	MECHANICAL CONTRACTOR
ARCH	ARCHITECT/ARCHITECTURAL	MD	MOTORIZED DAMPER
BAS	BUILDING AUTOMATION SYSTEM	MECH	MECHANICAL
BFF	BELOW FINISHED FLOOR	MFR	MANUFACTURER
BHP	BRAKE HORSEPOWER	MIN	MINIMUM
BLW	BELOW	MISC	MISCELLANEOUS
BTU	BRITISH THERMAL UNITS	MP	MEDIUM PRESSURE
BTUH	BRITISH THERMAL UNITS PER HOUR	MTR	MOTOR
CAP	CAPACITY	MUA	MAKE-UP/AIR
CB	CATCH BASIN	NC	NOISE CRITERIA
CD	CEILING DIFFUSER	NC	NORMALLY CLOSED
CFM	CUBIC FEET PER MINUTE	NIC	NOT IN CONTRACT
CFH	CUBIC FEET PER HOUR	NG	NATURAL GAS
CLG	CEILING	NO	NUMBER
C.M.	CONSTRUCTION MANAGER	NO	NORMALLY OPEN
CO	CLEAN OUT	NTS	NOT TO SCALE
CV	CONTROL VALVE	O	OXYGEN
CW	COLD WATER	OA	OUTSIDE AIR
D	DEGREE	ORD	OVERFLOW ROOF DRAIN
DB	DRY BULB	PD	PRESSURE DROP
DDC	DIRECT DIGITAL CONTROLS	PIV	POST INDICATOR VALVE
DIA	DIAMETER	PLBG	PLUMBING
DN	DOWN	PRESS	PRESSURE
DW	DEIONIZED WATER	PRV	PRESSURE REDUCING VALVE
EAT	ENTERING AIR TEMPERATURE	PSI	POUNDS PER SQUARE INCH
E.C.	ELECTRICAL CONTRACTOR	PSIG	POUNDS PER SQUARE INCH GAUGE
ELEC	ELECTRICAL	PWR	POWER
EQUIP	EQUIPMENT	R	DUCT RISER
EWC	ELECTRIC WATER COOLER	RA	RETURN AIR
EWT	ENTERING WATER TEMPERATURE	RCP	RADIANT CEILING PANEL
EA	EXHAUST AIR	RD	ROOF DRAIN
EG	EXHAUST GRILLE	REC	RECESSED
EXIST	EXISTING	RED	REDUCER
F	DEGREES FAHRENHEIT	RG	RETURN GRILLE
FCO	FLOOR CLEAN OUT	RH	RELATIVE HUMIDITY
FD	FLOOR DRAIN	RLA	RELIEF AIR
FDC	FIRE DEPARTMENT CONNECTION	RM	ROOM
FL	FLOOR	RPM	REVOLUTIONS PER MINUTE
FO	FUEL OIL	SA	SUPPLY AIR
FOV	FUEL OIL VENT	SAN	SANITARY
FOR	FUEL OIL RETURN	SD	SMOKE DAMPER
FOS	FUEL OIL SUPPLY	SF	SQUARE FOOT
FPC	FIRE PROTECTION CONTRACTOR	SG	SUPPLY GRILLE
FPM	FEET PER MINUTE	SM	SURFACE MOUNT
FS	FLOOR SINK	SP	STATIC PRESSURE
FT	FOOT/FEET	SR	SUPPLY REGISTER
FTR	FIN TUBE RADIATION	STM	STEAM
GAL	GALLON	T	THERMOSTAT
GF	GAS-FIRED	T.C.	TEMP CONTROLS CONTRACTOR
G.C.	GENERAL CONTRACTOR	TD	TEMPERATURE DROP
GPM	GALLONS PER MINUTE	TD	TRENCH DRAIN
GW	GREASE WASTE	TEMP	TEMPERATURE
HB	HOSE BIBB	TYP	TYPICAL
HP	HORSE POWER	UG	UNDERGROUND
HP	HIGH PRESSURE	VAC	VACUUM
HTG	HEATING	V	VENT
HTR	HEATER	VAV	VARIABLE AIR VOLUME
HW	HOT WATER	VENT	VENTILATION
HYD	HYDRANT	VTR	VENT THROUGH ROOF
ID	INDIRECT DRAIN	W	WASTE
IN	INCH	WB	WET BULB
I.E.	INVERT ELEVATION	WCO	WALL CLEAN OUT
K.E.C.	KITCHEN EQUIPMENT CONTRACTOR	WH	WALL HYDRANT
LAT	LEAVING AIR TEMPERATURE	YCO	YARD CLEANOUT

EQUIPMENT ABBREVIATIONS

AC	AIR CONDITIONING UNIT	ERV	ENERGY RECOVERY VENTILATOR
ACCU	AIR COOLING CONDENSING UNIT	EWH	ELECTRIC WATER HEATER
AHU	AIR HANDLING UNIT	FCU	FAN COIL UNIT
AS	AIR SEPARATOR	FP	FIRE PUMP
B	BOILER	GI	GREASE INTERCEPTOR
BCU	BLOWER COIL UNIT	GRV	GRAVITY ROOF VENTILATOR
CH	CHILLER	HP	HEAT PUMP
CT	COOLING TOWER	HWP	HEATING WATER PUMP
CUH	CABINET UNIT HEATER	HRU	HEAT RECOVERY UNIT
CHWP	CHILLED WATER PUMP	P	PUMP
CP	CONDENSER PUMP	PRV	POWER ROOF VENTILATOR
DBP	DOMESTIC WATER BOOSTER PUMP	RF	RETURN FAN
DC	DUCT MOUNTED COIL	RHC	REHEAT COIL
CP	DOMESTIC WATER CIRCULATING PUMP	RTU	ROOFTOP UNIT
EF	EXHAUST FAN	SP	SUMP PUMP
EDC	ELECTRIC DUCT COIL	UH	UNIT HEATER
ET	EXPANSION TANK	WH	WATER HEATER

* NOTE *

ALL GENERAL NOTES ON THIS SHEET ARE TO BE APPLIED TO ALL SUBSEQUENT SHEETS IN SHEET LIST. THE SYMBOLS AND ABBREVIATIONS SHOWN ON THIS SHEET MAY OR MAY NOT BE USED IN THIS SET OF DRAWINGS.

GENERAL PLAN SYMBOLS

- PLAN REVISION NUMBER
- DETAIL NUMBER ON SHEET / SHEET NUMBER WHERE DETAIL IS PLACED
- KEYNOTE SYMBOL
- POINT WHERE NEW CONNECTS TO EXISTING
- Room Name / Number — ROOM NAME / NUMBER
- AREA BEING DEMOLISHED
- AREA NOT IN CONTRACT
- MARK — SCHEDULED EQUIPMENT (UNDERLINED)
- MARK — NONSCHEDULED EQUIPMENT
- (E) MARK — EXISTING EQUIPMENT - HALFTONE - (E) PREFIX
- (R) MARK — EXISTING RELOCATED EQUIPMENT - (R) PREFIX

DUCTWORK SYMBOLS

- 24/12 — RECT. DUCT SIZE (WIDTH / HEIGHT)
- 18Ø — ROUND DUCT SIZE (DIAMETER)
- 18/12Ø SUPPLY AIR — OVAL DUCT SIZE (WIDTH / HEIGHT)
- 18/12 — EXISTING DUCT TO REMAIN
- 16/12 — DUCT TO BE DEMOLISHED
- SA — SUPPLY AIR
- RA — RETURN AIR
- EA — EXHAUST AIR
- OA — OUTSIDE AIR
- FLUE — FLUE GAS VENT
- CA — COMBUSTION AIR
- RECT. SUPPLY DUCT RISE / DROP
- ROUND SUPPLY DUCT RISE / DROP
- RECT. RETURN DUCT RISE / DROP
- ROUND RETURN DUCT RISE / DROP
- RECT. EXHAUST DUCT RISE / DROP
- ROUND EXHAUST DUCT RISE / DROP
- FLEXIBLE DUCTWORK

AIR TERMINALS

- SUPPLY GRILLE, REGISTER, DIFFUSER
- RETURN GRILLE, REGISTER, DIFFUSER
- EXHAUST GRILLE, REGISTER, DIFFUSER
- CD / EXG / 100 — MARK / NECK / CFM — DIFFUSER CALLOUT SYMBOL
- CD / XXX — MARK / CFM N/A — DIFFUSER CALLOUT SYMBOL UNDEFINED CFM

DAMPER TYPES

- MANUAL DAMPER
- MOTORIZED DAMPER
- BACKDRAFT DAMPER
- SMOKE DAMPER
- FIRE DAMPER
- COMB. FIRE/ SMOKE DAMPER

MECHANICAL PIPING SYMBOLS

- 2" — NOMINAL PIPE SIZE
- 2" CHWS — EXISTING PIPE TO REMAIN
- PIPE TO BE DEMOLISHED
- BD — BOILER BLOW DOWN
- BFW — BOILER FEED-WATER
- CHWS — CHILLED-WATER SUPPLY
- CHWR — CHILLED-WATER RETURN
- CWS — CONDESNER-WATER SUPPLY
- CWR — CONDESNER-WATER RETURN
- FOS — FUEL OIL SUPPLY
- FOR — FUEL OIL RETURN
- GLS — GEOTHERMAL LOOP SUPPLY
- GLR — GEOTHERMAL LOOP RETURN
- HWS — HOT-WATER SUPPLY
- HWR — HOT-WATER RETURN
- RL — REFRIGERANT LINESET
- LPS — LOW PRESSURE STEAM SUPPLY
- LPR — LOW PRESSURE STEAM RETURN
- MPS — MEDIUM PRESSURE STEAM SUPPLY
- MPR — MEDIUM PRESSURE STEAM RETURN
- HPS — HIGH PRESSURE STEAM SUPPLY
- HPR — HIGH PRESSURE STEAM SUPPLY
- NG — NATURAL GAS
- LP — LIQUID PROPANE
- C — CONDENSATE DRAIN

PIPE FITTINGS

- PIPE RISE / DROP
- PIPE ELBOW
- PIPE TEE HORIZONTAL / RISER / DROP
- PIPE CAP / CONTINUATION

PIPE ACCESSORIES

- BALANCING VALVE
- BALL VALVE
- ELEC. CONTROL VALVE
- GATE VALVE
- GENERIC ISOLATION VALVE
- PRESSURE REDUCING VALVE
- 2-WAY ELEC. CONTROL VALVE
- 3-WAY ELEC. CONTROL VALVE
- FLOW SENSOR
- PRESSURE SENSOR
- TEMPERATURE SENSOR & WELL
- UNION
- STRAINER
- ANGLE VALVE
- BUTTERFLY VALVE
- PLUG VALVE
- GAS METER
- INLINE PUMP
- HOSE BIBB/ HYDRANT
- PRESSURE GAUGE
- AIR VENT
- PRESSURE RELIEF
- STEAM TRAP

DATA DEVICES

- T — THERMOSTAT
- H — HUMIDISTAT
- H/T — TEMPERATURE & HUMIDITY DETECTOR
- T/C — TEMPERATURE & CO2 DETECTOR
- D — GENERIC DETECTOR
- DDC SENSOR. SEE ABBREVIATIONS LIST

GENERAL NOTES - MECHANICAL DEMOLITION

1. CONTRACTOR SHALL VISIT THE JOB SITE AND EXAMINE THE DRAWINGS OF OTHER TRADES PRIOR TO BIDDING TO THOROUGHLY FAMILIARIZE HIMSELF WITH EXISTING CONDITIONS AND THE SCOPE OF THE PROJECT. FAILURE TO DO SO DOES NOT RELIEVE THE CONTRACTOR OF THE RESPONSIBILITY TO UNDERSTAND THE SCOPE OR OF UNDERSTANDING ANY FIELD CONDITIONS WHICH COULD BE REASONABLY EXPECTED TO BE KNOWN BY A THOROUGH INVESTIGATION.
2. AN ATTEMPT HAS BEEN MADE TO SHOW ALL HVAC EQUIPMENT, PIPING, DUCTWORK AND DIFFUSERS. ALL CONTRACTORS SHALL VISIT THE SITE TO VERIFY COMPONENTS, LOCATIONS AND SIZES SHOWN OR NOT SHOWN. ALL COMPONENTS INDICATED FOR DEMOLITION NEED TO BE REMOVED AS NOTED ON THE DRAWINGS.
3. IT IS MANDATORY THAT THE EXISTING BUILDING REMAIN IN CONTINUOUS AND UNINTERRUPTED OPERATION DURING REPLACEMENT/UPGRADE OF THE HVAC SYSTEM. THE SPECIFIC AREAS UNDER CONSTRUCTION AT ANY SCHEDULED TIME ARE EXCLUSIVE OF THE STATEMENT. SERVICES TO THE EXISTING BUILDING SHALL BE KEPT ON CONTINUOUS OPERATION INCLUDED DOMESTIC WATER; SANITARY; STORM; STEAM; HEATING HOT WATER; HVAC SUPPLY, RETURN, AND EXHAUST DUCTWORK. ANY ABSOLUTELY NECESSARY INTERRUPTION OF THESE SERVICES TO ACCOMPLISH PROJECT CONSTRUCTION SHALL BE ARRANGED WITH THE OWNER, A MINIMUM OF TWO WEEKS IN ADVANCE. TEMPORARY SERVICES SHALL BE FURNISHED AND INSTALLED WHERE NECESSARY TO ACCOMPLISH THIS PURPOSE. TEMPORARY SERVICES SHALL BE REMOVED ONLY AFTER NEW PERMANENT SERVICES ARE INSTALLED AND FULLY OPERATIONAL.
4. EACH CONTRACTOR SHALL BE RESPONSIBLE FOR THEIR OWN DEMOLITION, REMOVAL, CAPPING, STORING, ABANDONING, DISCONNECTING, RELOCATING AND RECONNECTION OF EXISTING EQUIPMENT AND MATERIAL. ALL CUTTING, PATCHING, REPAIRING, REPLACEMENT AND REFINISHING SHALL MATCH EXISTING SUBSTRATE AS NEARLY AS POSSIBLE, FINISH WORK BY OTHERS.
5. EXCEPT WHERE OTHERWISE SHOWN OR NOTED ON THE DRAWINGS, ALL EXISTING EQUIPMENT AND MATERIAL IN AREAS TO BE REMODELED/ALTERED SHALL BE REMOVED WHERE THEY INTERFERE WITH PROPOSED NEW CONSTRUCTION AND/OR INTERFERE WITH PROPOSED USAGE OF SPACE BY OWNER AS FOLLOWS:
   a. REMOVE ANY PIPES PROTRUDING ABOVE FINISHED FLOOR OR THROUGH WALL AND CAP AND FINISH OVER WITH MATERIAL TO MATCH EXISTING.
   b. REMOVE PIPING, DUCTWORK, EQUIPMENT, ETC. INCLUDING ABANDONED TO SOURCE OF SUPPLY AND/OR MAIN LINES AS NOTED. CAP AT NEAREST ACTIVE MAIN. SUPPLY AND RETURN MAINS TO BE CAPPED. REMOVE ALL ASSOCIATED CLAMPS, HANGERS, SUPPORTS, ETC. ASSOCIATED WITH REMOVAL.
   c. IN REMODELED/ALTERED AREAS ANY PIPING OR DUCTWORK PASSING THROUGH THE REMODELED AREAS TO SERVE (OR BEING SERVED FROM EXISTING ADJACENT, REMOTE, OR SURROUNDING AREA THAT ARE TO REMAIN) SHALL BE RETAINED AND KEPT OPERATIONAL AND SHALL BE RE-ROUTED IN ALL CASES WHERE THEY INTERFERE WITH ANY NEW WORK OR USAGE TO BE ACCOMPLISHED IN THE REMODELED AREA.
   d. REPAIR ADJACENT CONSTRUCTION AND FINISHES DAMAGED DURING DEMOLITION AND EXTENSION WORK. MATCH ORIGINAL CONSTRUCTION. VERIFY ALTERNATIVE OR SPECIAL REPAIR METHODS WITH A/E BEFORE PROCEEDING WITH DEMOLITION.
   e. REPAIR ANY PIPING OR DUCT INSULATION THAT IS DAMAGED OR REMOVED DURING CONSTRUCTION.
6. SEE ARCHITECTURAL DRAWINGS AND SPECIFICATIONS FOR PHASES OF DEMOLITION AND CONSTRUCTION. COORDINATE WITH GENERAL CONTRACTOR\ CONSTRUCTION MANAGER AND ALL OTHER TRADES.
7. ITEMS THAT ARE NOT IN THE REQUIRED SCOPE OF DEMOLITION, OR AS SPECIFICALLY NOTED, SHALL REMAIN IN PLACE. SUCH ITEMS, INCLUDING ASSOCIATED EQUIPMENT, FIXTURES, DOMESTIC PLUMBING, SANITARY AND STORM PIPING, SHALL BE MAINTAINED OPERATIONAL AND IN GOOD CONDITION BY THIS CONTRACTOR.

PROJECT NOTES - MECHANICAL

1. ALL WORK OUTSIDE OF THE PROJECT AREA SHALL BE PERFORMED ON NIGHTS OR WEEKENDS. MECHANICAL CONTRACTOR SHALL INCLUDE ALL PREMIUM LABOR COSTS IN THEIR BID. COORDINATE WORK WITH THE GENERAL CONTRACTOR AND OWNER.
2. THE MECHANICAL CONTRACTOR SHALL USE THE GRAPHIC PRODUCTS ANSI PIPE MARKERS, STANDARDS COMPLIANT PIPE LABELS, THE GRAPHIC PRODUCTS LINE OF ANSI PIPE MARKERS. FOLLOW THE ANSI/ASME PIPE MARKER SIZE CHART AND PLACEMENT GUIDANCE FOR LABELING OF MECHANICAL PIPE, DUCTWORK AND EQUIPMENT.

GENERAL NOTES - MECHANICAL

1. PROVIDE ALL MATERIALS AND EQUIPMENT AND PERFORM ALL LABOR REQUIRED TO INSTALL COMPLETE AND OPERABLE HVAC SYSTEMS AS INDICATED ON DRAWINGS, AS SPECIFIED, AND AS REQUIRED BY MOST CURRENT INTERNATIONAL MECHANICAL CODE AND ANY APPLICABLE LOCAL CODES. PROVIDE CLEARANCE FOR INSPECTION, REPAIR, REPLACEMENT, AND SERVICE TO ALL EQUIPMENT TO INCLUDE A MINIMUM OF 36 INCHES FROM ALL OBSTRUCTIONS (WALLS, STRUCTURE, DUCTWORK, PIPES, ETC.). CLEARANCE SHALL MAINTAIN ACCESS TO ALL ELECTRICAL PANELS, ACCESS DOORS, CONTROLLERS, VALVES, JUNCTION BOXES AND OPERATORS AND INCLUDE THE AREA DIRECTLY IN FRONT OF AND ABOVE THE SYSTEM COMPONENTS. INSTALL PIPING SO THAT ALL VALVES, STRAINERS, UNIONS, FLANGES, ACCESSORIES, AND OTHER APPARATUS REQUIRING ACCESS ARE ACCESSIBLE.
2. MECHANICAL CONTRACTOR SHALL VISIT THE JOB SITE AND EXAMINE THE DRAWINGS OF OTHER TRADES PRIOR TO BIDDING TO THOROUGHLY FAMILIARIZE HIMSELF WITH EXISTING CONDITIONS AND THE SCOPE OF THE PROJECT. FAILURE TO DO SO DOES NOT RELIEVE THE MECHANICAL CONTRACTOR OF THE RESPONSIBILITY TO UNDERSTAND THE SCOPE OR OF UNDERSTANDING ANY FIELD CONDITIONS WHICH COULD BE REASONABLY EXPECTED TO BE KNOWN BY A THOROUGH INVESTIGATION.
3. DRAWINGS ARE DIAGRAMMATICAL IN NATURE. IT IS NOT INTENDED THAT THE DRAWINGS SHOW EVERY DUCT, FITTING, TRANSITION, DAMPER, ETC., AND IT IS UNDERSTOOD THAT WHILE THE DRAWINGS MUST BE FOLLOWED AS CLOSELY AS CIRCUMSTANCES WILL PERMIT, THE PROPER INSTALLATION ACCORDING TO THE TRUE INTENT AND MEANING OF THE DRAWINGS, LOCAL CODES AND STANDARD PRACTICES SHALL BE PROVIDED. MECHANICAL CONTRACTOR TO PROVIDE ALL DUCTWORK TRANSITIONS, FLEXIBLE CONNECTIONS, AND ACCESSORIES AS REQUIRED. FIELD VERIFY ALL EXISTING CONDITIONS PRIOR TO INSTALLATION. REPORT ANY PROBLEMS OR CONFLICTS TO THE OWNER OR ENGINEER.
4. ANY MINOR CHANGES IN THE LOCATION OF EQUIPMENT, DUCTS, PIPE CONTROL DEVICES, ETC., FROM THOSE LOCATIONS SHOWN ON THE DRAWINGS SHALL BE MADE WITHOUT EXTRA COST IF SO DIRECTED BY THE OWNERS REPRESENTATIVE OR ENGINEER BEFORE THE INSTALLATION IS MADE. A MINOR CHANGE IN LOCATION SHALL BE CONSIDERED TO BE WITHIN 6'-0 " OF THE ORIGINALLY INDICATED LOCATIONS.
5. VERIFY ALL DIMENSIONS BY FIELD MEASUREMENTS. VERIFY FINAL LOCATIONS FOR ROUGH-INS WITH FIELD MEASUREMENTS AND WITH THE REQUIREMENTS OF THE ACTUAL EQUIPMENT TO BE CONNECTED.
6. WHERE MOUNTING HEIGHTS ARE NOT DETAILED OR DIMENSIONED, INSTALL SYSTEMS, MATERIALS, AND EQUIPMENT TO PROVIDE THE MAXIMUM HEADROOM POSSIBLE.
7. INSTALL SYSTEMS, MATERIALS AND EQUIPMENT LEVEL AND PLUMB, PARALLEL AND PERPENDICULAR TO OTHER BUILDING SYSTEMS AND COMPONENTS WHERE INSTALLED EXPOSED IN FINISHED SPACES AND GIVING RIGHT-OF-WAY PRIORITY TO SYSTEMS REQUIRED TO BE INSTALLED AT A SPECIFIED SLOPE.
8. INSTALL ALL HVAC EQUIPMENT IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS, CONTRACT DOCUMENTS, AND APPLICABLE CODES AND REGULATIONS.
9. ALL OPENINGS IN FIRE-RATED AND SMOKE-RATED WALLS DUE TO DUCTWORK, PIPING AND CONTROL CONDUIT SHALL BE FIRE-STOPPED WITH AN APPROVED FIRE STOP MATERIAL. COORDINATE INSTALLATION WITH ARCHITECTURAL CODE PLANS.
10. PROVIDE ACCESS DOORS IN DUCTWORK OR WALLS/CEILING FOR OPERATION, ADJUSTMENT, AND MAINTENANCE OF ALL FANS, VALVES, COILS, AND MECHANICAL EQUIPMENT. COILS LOCATED IN DUCTWORK TO BE PROVIDED WITH ACCESS DOORS ON OUTLET SIDE OF COIL.
11. LOCATIONS AND SIZES OF ALL FLOOR, CEILING AND WALL OPENINGS SHALL BE COORDINATED WITH ALL OTHER TRADES INVOLVED AND THE OWNER.
12. MECHANICAL CONTRACTOR SHALL COORDINATE CEILING DIFFUSER/GRILLE/REGISTER LOCATIONS WITH LIGHTING, FIRE ALARM EQUIPMENT AND FIRE SUPPRESSION SYSTEMS.
13. WHERE NEW WORK OCCURS, MECHANICAL CONTRACTOR SHALL PATCH AND SEAL ALL WALLS, FLOORS AND CEILINGS TO MATCH EXISTING. MECHANICAL CONTRACTOR SHALL VERIFY WITH OWNER ALL PATCHING MATERIALS AND INSTALLATION METHODS.
14. MECHANICAL CONTRACTOR SHALL PROVIDE MANUAL BALANCE DAMPERS IN ALL BRANCH TAKE-OFFS TO SUPPLY DIFFUSERS. PROVIDE ADDITIONAL MANUAL BALANCE DAMPERS IN MAIN AND SUB-MAIN DUCTS AS REQUIRED TO ENSURE THE SUPPLY AND RETURN AIR SYSTEMS CAN BE BALANCED TO THE SPECIFIED DESIGN AIRFLOW.
15. IN AREAS WHERE A CEILING GRID EXISTS, THE MECHANICAL CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVAL AND REPLACEMENT OF EXISTING CEILING GRID AND TILES AS NECESSARY FOR INSTALLATION OF VENTILATING WORK. ANY PORTION OF THE EXISTING TILES OR GRID WHICH BECOME DAMAGED DURING REMOVAL SHALL BE REPLACED BY THE MECHANICAL CONTRACTOR.
16. DO NOT ROUTE DUCT OR PIPING ABOVE OR BELOW ELECTRICAL PANELS INCLUDING SERVICE CLEARANCES.
17. ALL RECTANGULAR AND/OR ROUND SUPPLY AND RETURN DUCTWORK SHOWN ON THE PLANS MAY BE CONVERTED TO EQUIVALENT ROUND/RECTANGULAR DUCTWORK AT THE DISCRETION OF THE MECHANICAL CONTRACTOR. ANY DUCT CONVERSIONS SHALL BE SUBMITTED AS PART OF THE DUCTWORK SHOP DRAWINGS FOR APPROVAL BY THE ENGINEER.
18. MECHANICAL CONTRACTOR IS RESPONSIBLE FOR FIELD VERIFYING METHODS OF BRINGING IN MECHANICAL EQUIPMENT THROUGH BUILDING INTO MECHANICAL ROOMS.
19. PIPING SHALL NOT BE SUPPORTED FROM OTHER PIPING, CONDUIT, OR DUCTWORK.
20. PROVIDE CHAIN WHEEL OPERATORS FOR ALL VALVES IN EQUIPMENT ROOMS MOUNTED GREATER THAN 7'-0" ABOVE FLOOR LEVEL. CHAIN SHALL EXTEND TO 7'-0" ABOVE FLOOR LEVEL.
21. COORDINATE PIPE ROUTING TO AVOID RUNNING PIPING BELOW ROOF HATCHES, SKYLIGHTS AND ACCESS PANELS.
22. ALL CONTROL WIRING ROUTED EXPOSED IN SPACES SUCH AS MECHANICAL ROOMS OR ABOVE HARD CEILINGS SHALL BE ROUTED IN CONDUIT. CONTROL WIRING ROUTED ABOVE ACCESSIBLE CEILINGS IS NOT REQUIRED TO BE RUN IN CONDUIT, BUT SHOULD BE SECURELY STRAPPED TO PERMANENT SUPPORTS FOR A CLEAN INSTALLATION.
23. ALL THERMOSTATS SHALL BE MOUNTED AT SAME ELEVATION AS ADJACENT LIGHT SWITCHES UNLESS NOTED OTHERWISE.

MECHANICAL SHEET INDEX

M000	MECHANICAL TITLE SHEET
MD100	LOWER LEVEL - MECHANICAL DEMOLITION
M100	LOWER LEVEL - MECHANICAL NEW WORK
M500	MECHANICAL DETAILS
M600	MECHANICAL SCHEDULES

ADAM CARTER
062-072502
EXPIRES: 30NOV27
REGISTERED PROFESSIONAL ENGINEER
STATE OF ILLINOIS

DATE: 04/03/2026

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Noble Center Chiller Replacement

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REVISIONS:

NO.	DESCRIPTION	DATE

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DESIGNED BY: JJO | CHECKED BY: AEC

PROJECT NO: 325-082

ISSUE DATE: 04/03/2026

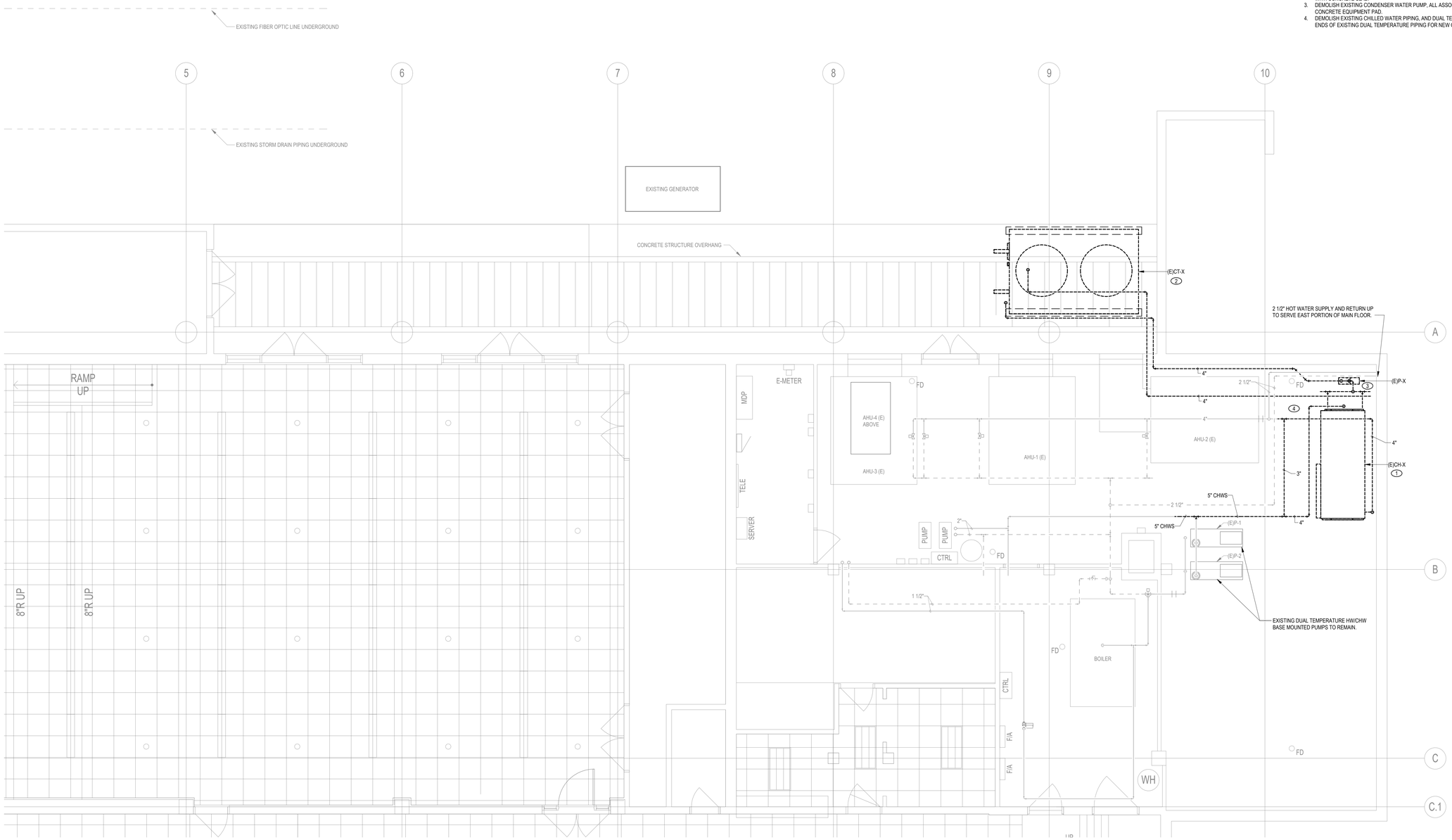
ISSUANCE: ISSUED FOR BIDDING

SHEET NAME: **MECHANICAL TITLE SHEET**

SHEET (30X42): M000

KEYED NOTES:

1. DEMOLISH EXISTING CHILLER, 12" TALL CONCRETE EQUIPMENT PAD, FEET, AND DISCONNECT PNEUMATIC CONTROLS AND PROPERLY CAP. BENDING OR CRIMPING OF PNEUMATIC TUBES IS NOT ACCEPTABLE. VACUUM DOWN AND RECLAIM ALL REFRIGERANT FOR PROPER DISPOSAL.
2. DEMOLISH EXISTING COOLING TOWER, ALL ASSOCIATED CONDENSER WATER PIPING, ALL MAKE UP WATER PIPING, ALL CHEMICAL FEED PIPING, AND EQUIPMENT. DISCONNECT PNEUMATIC CONTROLS AND PROPERLY CAP. BENDING OR CRIMPING OF PNEUMATIC TUBES IS NOT ACCEPTABLE. DEMOLISH EXISTING CONCRETE EQUIPMENT SUPPORT CURBS BENEATH EXISTING COOLING TOWER, FLUSH WITH CONCRETE SLAB.
3. DEMOLISH EXISTING CONDENSER WATER PUMP, ALL ASSOCIATED CONDENSER WATER PIPING, AND CONCRETE EQUIPMENT PAD.
4. DEMOLISH EXISTING CHILLED WATER PIPING, AND DUAL TEMPERATURE PIPING AS SHOWN. PREPARE ENDS OF EXISTING DUAL TEMPERATURE PIPING FOR NEW CONNECTIONS (TYP).



N

1 LOWER LEVEL - MECHANICAL DEMOLITION PLAN

1/4" = 1'-0"

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PROJECT NO: 325-082	
ISSUE DATE: 04/03/2026	
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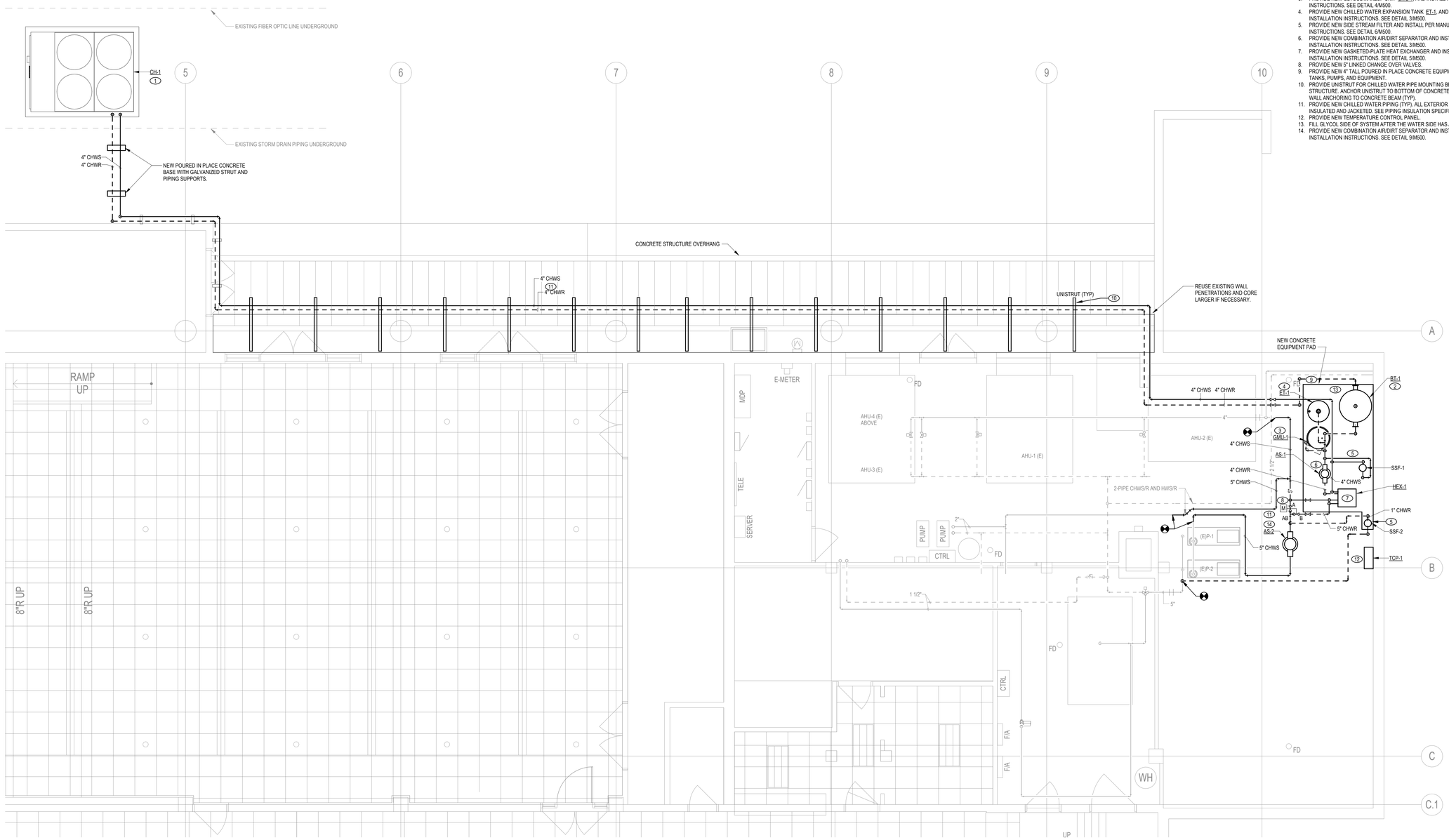
SHEET NAME: LOWER LEVEL - MECHANICAL DEMOLITION	
SHEET (30X42): MD100	



N

1 LOWER LEVEL - MECHANICAL PLAN

1/4" = 1'-0"

KEYED NOTES:

1. PROVIDE NEW PACKAGED AIR COOLED CHILLER CH-1, AND INSTALL PER MANUFACTURER'S INSTALLATION INSTRUCTIONS. PROVIDE 6" TALL POURED IN PLACE CONCRETE EQUIPMENT PAD WITH AT LEAST 6" SURROUNDING THE FOOTPRINT OF THE NEW CHILLER. SEE DETAIL 7/M500. COORDINATE EXACT LOCATION OF NEW CONCRETE EQUIPMENT PAD WITH EXISTING STORM DRAIN PIPING AND FIBER OPTIC LINES UNDERGROUND.
2. PROVIDE NEW BUFFER TANK BT-1, AND INSTALL PER MANUFACTURER'S INSTALLATION INSTRUCTIONS. SEE DETAIL 9/M500.
3. PROVIDE NEW GLYCOL MAKEUP UNIT GMU-1, AND INSTALL PER MANUFACTURER'S INSTALLATION INSTRUCTIONS. SEE DETAIL 4/M500.
4. PROVIDE NEW CHILLED WATER EXPANSION TANK ET-1, AND INSTALL PER MANUFACTURER'S INSTALLATION INSTRUCTIONS. SEE DETAIL 3/M500.
5. PROVIDE NEW SIDE STREAM FILTER AND INSTALL PER MANUFACTURER'S INSTALLATION INSTRUCTIONS. SEE DETAIL 6/M500.
6. PROVIDE NEW COMBINATION AIR/DIRT SEPARATOR AND INSTALL PER MANUFACTURER'S INSTALLATION INSTRUCTIONS. SEE DETAIL 3/M500.
7. PROVIDE NEW GASKETED-PLATE HEAT EXCHANGER AND INSTALL PER MANUFACTURER'S INSTALLATION INSTRUCTIONS. SEE DETAIL 5/M500.
8. PROVIDE NEW 5" LINKED CHANGE OVER VALVES.
9. PROVIDE NEW 4" TALL POURED IN PLACE CONCRETE EQUIPMENT PAD FOR FLOOR-STANDING TANKS, PUMPS, AND EQUIPMENT.
10. PROVIDE UNISTRUT FOR CHILLED WATER PIPE MOUNTING BENEATH EXTERIOR CONCRETE TRUSS STRUCTURE. ANCHOR UNISTRUT TO BOTTOM OF CONCRETE TRUSS AND EXTEND TO EXTERIOR WALL ANCHORING TO CONCRETE BEAM (TYP).
11. PROVIDE NEW CHILLED WATER PIPING (TYP). ALL EXTERIOR CHILLED WATER PIPING TO BE INSULATED AND JACKETED. SEE PIPING INSULATION SPECIFICATION FOR MORE INFORMATION.
12. PROVIDE NEW TEMPERATURE CONTROL PANEL.
13. FILL GLYCOL SIDE OF SYSTEM AFTER THE WATER SIDE HAS ALREADY BEEN FILLED WITH WATER.
14. PROVIDE NEW COMBINATION AIR/DIRT SEPARATOR AND INSTALL PER MANUFACTURER'S INSTALLATION INSTRUCTIONS. SEE DETAIL 9/M500.

LICENSED PROFESSIONAL ENGINEER
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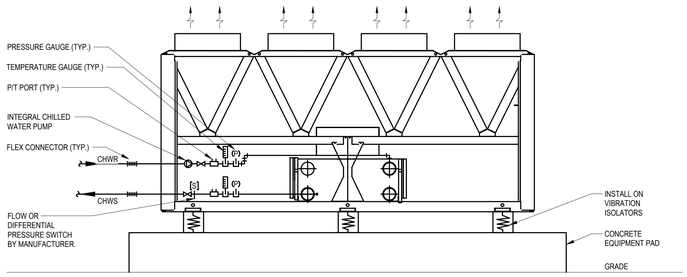
ISSUANCE: ISSUED FOR BIDDING	

SHEET NAME:

LOWER LEVEL - MECHANICAL NEW WORK

SHEET (30X42):

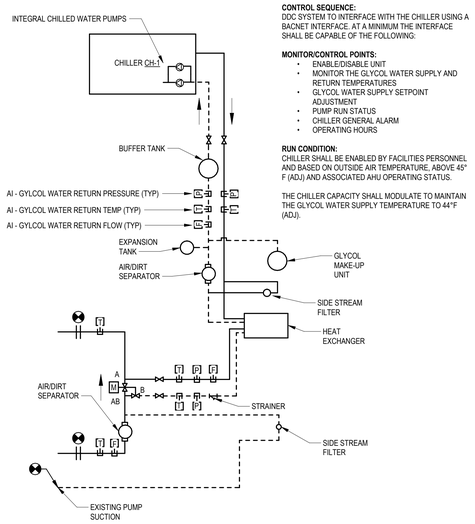
M100



GENERAL NOTES:

1. INSTALL CHILLER, TRIM, AND CONTROLS PER MANUFACTURERS INSTRUCTIONS.
2. INSTALL VALVED DRAIN LINE WITH 3/4" HOSE CONNECTIONS AT BOTTOM OF EACH PIPING RISER TO CHILLER.
3. VIBRATION ISOLATORS PROVIDED WITH CHILLER.
4. PIPING CONNECTED TO CHILLER SHALL HAVE BRAIDED STAINLESS STEEL FLEXIBLE CONNECTORS OR (3) VICTAULIC FLEXIBLE COUPLINGS.
5. SEE DRAWINGS FOR PIPE SIZES & ROUTING.
6. CHILLER PUMPS ARE FACTORY INSTALLED. M.C. TO BE RESPONSIBLE FOR CONNECTION OF CWS/CWR MAINS TO CHILLER INLET & OUTLET.

1 AIR COOLED CHILLER WITH INTEGRAL PUMP DETAIL
N.T.S.



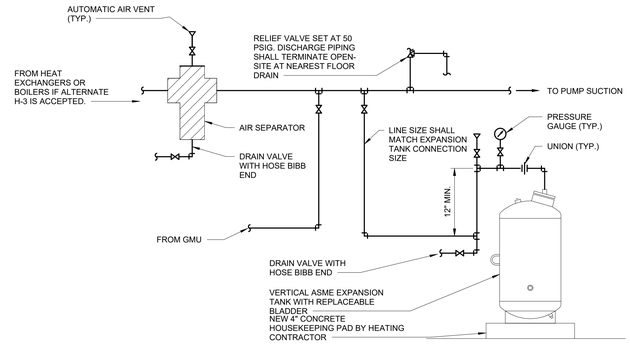
CONTROL SEQUENCE:
DDC SYSTEM TO INTERFACE WITH THE CHILLER USING A BACNET INTERFACE. AT A MINIMUM THE INTERFACE SHALL BE CAPABLE OF THE FOLLOWING:

MONITOR/CONTROL POINTS:
- ENABLED/DISABLE UNIT
- MONITOR THE GLYCOL WATER SUPPLY AND RETURN TEMPERATURES
- GLYCOL WATER SUPPLY SETPOINT ADJUSTMENT
- PUMP RUN STATUS
- CHILLER GENERAL ALARM
- OPERATING HOURS

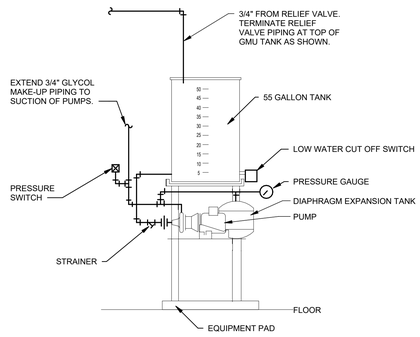
RUN CONDITION:
CHILLER SHALL BE ENABLED BY FACILITIES PERSONNEL AND BASED ON OUTSIDE AIR TEMPERATURE. ABOVE 45° F (ADJ.) AND ASSOCIATED AHU OPERATING STATUS.

THE CHILLER CAPACITY SHALL MODULATE TO MAINTAIN THE GLYCOL WATER SUPPLY TEMPERATURE TO 44°F (ADJ.).

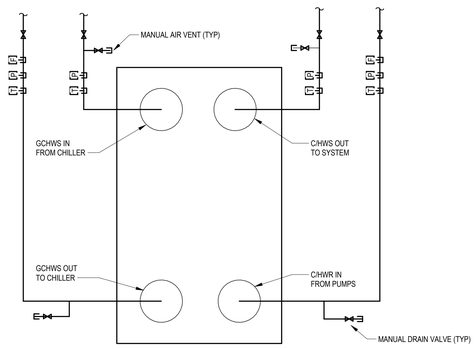
2 AIR COOLED CHILLER - PIPING DETAIL
N.T.S.



3 AIR SEPARATOR AND EXPANSION TANK DETAIL
N.T.S.

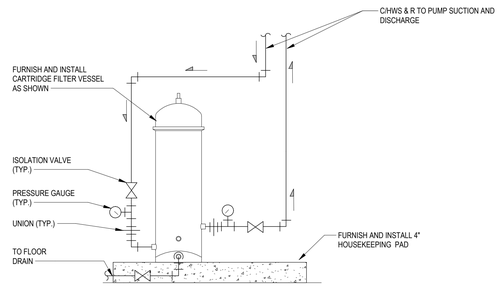


4 GLYCOL MAKEUP UNIT
N.T.S.

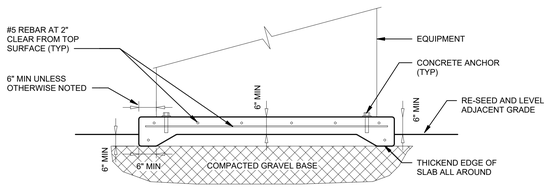


5 PLATE AND FRAME HEAT EXCHANGER
N.T.S.

PROVIDE SIDE STREAM FILTER MODEL SHELCO 4FOS3 OR EQUAL. FILTER HOUSING SHALL BE CAPABLE OF HOLDING FOUR (4) 30" LONG FILTER CARTRIDGES RATED FOR A MINIMUM OF 16GPM. REVISE ALL PIPING IN DETAIL TO 1-1/2" PIPE SIZE FROM PUMP SUCTION AND DISCHARGE TO SIDE STREAM FILTER.

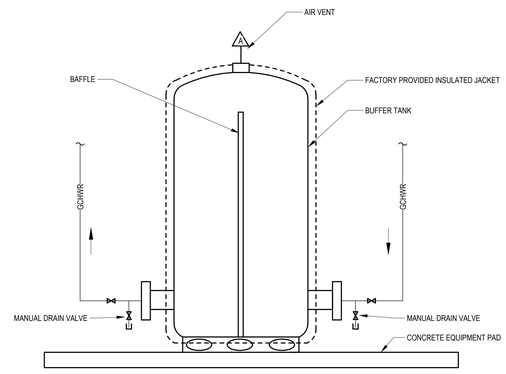


6 SIDE STREAM FILTER
N.T.S.

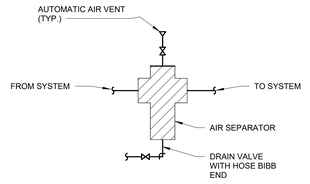


NOTES:
1. PAD SIZE SHALL BE MINIMUM INDICATED OR AS SHOWN ON THE PLANS OR AS INDICATED BY THE MANUFACTURE AND APPROVED BY THE ENGINEER.
2. THE SIZE, NUMBER, TYPE, LOCATION, THREAD PROJECTION, AND ALL OTHER RECOMMENDATIONS FOR THE ANCHOR BOLTS SHALL BE DETERMINED BY THE EQUIPMENT MANUFACTURER AND AS APPROVED BY THE ENGINEER. ANCHOR BOLTS SHALL BE HELD IN POSITION WITH A TEMPLATE OR OTHER ACCEPTABLE MEANS, MATCHING THE BASE PLACE WHILE PAD IS BEING POURED.
3. EQUIPMENT BASES SHALL BE INSTALLED LEVEL UNLESS INDICATED OTHERWISE.
4. HEIGHT OF PADS SHALL BE MINIMUM REQUIRED FOR ANCHOR BOLT CLEARANCE TO KEEP ANCHOR BOLT ABOVE SUPPORTING SLAB.
5. CONCRETE ANCHORS MAY BE USED IN LIEU OF CAST IN PLACE ANCHOR BOLTS FOR EQUIPMENT ANCHOR BOLTS LESS THAN 3/4" DIAMETER WHEN APPROVED BY THE EQUIPMENT MANUFACTURE AND ENGINEER. ANCHORS SHALL BE INSTALLED WITH A 4" MINIMUM EDGE DISTANCE IN EACH DIRECTION.

7 POURED IN PLACE CONCRETE EQUIPMENT PAD DETAIL
N.T.S.



8 BUFFER TANK DETAIL
N.T.S.



9 AIR SEPARATOR (BUILDING SYSTEM SIDE)
N.T.S.

ADAM CARTER
062-072502
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LICENSED PROFESSIONAL ENGINEER
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REVISIONS:

NO.	DESCRIPTION	DATE

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DESIGNED BY: JJO | CHECKED BY: AEC

PROJECT NO: 325-082

ISSUE DATE: 04/03/2026

ISSUANCE: ISSUED FOR BIDDING

SHEET NAME: **MECHANICAL DETAILS**

SHEET (30X42): M500

AIR COOLED PACKAGED CHILLER SCHEDULE

MARK	DESIGN BASIS		DESCRIPTION	CAPACITY		EVAPORATOR DATA				AMBIENT (TEMP)	EVAPORATOR		UNIT POWER	EFFICIENCY	COMPRESSOR DATA				CONDENSER FAN DATA				SINGLE POINT POWER					REMARKS
	MAKE	MODEL / SERIES		NOMINAL (TONS)	ACTUAL (TONS)	FLOW (GPM)	EWT (F)	LWT (F)	PD (IN FT)		FLUID TYPE	REFRIGERANT	KW	EER	NO.	TOTAL (KW)	VOLTS	PHASE	NO.	TOTAL (KW)	VOLTS	PHASE	MCA (AMPS)	MOP (AMPS)	VOLTS	PHASE	HZ	
CH-1	YORK	YLAA0065HJ	AIR COOLED SCROLL CHILLER WITH SKID AND PUMP PACKAGE	65	60	152.1	55	45	19.2	95	30% PROP. GLYCOL	R454B	79.32	10.59	5	69.26	208	3	2 / 2	6.72	208	3	344	400	208	3	60	SEE NOTES 1 - 6

NOTES:
1. COMPRESSORS MUST BE SCROLL TYPE DESIGN WITH SERVICE ISOLATION VALVES. SCREW COMPRESSORS ARE NOT ACCEPTABLE.
2. PROVIDE SINGLE POINT ELECTRICAL CONNECTION WITH FACTORY DISCONNECT SWITCH.
3. PROVIDE VARIABLE SPEED ON ALL CONDENSER FANS.
4. PROVIDE FACTORY VARIABLE SPEED CHILLED WATER PUMPS.
5. PROVIDE FULL FACTORY CONTROLS WITH BACNET COMMUNICATION.
6. PROVIDE HAIL GUARDS AND LOUVERS.
7. PROVIDE ULTRA LOW SOUND ATTENUATION PACKAGE. COMPRESSOR BLANKETS AND VARIABLE CONDENSER FANS.
8. PROVIDE 115V CONVENIENCE OUTLET.

BUFFER TANK SCHEDULE

MARK	DESIGN BASIS		DESCRIPTION	DESIGN VOLUME (GAL.)	PIPE PORTS (IN.)	DIMENSIONS		NOTES
	MAKE	MODEL				HEIGHT (IN.)	DIAMETER (IN.)	
BT-1	WESSELS	CBT-300	CHILLED WATER BUFFER TANK WITH FACTORY PROVIDED INSULATED JACKET	300	4	72	30	SEE NOTE 1

NOTES:
1. PROVIDE INSULATION ON ALL EXPOSED SURFACES OF BUFFER TANK, MINIMUM THICKNESS 1/2"

EXPANSION TANK SCHEDULE

MARK	DESIGN BASIS		DESCRIPTION	SYSTEM VOLUME (GAL.)	SYSTEM TEMP. (°F)	TANK VOLUME (GAL.)	REQUIRED TANK VOLUME (GAL.)	SYSTEM EXPANSION VOLUME (GAL.)	PRECHARGE PRESSURE (PSI)	RELIEF VALVE SETTING (PSI)	NOTES
	MAKE	MODEL									
ET-1	WESSELS	NLAP-100	EXPANSTION TANK WITH INTERNAL BLADDER	2,000	45 - 55	100	25	12.6	12	1"	SEE NOTE 1

NOTES:
1. PROVIDE BLADDER MONITORING PRESSURE GAUGE.

AIR SEPARATOR SCHEDULE

MARK	DESIGN BASIS		DESCRIPTION	DESIGN FLOW (GPM)	DIMENSIONS			VOLUME (GAL.)	NOTES
	MAKE	MODEL			HEIGHT (IN.)	DIAMETER (IN.)	PIPE (IN.)		
AS-1	SPIROTHERM	VDN-400	COALESCING AIR ELMINATOR AND DIRT SEPARATOR	162	25.3"	8.6"	4"	6.6	SEE NOTE 1
AS-2	SPIROTHERM	VDN-400	COALESCING AIR ELMINATOR AND DIRT SEPARATOR	152	25.3"	8.6"	4"	6.6	SEE NOTE 1

NOTES:
1. PROVIDE MANUAL BLOWDOWN VALVE.

HEAT EXCHANGER SCHEDULE

MARK	DESIGN BASIS		DESCRIPTION	HEADER DIAMETER WATER / GLYCOL (IN)	HEAT TRANSFER CAPACITY (MBH)	WATER SIDE					GLYCOL SIDE					HEATING	DIMENSIONS
	MAKE	MODEL / SERIES				FLUID	FLOW RATE (GPM)	PRESSURE DROP (FT HEAD)	E.W.T. (F)	L.W.T. (F)	FLUID	FLOW RATE (GPM)	PRESSURE DROP (FT HEAD)	E.W.T. (F)	L.W.T. (F)	SURFACE AREA (SQ FT)	(H"xW"xL")
HX-1	BELL & GOSSET	GPX	GASKETED PLATE HYDRONIC HEAT EXCHANGER	4 / 4	720	30% P.G.	143	2.33	47	57	30% P.G.	153	3.48	45	55	719.0	72.50"x20.50"x39.37"

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EXPIRES: 11/30/27
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PROJECT NO: 325-082

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ISSUANCE:
ISSUED FOR BIDDING

SHEET NAME:
MECHANICAL SCHEDULES

SHEET (30X42):
M600

ELECTRICAL ABBREVIATIONS

1P	1 POLE (2P, 3P, 4P, ETC.)	LTNG	LIGHTNING
A	6" ABOVE COUNTER OR BACKSPLASH TO CENTERLINE OF DEVICE	LV	LOW VOLTAGE
		M	INSTALL DEVICE IN MILLWORK
A, AMP	AMPERE	MAX	MAXIMUM
AC	ABOVE COUNTER	MAG.S	MAGNETIC STARTER
ACLG	ABOVE CEILING	M/C	MOMENTARY CONTACT
AF	AMP FRAME	MC	MECHANICAL CONTRACTOR
AFF	ABOVE FINISHED FLOOR	MCB	MAIN CIRCUIT BREAKER
AFG	ABOVE FINISHED GRADE	MCC	MOTOR CONTROL CENTER
AFCI	ARC FAULT CIRCUIT INTERRUPTER	MDC	MAIN DISTRIBUTION CENTER
		MDP	MAIN DISTRIBUTION PANEL
AHU	AIR HANDLING UNIT	MFR	MANUFACTURER
AL	ALUMINUM	MFS	MAIN FUSED DISCONNECT SWITCH
ALT	ALTERNATE	MH	MANHOLE
AMP	AMPERE	MIC	MICROPHONE
AMPL	AMPLIFIER	MIN	MINIMUM
ANNUN	ANNUNCIATOR	MISC	MISCELLANEOUS
APPROX	APPROXIMATELY	MLO	MAIN LUGS ONLY
AQ-STAT	AQUASTAT	MMS	MANUAL MOTOR STARTER
ARCH	ARCHITECT, ARCHITECTURAL	MOA	MULTIOUTLET ASSEMBLY
AS	AMP SWITCH	MSP	MOTOR STARTER PANELBOARD
AT	AMP TRIP	MSBD	MAIN SWITCHBOARD
A.T.C.	AUTOMATIC TEMPERATURE CONTROLS CONTRACTOR	MSS	MOTOR STARTER SWITCH
		MT	MOUNT
ATS	AUTOMATIC TRANSFER SWITCH	MTS	MANUAL TRANSFER SWITCH
AUTO	AUTOMATIC	MTR	MOTOR, MOTORIZED
AUX	AUXILIARY	N.C.	NORMALLY CLOSED
AV	AUDIO VISUAL	NEC	NATIONAL ELECTRICAL CODE
AWG	AMERICAN WIRE GAUGE	NEMA	NATIONAL ELECTRICAL
B	BLACK DEVICE COLOR WITH BLACK UNBREAKABLE THERMOPLASTIC COVER PLATE		MANUFACTURER'S ASSOCIATION
		NFDS	NON-FUSED SAFETY DISCONNECT SWITCH
BATT	BATTERY	NIC	NOT IN CONTRACT
BD	BOARD	NL	NIGHT LIGHT
BLDG	BUILDING	N.O.	NORMALLY OPEN
BMS	BUILDING MANAGEMENT SYSTEM	NPF	NORMAL POWER FACTOR
C	CONDUIT	NTS	NOT TO SCALE
CAB	CABINET	OC	ON CENTER
CAT	CATALOG	OH	OVERHEAD
CATV	CABLE TELEVISION	OL	OVERLOADS
CB	CIRCUIT BREAKER	PA	PUBLIC ADDRESS
CCTV	CLOSED CIRCUIT TELEVISION	PB	PULL BOX OR PUSHBUTTON
CKT	CIRCUIT	PC	PLUMBING CONTRACTOR
CLG	CEILING	PE	PNEUMATIC ELECTRIC
CM	CONSTRUCTION MANAGER	PED	PEDESTAL
COMB	COMBINATION	PF	POWER FACTOR
CMPR	COMPRESSOR	PH	PHASE
CONN	CONNECTION	PIV	POST INDICATING VALVE
CONST	CONSTRUCTION	PNL	PANEL
CONT	CONTINUATION OR CONTINUOUS	PP	POWER POLE
CONTR	CONTRACTOR	PR	PAIR
CONV	CONVECTOR	PRI	PRIMARY
CP	CIRCULATING PUMP	PROJ	PROJECTION
CRT	CATHODE-RAY TUBE	PRV	POWER ROOF VENTILATOR
CT	CURRENT TRANSFORMER	PT	POTENTIAL TRANSFORMER
CTR	CENTER	PVC	POLYVINYL CHLORIDE (CONDUIT)
CU	COPPER	PWR	POWER
DEPT	DEPARTMENT	QUAN	QUANTITY
DET	DETAIL	RAC	RIGID ALUMINUM CONDUIT
DIA	DIAMETER	RCPT	RECEPTACLE
DISC	DISCONNECT	REQD	REQUIRED
DIST	DISTRIBUTION	RM	ROOM
DN	DOWN	RMC	RIGID METALLIC CONDUIT
DO	AUTOMATIC DOOR OPENER	RTU	ROOF TOP UNIT
DPR	DAMPER	SC	SURFACE CONDUIT
DS	SAFETY DISCONNECT SWITCH	SEC	SECONDARY
DT	DOUBLE THROW	SHT	SHEET
DWG	DRAWING	SIM	SIMILAR
EC	ELECTRICAL CONTRACTOR	SLD	SINGLE-LINE DIAGRAM
ELEC	ELECTRIC, ELECTRICAL	S/N	SOLID NEUTRAL
ELEV	ELEVATOR	SPEC	SPECIFICATION
ELU	EMERGENCY LIGHTING UNIT	SPKR	SPEAKER
EM	EMERGENCY	SP	SPARE
EMS	ENERGY MANAGEMENT SYSTEM	SPP	SINGLE-POINT POWER
EMT	ELECTRICAL METALLIC TUBING	SR	SURFACE RACEWAY
EP	ELECTRIC PNEUMATIC	SS	STAINLESS STEEL
EPO	EMERGENCY POWER OFF	SSW	SELECTOR SWITCH
EQUIP	EQUIPMENT	S/S	STOP/START PUSHBUTTONS
EWC	ELECTRIC WATER COOLER	STA	STATION
EXIST	EXISTING	STD	STANDARD
EXH	EXHAUST	SURF	SURFACE MOUNTED
EXP	EXPLOSION PROOF	SW	SWITCH
FA	FIRE ALARM	SWBD	SWITCHBOARD
FABP	FIRE ALARM BOOSTER POWER SUPPLY PANEL	SYM	SYMMETRICAL
		SYS	SYSTEM
FACP	FIRE ALARM CONTROL PANEL	TEL	TELEPHONE
FCU	FAN COIL UNIT	TERM	TERMINAL
FIXT	FIXTURE	T	TAMPER RESISTANT
FLR	FLOOR	TL	TWIST LOCK
FLUOR	FLUORESCENT	T-STAT	THERMOSTAT
F.P.C.	FIRE PROTECTION CONTRACTOR	TTC	TELEPHONE TERMINAL CABINET
FU	FUSE	TV	TELEVISION
FUDS	FUSED SAFETY DISCONNECT SWITCH	TVTC	TELEVISION TERMINAL CABINET
GA	GAUGE	TYP	TYPICAL
GAL	GALLON	UC	UNDER COUNTER
GALV	GALVANIZED	UE	UNDERGROUND ELECTRICAL
GC	GENERAL CONTRACTOR	UG	UNDERGROUND
GEN	GENERATOR	UH	UNIT HEATER
GFI	GROUND FAULT CIRCUIT INTERRUPTER	UT	UNDERGROUND TELEPHONE
GFP	GROUND FAULT PROTECTOR	UTIL	UTILITY
GND	GROUND	UV	ULTRAVIOLET
GYP BD	GYPSUM BOARD	V	VOLT
HWC#	DOMESTIC WATER CIRCULATING PUMP	VA	VOLT-AMPERES
HOA	HANDS-OFF-AUTOMATIC SWITCH	VDT	VIDEO DISPLAY TERMINAL
H	INSTALL DEVICE HORIZONTALLY	VERT	VERTICAL
HP	HORSEPOWER	VFD	VARIABLE FREQUENCY DRIVE
HPF	HIGH POWER FACTOR	VOL	VOLUME
HT	HEIGHT	W	WATT
HTG	HEATING	W/	WITH
HTR	HEATER	WG	WIRE GUARD
HV	HIGH VOLTAGE	WH	WATER HEATER
HVAC	HEATING, VENTILATING AND AIR CONDITIONING	W/O	WITHOUT
		WP	WEATHERPROOF
IC	INTERRUPTING CAPACITY	XFMR	TRANSFORMER
IG	ISOLATED GROUND	XFR	TRANSFER
IMC	INTERMEDIATE METAL CONDUIT	XX	LOCATION-SPECIFIC MOUNTING HEIGHT ABOVE FINISHED FLOOR TO CENTERLINE OF DEVICE
INCAND	INCANDESCENT		
IR	INFRARED		
I/W	INTERLOCK WITH		
J-BOX	JUNCTION BOX	∠	ANGLE
K.E.C.	KITCHEN EQUIPMENT CONTRACTOR	@	AT
KV	KILOVOLT	▲	DELTA
KVA	KILOVOLT-AMPERE	'	FEET
KVAR	KILOVOLT-AMPERE REACTIVE	"	INCHES
KW	KILOWATT	#	NUMBER
KWH	KILOWATT HOUR	Ø	PHASE
LOC	LOCATE OR LOCATION	C	CENTER LINE
LT	LIGHT	P	PLATE
LTG	LIGHTING		

BREAKER FUNCTION SCHEDULE

SYMBOL	DESCRIPTION
A	ARC FAULT INTERUPTER (AFCI)
AR	ARC ENERGY REDUCTION MAINTENANCE SWITCH
E	EXISTING BREAKER TO REMAIN
EM	PROVIDE IDENTIFICATION PER NEC 700.12(I)(2)(4)
EN	EXISTING BREAKER SERVING NEW CIRCUIT
G	GROUND FAULT CIRCUIT INTERUPTER (GFCI)PROTECTION (5mA)
GE	GROUND FAULT CIRCUIT INTERRUPTER FOR EQUIPMENT (30mA)
GF	ADJUSTABLE GROUND FAULT PROTECTION FOR EQUIPMENT
HL	HANDLE LOCK TO LOCK BREAKER IN CLOSED POSITION
K#	KEY INTERLOCK (# REPRESENTS GROUPED KEYING)
LSI	LONG-TIME, SHORT-TIME, INSTANTANEOUS ADJUSTMENT
LSIG	LONG-TIME, SHORT-TIME, INSTANTANEOUS ADJUSTMENT, AND GROUND FAULT ADJUSTMENT
LSIA	LONG-TIME, SHORT-TIME, INSTANTANEOUS ADJUSTMENT, AND GROUND FAULT ALARM
N	NEW BREAKER IN EXISTING PANEL
NE	NEW BREAKER SERVING EXISTING CIRCUIT
SD	DENOTE SERVICE DISCONNECT
ST	SHUNT TRIP (120V OPERATED UNLESS NOTED OTHERWISE)

EQUIPMENT/DEVICE HOME RUN KEY

1. BRANCH CIRCUIT WIRING SHALL BE #12AWG UNLESS NOTED OTHERWISE ON THE PLAN OR IN THE SCHEDULES.
2. AS A MINIMUM USE 10 AWG CONDUCTOR FOR 20 AMPERE, 120 VOLT BRANCH CIRCUIT HOME RUNS LONGER THAN 100 FEET AND 277 VOLT BRANCH CIRCUIT HOME RUNS LONGER THAN 200 FEET.
3. REFER TO SPECIFICATION SECTION 260519 FOR ADDITIONAL REQUIREMENTS.

EQUIPMENT GROUNDING CONDUCTOR
PHASE CONDUCTOR (SHORT LINE)
NEUTRAL CONDUCTOR (LONG LINE)

GENERAL PLAN SYMBOLS

MARK	SCHEDULED EQUIPMENT (UNDERLINED)
MARK	NONSCHEDULED EQUIPMENT
(E) MARK	EXISTING EQUIPMENT - HALFTONE - (E) PREFIX
(R) MARK	EXISTING RELOCATED EQUIPMENT - (R) PREFIX
# / #	SECTION VIEW, TOP REPRESENTS DETAIL NUMBER, BOTTOM REPRESENTS SHEET NUMBER
# / #	ENLARGED VIEW, TOP REPRESENTS VIEW NUMBER, BOTTOM REPRESENTS SHEET NUMBER
	NEW WORK BY THE E.C. (DARK SOLID LINE)
	NEW UNDERGROUND WORK BY THE E.C. (DARK DASHED LINE)
	WORK BY OTHERS AND/OR EXISTING (LIGHT SOLID LINE)
	DEMO WORK BY THE E.C. (DARK DASHED LINE)
	MATCHLINE
X	KEYED NOTE
1	LIGHTING CONTROL SYMBOL (DIAMOND)
1	KITCHEN EQUIPMENT SYMBOL (OCTOGON)

GENERAL ELECTRICAL SYMBOLS

ⓘ ⓙ ⓨ	ELECTRICAL CONNECTION TO EQUIPMENT
EPO	EMERGENCY STOP PUSH BUTTON. REFER TO SCHEDULE FOR ADDITIONAL INFORMATION.
DPM	DIGITAL POWER METER, LCD DISPLAY, MONITORING OF VOLTAGE, CURRENT, POWER, PF, FREQUENCY, MIN/MAX AND AVERAGE VALUES, AND ENERGY
PP	AUTOMATIC DOOR PUSH PAD
	PANELBOARD - SEE SCHEDULES FOR MORE INFORMATION
	UTILITY TRANSFORMER - PROVIDED BY UTILITY
	SWITCHBOARD - SEE SCHEDULES FOR MORE INFORMATION
T	TRANSFORMER - SEE SCHEDULES FOR MORE INFORMATION
	DISCONNECT SWITCH, SEE SCHEDULES FOR MORE INFORMATION
	POWER METER
	COMBINATION STARTER, SEE SCHEDULES FOR MORE INFORMATION
	ELECTRICAL EQUIPMENT, DASHED LINES INDICATE CODE REQUIRED CLEARANCES. SEE SCHEDULES FOR MORE INFORMATION
	GROUND BAR

GENERAL POWER SYMBOLS

SYMBOL	DESCRIPTION
	DUPLEX / DOUBLE DUPLEX RECEPTACLE, NEMA 5-20R. EMERGENCY POWER. REFER TO SUBSCRIPT SCHEDULE FOR MORE INFORMATION
	DUPLEX / DOUBLE DUPLEX RECEPTACLE, REFER TO SUBSCRIPT SCHEDULE FOR MORE INFORMATION.
CD CR	CORD REEL / CORD DROP. REFER TO SUBSCRIPT SCHEDULE FOR MORE INFORMATION
	SIMPLEX RECEPTACLE, NEMA 5-20R
	SPECIAL RECEPTACLE
	RECESSED FLOOR BOX OR POKE-THRU
	CEILING MOUNTED RECEPTACLE. REFER TO SUBSCRIPT SCHEDULE FOR MORE INFORMATION
	SURFACE MOUNT MULTI-OUTLET ASSEMBLY, SEE GENERAL ELECTRICAL SCHEDULE FOR ADDITIONAL INFORMATION

GENERAL FIRE ALARM SYMBOLS

SYMBOL	DESCRIPTION
FAP	CONTROL PANEL
NEP	NOTIFICATION APPLIANCE CIRCUIT EXTENDER PANEL
FAA	REMOTE ANNUNCIATOR PANEL
PIV	POST INDICATOR VALVE AND TAMPER SWITCH
PS	AIR PRESSURE SWITCH
TS	VALVE TAMPER SWITCH
FS	WATER FLOW SWITCH
SB	BEAM SMOKE REFLECTOR
SB B#	LINEAR BEAM SMOKE DETECTOR
SB	LINEAR BEAM SMOKE DETECTOR
DSD	DUCT SMOKE DETECTOR
RI	DUCT SMOKE DETECTOR REMOTE INDICATOR STATION
H	HEAT DETECTOR ADDRESSABLE
J	LINEAR HEAT DETECTION CABLE
F	ADDRESSABLE FIRE ALARM MANUAL PULL STATION
S	SMOKE DETECTOR
A	AUDIO/VISUAL NOTIFICATION APPLIANCE, CEILING MOUNTED
	VISUAL NOTIFICATION APPLIANCE, CEILING MOUNTED
	SPEAKER NOTIFICATION APPLIANCE, CEILING MOUNTED
	SPEAKER/VISUAL NOTIFICATION APPLIANCE, CEILING MOUNTED
A	HORN NOTIFICATION APPLIANCE, WALL MOUNTED
	AUDIO/VISUAL NOTIFICATION APPLIANCE, WALL MOUNTED
S	SPEAKER NOTIFICATION APPLIANCE, WALL MOUNTED
S	SPEAKER/VISUAL NOTIFICATION APPLIANCE, WALL SWITCH
	VISUAL NOTIFICATION APPLIANCE, WALL MOUNTED
AM	ADDRESSABLE MONITOR MODULE
AR	ADDRESSABLE RELAY MODULE
	MAGNETIC DOOR HOLDER
HD	HVAC ELEVATOR HOISTWAY DAMPER
SD	HVAC SMOKE DAMPER
ZAM	ZONE ADAPTER MODULES
CO	CO DETECTOR
VCC	VOICE COMMAND CENTER
DCB	DUCT CO DETECTOR
E	BELL
	HIGH FIDELITY SPEAKER - CEILING MOUNT
H	HIGH FIDELITY SPEAKER - WALL MOUNT
ASD	AIR SAMPLING SMOKE DETECTOR
FSD	FIRE SMOKE DAMPER

GENERAL SWITCH SYMBOLS

SYMBOL	DESCRIPTION
$	SWITCH,REFER TO SUBSCRIPT SCHEDULE FOR MORE INFORMATION.
DIM	REFER TO SUBSCRIPT SCHEDULE FOR MORE INFORMATION
M	REFER TO SUBSCRIPT SCHEDULE FOR MORE INFORMATION
LIM	REFER TO SUBSCRIPT SCHEDULE FOR MORE INFORMATION

NURSE CALL SYMBOLS

SYMBOL	DESCRIPTION
N	REFER TO SUBSCRIPT SCHEDULE FOR MORE INFORMATION
D	REFER TO SUBSCRIPT SCHEDULE FOR MORE INFORMATION

GENERAL LIGHTING SYMBOLS

SYMBOL	DESCRIPTION
	CRITICAL FIXTURE (FULL SHADED)
	LIFE SAFETY (HALF SHADED)
	RECESSED MOUNTED (DIAGONAL SLASH)
	SURFACE MOUNTED
	SURFACE OR PENDANT FIXTURE (DOTS)
	POLE MOUNTED SITE FIXTURE
	RECESSED DOWNLIGHT
	EMERGENCY FIXTURE
	SINGLE / DOUBLE FACED EXIT SIGN
	EMERGENCY REMOTE HEAD (SINGLE/DOUBLE)
	COMBINATION EXIT/EMERGENCY FIXTURE
	WALL MOUNTED FIXTURE (STEM OR STEMS)
	CYLINDRICAL FIXTURE (ARROW INDICATES WALL WASH)

GENERAL NOTES

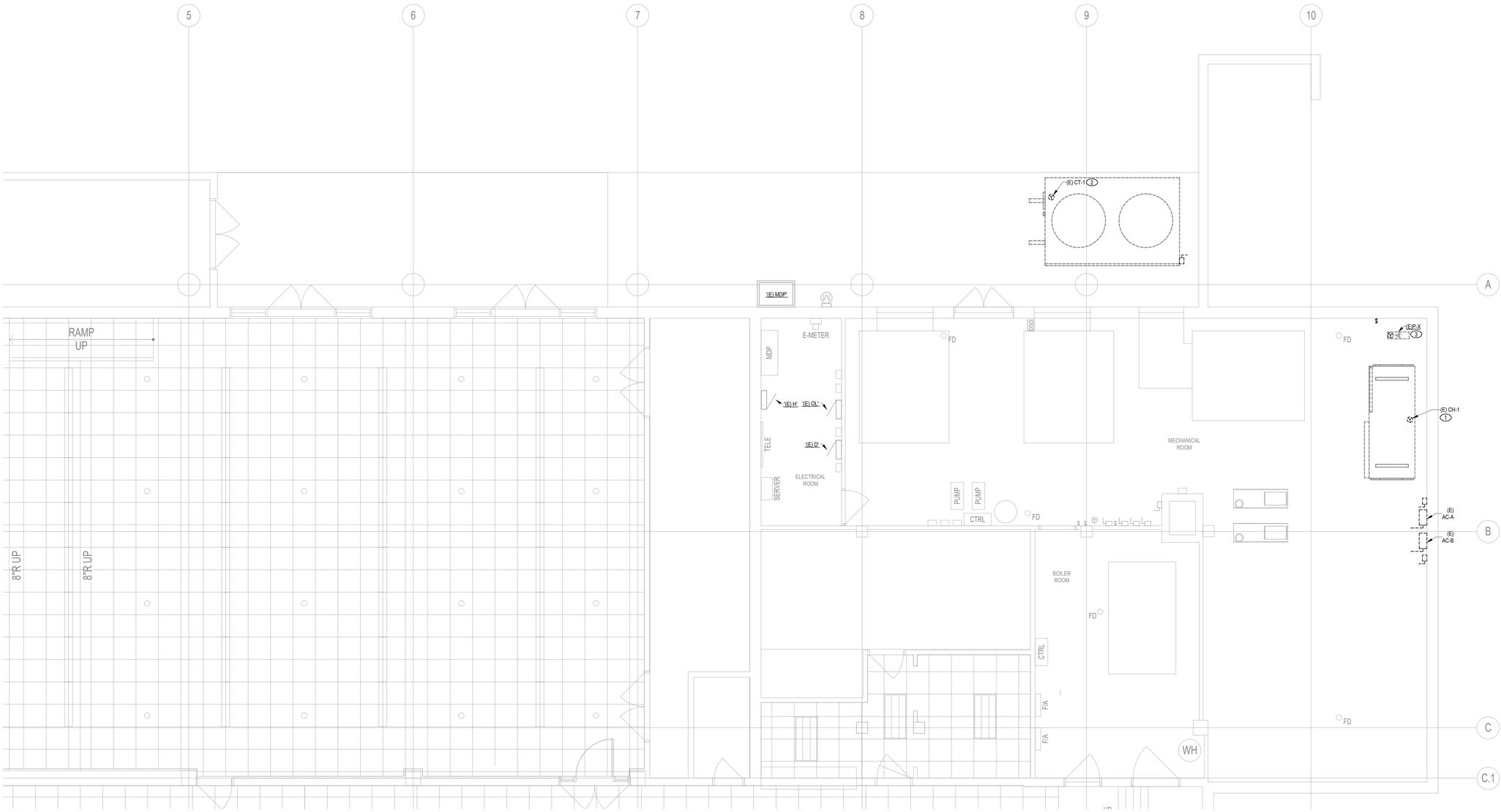
1. ALL INSTALLATIONS SHALL BE IN ACCORDANCE WITH ALL FEDERAL, STATE AND LOCAL CODES INCLUDING BUT NOT LIMITED TO THE NATIONAL ELECTRICAL CODE, THE INTERNATIONAL BUILDING CODE, AMERICANS WITH DISABILITIES ACT ACCESSIBILITY GUIDELINES, AND INTERNATIONAL ENERGY CONSERVATION CODE. THE AUTHORITY HAVING JURISDICTION SHALL HAVE THE FINAL DECISION ON ALL INSTALLATIONS AND PRACTICES.
2. ALL MATERIAL FURNISHED SHALL BE NEW, FREE OF DEFECTS, AND LISTED BY A NATIONALLY RECOGNIZED TESTING LABORATORY UNLESS NOTED OTHERWISE.
3. INSTALLATION OF EQUIPMENT SHALL BE IN ACCORDANCE WITH CURRENT STANDARDS AND SPECIFICATIONS APPROVED BY THE AUTHORITY HAVING JURISDICTION (AHJ). PLACE ALL CABLE/WIRING IN CONDUIT OR RACEWAY UNLESS NOTED OTHERWISE. DO NOT LIE ON, OR SUPPORT CABLE FROM, CEILING DEVICES, PIPING OR DUCTWORK. PROVIDE NEW WIRING FOR ALL BRANCH CIRCUITS AND FEEDERS.
4. FEEDERS ON DRAWINGS ARE SCHEMATIC ONLY. CONDUIT RUNS SHALL COMPLY WITH CONDUIT SPECIFICATIONS AND CONTAIN BENDS THAT ARE NOT GREATER THAN 90 DEGREES. CONDUITS ABOVE GRADE SHALL BE RUN PARALLEL TO OR PERPENDICULAR WITH BUILDING LINES AND STRUCTURE.
5. CIRCUIT WIRING FOR THE EMERGENCY SYSTEM SHALL BE INSTALLED IN SEPARATE CONDUIT/RACEWAY AND BE KEPT ENTIRELY INDEPENDENT OF ALL OTHER WIRING AND EQUIPMENT PER THE N.E.C.
6. ALL FEEDER AND BRANCH CIRCUITS TO PANELS, MOTORS, LIGHTS, RECEPTACLES, GENERAL DISTRIBUTION, ETC. SHALL CONTAIN AN EQUIPMENT GROUNDING CONDUCTOR SIZED ACCORDING TO THE N.E.C. THE CONDUIT SYSTEM SHALL NOT BE CONSIDERED AN ACCEPTABLE GROUND.
7. REFER TO MECHANICAL EQUIPMENT SCHEDULES FOR DETAILED INFORMATION ON EQUIPMENT, DISCONNECTS, AND CONTROLS. E.C. SHALL PROVIDE AND INSTALL ITEMS AS NOTED BY THE E.C. ON THE MECHANICAL SCHEDULES.
8. ELECTRICAL INSTALLATION SHALL BE INSTALLED IN PHASES AS DIRECTED BY THE G.C. PROVIDE TEMPORARY AND PERMANENT CONNECTIONS AS REQUIRED TO MEET THE PHASING REQUIREMENTS. COORDINATE ALL REQUIRED OUTAGES WITH THE G.C. AND OWNER AS OUTLINED IN THE SPECIFICATIONS.
9. RELOCATE EXISTING CONDUITS, WIRING, AND BOXES AS REQUIRED FOR INSTALLATION OF MECHANICAL EQUIPMENT AND PIPING, TEMPORARY AND PERMANENT WALLS, AND STRUCTURES.
10. ALL WIRING AND FEEDER SIZES ON DRAWINGS ARE SIZED FOR COPPER WIRING UNLESS SPECIFICALLY NOTED OTHERWISE.
11. IT IS THE RESPONSIBILITY OF THIS CONTRACTOR TO COORDINATE INSTALLATION OF ELECTRICAL SYSTEM AND THOSE REQUIRING ELECTRICAL CONNECTIONS TO MAINTAIN NEC REQUIRED CLEARANCES, INCLUDING BUT NOT LIMITED TO AREAS ABOVE ACCESSIBLE CEILINGS.
12. PROVIDE CABLE OR CONDUIT AND WIRE AS REQUIRED TO ACHIEVE CIRCUITING AS SHOWN. SIZE CONDUCTOR PER NEC AMPACITIES AND WIRE FILL CRITERIA. PROVIDE DEDICATED NEUTRALS AND GROUND CONDUCTOR FOR CIRCUITING, UNLESS NOTED OTHERWISE.
13. CONDUIT FOR POWER WIRING SHALL BE PERMITTED TO BE LOCATED BENEATH FLOOR SLAB UNLESS NOTED OTHERWISE. RACEWAYS FOR LOW VOLTAGE CABLING FOR CONTROL, TELECOMMUNICATIONS, AND OTHER LOW VOLTAGE SYSTEMS SHALL NOT BE ALLOWED BENEATH, NOR WITHIN THE FLOOR SLAB UNLESS SPECIFICALLY NOTED ON THE DRAWINGS. WHERE CABLING IS ROUTED BENEATH OR WITHIN THE FLOOR SLAB, IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO ENSURE THE CABLING IS LISTED FOR SUCH USE.
14. ALL ELECTRICAL CONDUCTORS SHALL BE STRANDED COPPER WITH TYPE THHN-THWN INSULATION UNLESS SPECIFICALLY NOTED OTHERWISE. THE MINIMUM WIRE SIZE SHALL BE #12 AWG.
15. ALL NEW CIRCUITS REQUIRING NEUTRAL CONDUCTORS SHALL HAVE DEDICATED NEUTRALS. SHARED NEUTRALS ARE NOT ALLOWED.
16. A GREEN GROUNDING CONDUCTOR SHALL BE CONNECTED TO ALL LOADS SERVED. THE CONDUCTOR SHALL BE SIZED PER THE NATIONAL ELECTRICAL CODE TO ACCOMMODATE THE LOAD SERVED. ALL GROUNDING CONDUCTORS SHALL BE INSTALLED IN CONDUIT.
17. ALL BUILDING WIRING SHALL BE INSTALLED IN CONDUIT. MINIMUM SIZE SHALL BE 3/4".
18. ALL HOME RUN CONDUITS SHALL BE A MINIMUM OF 1" CONDUIT WITH 4-1"/16" DEEP JUNCTION BOXES. ALL JUNCTION BOX COVERS SHALL BE CLEARLY MARKED TO IDENTIFY CIRCUIT NUMBERS IN THE ENCLOSURES. EACH HOME RUN RACEWAY SYSTEM SHALL HAVE SPARE CAPACITY FOR A MINIMUM OF 1 ADDITIONAL CIRCUIT AND ASSOCIATED DEDICATED NEUTRAL CONDUCTORS.
19. MC CABLING IS NOT PERMITTED UNLESS SPECIFICALLY NOTED OTHERWISE.
20. ALL CONDUITS SHALL BE CONCEALED IN WALLS, ABOVE CEILINGS, ETC. WHERE POSSIBLE. ALL CONDUIT ROUTED EXPOSED IN FINISHED SPACES SHALL BE A PRE-MANUFACTURED SURFACE RACEWAY (IE. WIREMOLD OR EQUAL) WITH THE EQUIVALENT USABLE AREA OF THE SUBSTITUTED CONDUIT. EXPOSED SURFACE RACEWAY SHALL NOT BE PERMITTED WITHOUT PRIOR APPROVAL FROM ARCHITECT/ENGINEER. ALL EXPOSED SURFACE RACEWAY SHALL BE ROUTED PARALLEL AND PERPENDICULAR TO WALLS AND CEILINGS. SURFACE WIREWAY SHALL BE FACTORY OR FIELD PAINTED TO MATCH MOUNTING SURFACE.
21. COORDINATE THE EXACT LOCATION OF ALL DEVICES LOCATED ABOVE OR BELOW COUNTERS, ETC. WITH OTHER TRADES, ARCHITECTURAL ELEVATIONS, AND REVIEWED SUBMITTALS PRIOR TO ROUGH-IN. ARCHITECTURAL ELEVATIONS AND DETAILS TAKE PRECEDENCE OVER LOCATIONS SHOWN ON ELECTRICAL DRAWINGS.
22. ALL CUTTING AND PATCHING REQUIRED FOR CONDUITS, DEVICES OR OTHER ELECTRICAL EQUIPMENT SHALL BE THE RESPONSIBILITY OF THE ELECTRICAL CONTRACTOR.
23. ALL PENETRATIONS THROUGH FIRE-RATED WALLS, FLOORS, AND CEILINGS SHALL BE SEALED WITH A NATIONALLY RECOGNIZED TESTING LABORATORY (NRTL) APPROVED FIRE-RATED SYSTEM EQUAL TO OR EXCEEDING THE RATING OF THE MATERIAL PENETRATED.
24. COORDINATE LOCATIONS OF ALL ELECTRICAL ITEMS INCLUDING LIGHTING FIXTURES, CEILING MOUNTED DEVICES (OCCUPANCY SENSORS, FIRE ALARM DETECTORS, SPEAKERS, ETC.) WITH EACH OTHER AND WITH ALL SPRINKLER HEADS, AIR SUPPLY DIFFUSER AND RETURN GRILLES. ALL CEILING DEVICES SHALL BE CENTERED IN CEILING TILE, WHERE POSSIBLE.
25. COORDINATE ALL MOUNTING OF ELECTRICAL MATERIALS , EQUIPMENT AND DEVICES REQUIRED FOR EQUIPMENT/DEVICES SUPPLIED BY OTHERS. ELECTRICAL ITEMS SHALL BE MOUNTED TO AVOID ANY INTERFERENCE WITH OTHER EQUIPMENT OPERATION OR ACCESS. ALL INSTALLATIONS OF ELECTRICAL ITEMS FOR EQUIPMENT/DEVICES SUPPLIED BY OTHERS SHALL BE COORDINATED AND APPROVED BY SUPPLYING CONTRACTOR PRIOR TO ROUGH-IN.
26. BOXES LOCATED ON OPPOSITE SIDES OF FIRE RATED WALLS SHALL BE OFFSET A MINIMUM OF 24" OR A FIRE RATED MATERIAL EQUAL TO OR GREATER THAN THE FIRE WALL MATERIAL RATING SHALL BE INSTALLED AROUND THE BOX. BOXES LOCATED ON OPPOSITE SIDES OF NON-FIRE RATED WALLS SHALL BE OFFSET A MINIMUM 6".
27. REMOVE AND INSTALL ALL CEILING TILES NECESSARY TO PERFORM REQUIRED ELECTRICAL WORK. ALL CEILING TILES WHICH ARE DAMAGED DURING REMOVAL/REINSTALLATION, SHALL BE REPLACED WITH NEW TILES OF THE SAME MANUFACTURER AND MODEL OF EXISTING TILE.
28. ALL REQUEST FOR CHANGE PROPOSALS IN THIS PROJECT SHALL INCLUDE A BREAKDOWNS OF MATERIALS, LABOR, AND SUBCONTRACTORS, WITH SUFFICIENT DETAIL FOR ENGINEER EVALUATION. EACH SEPARATE PROPOSAL REQUEST ITEM SHALL INCLUDE SEPARATE MATERIALS AND LABOR BREAKDOWNS. SUPPLIER BACK-UP PRICING SHALL BE INCLUDED ON THE SUPPLIERS' LETTERHEAD. ALL LABOR UNITS ASSOCIATED WITH THE NEW MATERIAL INSTALLATIONS SHALL NOT EXCEED 75% OF THE NECA 1 "NORMAL CONDITION" LABOR RATES, WITHOUT SPECIFIC APPROVAL.
29. EXISTING CIRCUITS SHOWN ARE BASED ON EXISTING DRAWINGS AND NEW CIRCUITS ARE SHOWN FOR DESIGN INTENT USING EXISTING CIRCUITS. CONTRACTOR MAY USE DISCRETION WITH EXISTING CONDITIONS TO MAKE CIRCUIT CHANGES. ALL CHANGES SHALL BE RECORD ON AS-BUILT DRAWINGS.

DEMOLITION NOTES

1. DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED FOR THIS PROJECT. THEY ARE NOT INTENDED TO INDICATE THE LOCATION OF ALL DEVICES, JUNCTION BOXES, CONDUITS, ETC. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO BIDDING TO VERIFY ALL RELEVANT EXISTING CONDITIONS.
2. INSPECT AND TEST EXISTING ELECTRICAL DEVICES AND EQUIPMENT INTENDED FOR REMOVAL AND REINSTALLATION, FOR GOOD CONDITION AND PROPER OPERATION PRIOR TO DEMOLITION. RECORD DEFICIENCIES PRIOR TO DISCONNECTION OR REMOVAL. PHOTOGRAPH, RECORD AND REPORT ALL SUCH EXISTING ITEMS DETERMINED TO BE DAMAGED, INOPERATIVE, OR OTHERWISE COMPROMISED. DAMAGED ITEMS FOUND TO BE DAMAGED OR INOPERATIVE AFTER REMOVAL SHALL BE REPLACED AT CONTRACTOR'S EXPENSE.
3. WHERE LIGHT FIXTURES, SWITCHES, RECEPTACLES, OR OTHER ELECTRICAL ITEMS ARE BEING REMOVED, ALL ASSOCIATED CONDUIT AND WIRE BACK TO THE PANELBOARD OR FEEDER JUNCTION BOX SERVING THE DEVICE SHALL ALSO BE REMOVED, UNLESS THE CONDUIT CAN BE USED FOR NEW CONDUCTORS.
4. NO PROJECT DEMOLITION SHALL OCCUR UNTIL COORDINATION WITH ANY/ALL TRADES' AFFECTED DEVICES, EQUIPMENT, WIRING, PIPING, DUCTWORK, OR OTHER COMPONENTS HAS BEEN COMPLETED. DEMOLITION OR NEW WORK THAT CAUSES DAMAGE TO COMPONENTS INTENDED TO REMAIN OR BE REMOVED AND REINSTALLED SHALL BE REPAIRED/REPLACED AT CONTRACTOR'S EXPENSE.
5. EXISTING CONDUIT IN GOOD CONDITION MAY BE REUSED IN PLACE. RELOCATED EXISTING CONDUIT SHALL NOT BE ALLOWED. EQUIPMENT GROUNDING (E.G.) CONDUCTORS SHALL BE INSTALLED IN ALL REUSED CONDUIT TO ASSURE PROPER GROUND PATH.
6. INVESTIGATION OF EXISTING POWER AND LIGHTING SYSTEMS WILL BE REQUIRED BY THE E.C. AS PART OF THE BIDDING PROCESS TO DETERMINE THE FULL EXTENT OF DEMOLITION WORK REQUIRED. THE E.C. SHALL BE RESPONSIBLE FOR REMOVAL OF SOME PORTIONS OF POWER AND LIGHTING SYSTEMS NOT EXPLICITLY SHOWN ON THESE DRAWINGS BUT ARE REQUIRED FOR THIS PHASE OF THE PROJECT. COORDINATE WITH THE G.C., OWNER, AND ENGINEER TO DETERMINE WHICH PORTIONS OF EXISTING SYSTEMS MUST REMAIN ACTIVE AND WHICH PORTIONS MUST BE REMOVED.
7. COORDINATE WORK IN PHASES WITH GENERAL CONTRACTOR AND OWNER TO FACILITATE DEMOLITION AND NEW CONSTRUCTION.
8. E.C. SHALL FIELD VERIFY ACTUAL LOCATION AND SIZES OF EXISTING CONDUIT, WIRING, AND EQUIPMENT.
9. REMOVE POWER, LIGHTING, CONTROL, AND COMMUNICATIONS DEVICES SHOWN, UNLESS NOTED OTHERWISE. REMOVE ALL UNUSED CONDUIT, RACEWAYS, WIRING, JUNCTION BOXES, DISCONNECTS, HANGERS AND ACCESSORIES COMPLETELY BACK TO THE SOURCE.
10. MAKE PROVISIONS AND BACK-FEED OR RE-CIRCUIT ANY ITEMS THAT ARE EXISTING TO REMAIN WHICH ARE AFFECTED BY DEMOLITION. COORDINATE OUTAGES WITH OWNER A MINIMUM OF 4 WORKING DAYS PRIOR TO THE OUTAGE OR AS NOTED IN THE SPECIFICATIONS.
11. ALL SALVAGE SHALL REMAIN THE PROPERTY OF THE OWNER. DELIVER TO A LOCATION ON SITE AS DESIGNATED BY THE OWNER. IN THE EVENT THE OWNER DOES NOT WANT TO RETAIN THE SALVAGE MATERIAL, THE MATERIAL BECOMES THE PROPERTY OF THE CONTRACTOR AND SHALL BE DISPOSED OF OR RECYCLED BY THE CONTRACTOR.
12. RELOCATE CONDUITS ABOVE CEILING AS REQUIRED TO ACCOMMODATE PLUMBING PIPING AND HVAC MODIFICATIONS ASSOCIATED WITH THE REMODELING.
13. PROVIDE CUTTING, PATCHING, AND RESTORATION OF FINISHES AS NECESSARY FOR COMPLETION OF WORK. PATCH AND REPAIR ALL FLOOR, WALL, AND CEILING OPENINGS DUE TO DEMOLITION WHICH WILL NOT BE REUSED. RESTORE SURFACE TO MATCH EXISTING SURFACES/CONDITIONS. COORDINATE WORK WITH THE FINISH CONTRACTORS.
14. EXISTING OPENINGS IN WALLS TO REMAIN SHALL BE PATCHED WITH DRYWALL, TAPED AND PAINTED TO MATCH EXISTING CONDITIONS. BLANK COVERPLATES OVER UNUSED OPENINGS ARE NOT ALLOWED. ALL ABANDONED CONDUITS EXTENDING FROM WALLS ABOVE CEILINGS SHALL BE CUT OFF FLUSH WITH THE STUD AND PLUGGED.
15. PROTECT ALL WALLS, CEILINGS, FLOORS, LIGHTS, AND OTHER FINISHED SURFACES THAT ARE NOT SCHEDULED FOR DEMOLITION. IF DAMAGED, THE RESPONSIBLE CONTRACTOR SHALL REPAIR TO MATCH EXIST

KEYED ELECTRICAL DEMOLITION NOTES (THIS SHEET):

1. DEMOLISH ELECTRICAL CONNECTIONS TO CH-1. DEMOLISH ALL ASSOCIATED ABANDONED ELECTRICAL BACK TO THE ACTIVE SOURCE. COORDINATE PHASING WITH THE MECHANICAL CONTRACTOR PRIOR TO DISCONNECTION.
2. DEMOLISH ELECTRICAL CONNECTIONS TO CT-1. DEMOLISH ALL ASSOCIATED ABANDONED ELECTRICAL BACK TO THE ACTIVE SOURCE. COORDINATE PHASING WITH THE MECHANICAL CONTRACTOR PRIOR TO DISCONNECTION.
3. DEMOLISH ELECTRICAL CONNECTIONS TO P-X. DEMOLISH ALL ASSOCIATED ABANDONED ELECTRICAL BACK TO THE ACTIVE SOURCE. COORDINATE PHASING WITH THE MECHANICAL CONTRACTOR PRIOR TO DISCONNECTION.



N

1 LOWER LEVEL - ELECTRICAL DEMOLITION
1/4" = 1'-0"

NOTE:

ALL OUTAGES SHALL BE COORDINATED WITH OWNER'S REPRESENTATIVE A MINIMUM OF TWO WEEKS IN ADVANCE. THE MAXIMUM OUTAGE DURATION SHALL NOT EXCEED FOUR CONSECUTIVE HOURS AND SHALL BE PERFORMED ON AN OFF-SHIFT BASIS. INCLUDE ALL PREMIUM TIME IN BID PROPOSAL.

NOTE:

1. HANDWRITTEN BRANCH CIRCUIT PANELBOARD SCHEDULES ARE NOT ACCEPTABLE.
2. ALL CIRCUITS IN EXISTING PANELS MODIFIED WITH THE SCOPE OF WORK AND NEW PANELS SHALL HAVE TYPEWRITTEN CIRCUIT DIRECTORIES WITH SPECIFIC INFORMATION ON THE DEVICE AND ROOM(S) SERVED BY THE CORRESPONDING BREAKER.
3. INCLUDE A PRINTED THERMOGRAPHIC LABEL AT EACH BREAKER SPACE CORRESPONDING TO THE TYPEWRITTEN PANEL SCHEDULE.
4. ALL WIRING DEVICES SHALL HAVE A THERMOGRAPHIC LABEL ON EACH FACE PLATE INDICATING THE PANEL AND CIRCUIT NUMBER THE DEVICE IS SERVED BY.

LICENSED PROFESSIONAL ENGINEER
BRIAN R. KEDDINGTON
062-050366
EXPIRES: 30NOV27
STATE OF ILLINOIS
DATE: 04/03/2026

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REVISIONS:

NO.	DESCRIPTION	DATE

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DESIGNED BY: SRB | CHECKED BY: BRK

PROJECT NO: 325-082

ISSUE DATE: 04/03/2026

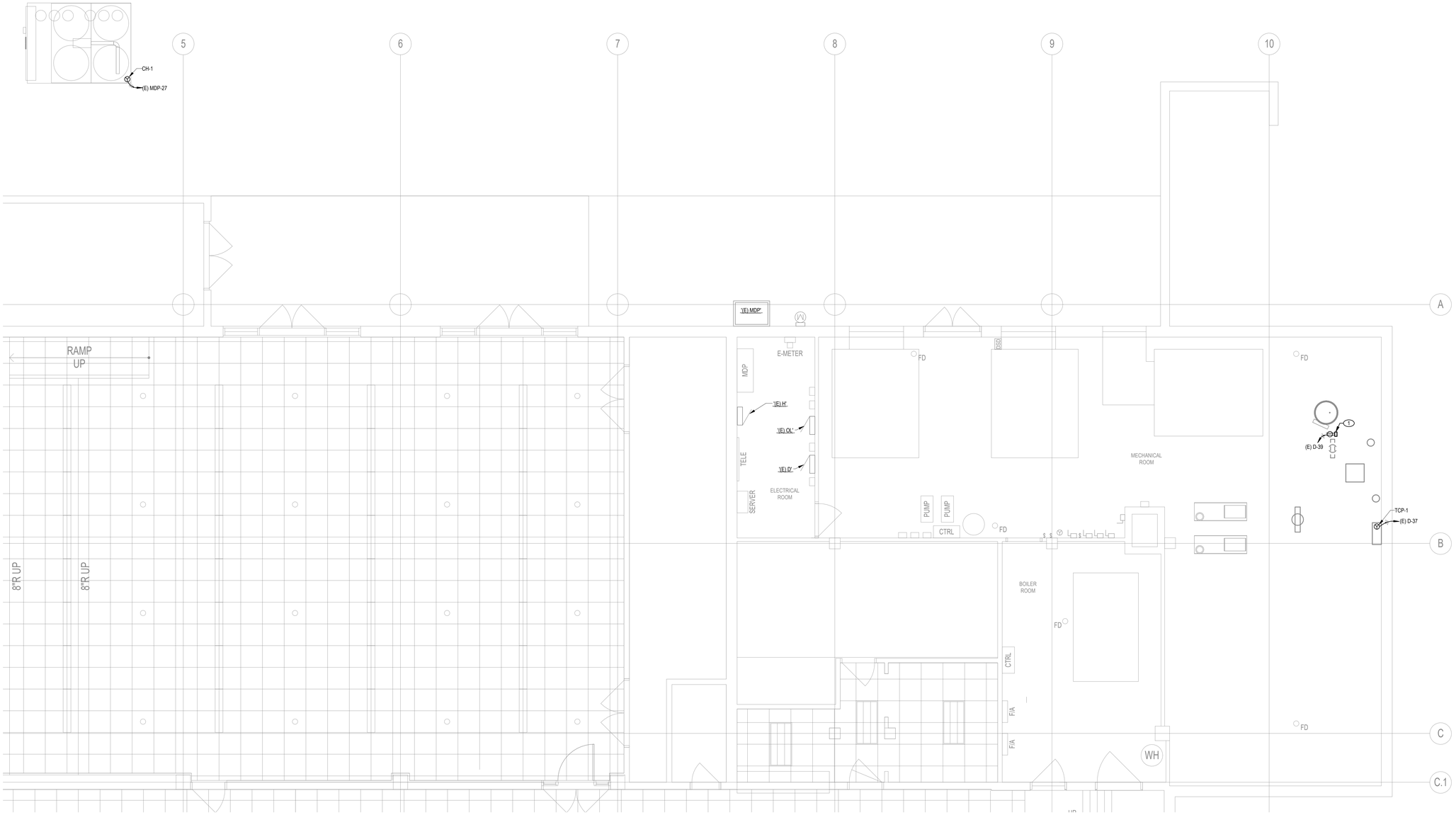
ISSUANCE: ISSUED FOR BIDDING

SHEET NAME: **LOWER LEVEL - ELECTRICAL DEMOLITION**

SHEET (30X42): ED100

KEYED ELECTRICAL NOTES (THIS SHEET):

1. FURNISH AND INSTALL RECEPTACLE FOR GLYCOL MAKE-UP PUMP. FURNISH AND INSTALL A FREE STANDING PIECE OF UNISTRUT FOR MOUNTING OF RECEPTACLE. UNISTRUT SHALL BE ANCHORED TO BOTH FLOOR AND CEILING. ROUTE CONDUIT DOWN UNISTRUT TO RECEPTACLE. COORDINATE FINAL LOCATIONS WITH MECHANICAL CONTRACTOR.



N

1 LOWER LEVEL - ELECTRICAL NEW WORK

1/4" = 1'-0"

NOTE:

ALL OUTAGES SHALL BE COORDINATED WITH OWNER'S REPRESENTATIVE A MINIMUM OF TWO WEEKS IN ADVANCE. THE MAXIMUM OUTAGE DURATION SHALL NOT EXCEED FOUR CONSECUTIVE HOURS AND SHALL BE PERFORMED ON AN OFF-SHIFT BASIS. INCLUDE ALL PREMIUM TIME IN BID PROPOSAL.

NOTE:

1. HANDWRITTEN BRANCH CIRCUIT PANELBOARD SCHEDULES ARE NOT ACCEPTABLE.
2. ALL CIRCUITS IN EXISTING PANELS MODIFIED WITH THE SCOPE OF WORK AND NEW PANELS SHALL HAVE TYPEWRITTEN CIRCUIT DIRECTORIES WITH SPECIFIC INFORMATION ON THE DEVICE AND ROOM(S) SERVED BY THE CORRESPONDING BREAKER.
3. INCLUDE A PRINTED THERMOGRAPHIC LABEL AT EACH BREAKER SPACE CORRESPONDING TO THE TYPEWRITTEN PANEL SCHEDULE.
4. ALL WIRING DEVICES SHALL HAVE A THERMOGRAPHIC LABEL ON EACH FACE PLATE INDICATING THE PANEL AND CIRCUIT NUMBER THE DEVICE IS SERVED BY.

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PROJECT NO: 325-082	
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ISSUANCE: ISSUED FOR BIDDING	
SHEET NAME: **LOWER LEVEL - ELECTRICAL NEW WORK**	
SHEET (30X42): **E100**	

GENERAL ELECTRICAL SCHEDULE

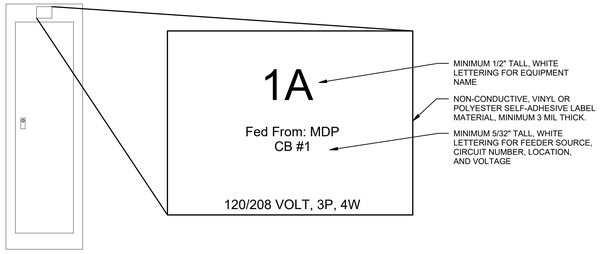
SYMBOL	DESCRIPTION	MANUFACTURER
⊕ ◯	CONNECTION TO MECHANICAL EQUIPMENT	MOTOR/EQUIPMENT FURNISHED AND INSTALLED BY M.C.
J J	ELECTRICAL CONNECTION TO MISC. EQUIPMENT	EQUIPMENT FURNISHED AND INSTALLED BY OTHERS
SWITCHBOARD 'MDP'	EXISTING SWITCHBOARD TO REMAIN, 120/208-VOLT, 3-PHASE, 4-WIRE, NEMA-3R ENCLOSURE. REFER TO PANEL SCHEDULES FOR DETAILS.	SQUARE D
PANEL 'E', 'OL', 'H', & 'D'	BRANCH CIRCUIT PANELBOARD, 208/120V, 3-PHASE, 4-WIRE, NEMA 1 HOUSING, REFER TO PANEL SCHEDULES FOR DETAILS	SQUARE D CUTLER-HAMMER

NEMA 5-20R RECEPTACLE SUBSCRIPT SCHEDULE

SUBSCRIPT	DESCRIPTION	MODEL
NO SUBSCRIPT	DUPLEX GROUND FAULT TAMPER RESISTANT RECEPTACLE, HEAVY DUTY SPECIFICATION GRADE, NEMA 5-20R	HUBBELL HBL5362 LEVITON PASS & SEYMOUR COOPER

ELECTRICAL CONNECTION SCHEDULE

CALLOUT	LOAD CHARACTERISTICS				PANEL AND CIRCUIT INFORMATION			
	VOLTAGE	PHASE	LOAD	LOAD CLASS	FED FROM	CIRCUIT	MOCP	CONDUIT & WIRE
CH-1	208 V	3	92589 VA	CHILLER-1	(E) MDP	27	400/3	4"C, 3-600kcmil, #2G
TCP-1	120 V	1	180 VA	HVAC	(E) D	37	20/1	3/4"C, 1#12, #12N, #12G



NOTE:

PROVIDE NEW PANEL IDENTIFICATION LABEL FOR EACH PANELBOARD, SWITCHBOARD AND MECHANICAL EQUIPMENT DISCONNECT SWITCHES.

1 TYPICAL PANEL/EQUIPMENT LABEL DETAIL
N.T.S.

MAIN DISTRIBUTION PANEL TO REMAIN

DISTRIBUTION PANELBOARD: (E) MDP

LOCATION: EXTERIOR
MOUNTING: FLOOR
ENCLOSURE: NEMA 1
FED FROM: UTILITY
VOLTAGE: 208/120 Wye
PHASE: 3
WIRE: 4
LUGS: Standard
MAIN DEVICE: MCB 2000A
BUS RATING: 2,000
NEUTRAL RATING: 100.00%
A.I.C. RATING: 65,000

SQUARE D QED SERIES

CKT #	CIRCUIT DESCRIPTION	A	B	C	FRAME	TRIP	POLES	FEEDER RACEWAY & CONDUCTORS	NOTES
1	PUMP	0	0	0	40 A	40 A	3	--	
2	BOILER	0	0	0	30 A	30 A	3	--	
3	AIR COMP	0	0	0	70 A	70 A	3	--	
4	AC A	0	0	0	300 A	300 A	3	--	
5	PANEL CC	0	0	0	400 A	400 A	3	--	
6	SPACE	--	--	--	--	--	3	--	
7	ELECTRIC ROOM PANEL	0	0	0	400 A	400 A	3	--	
8	AC B	0	0	0	300 A	300 A	3	--	
9	PANEL C	0	0	0	300 A	300 A	3	--	
10	RANGE	0	0	0	225 A	225 A	3	--	
11	UNKNOWN	0	0	0	225 A	225 A	3	--	
12	SPARE	0	0	0	30 A	30 A	3	--	
13	SPARE	0	0	0	125 A	125 A	3	--	
14	SPARE	0	0	0	225 A	225 A	3	--	
15	SPARE	0	0	0	225 A	225 A	3	--	
16	PANEL BATH	0	0	0	150 A	150 A	3	--	
17	SPARE	0	0	0	150 A	150 A	3	--	
18	SPARE	0	0	0	125 A	125 A	3	--	
19	SPARE	0	0	0	225 A	225 A	3	--	
20	PANEL A	0	0	0	150 A	150 A	3	--	
21	IT	0	0	0	200 A	200 A	3	--	
22	PANEL D	0	0	0	125 A	125 A	3	--	
23	SPARE	0	0		60 A	60 A	2	--	
24	SPARE	0	0	0	200 A	200 A	3	--	
25	SPARE	0	0	0	20 A	20 A	3	--	
26	SPARE	0	0	0	20 A	20 A	3	--	
27	CH-1	30.9	30.9	30.9	400 A	400 A	3	4"C, 3-600kcmil, #2G	N
	TOTAL CONNECTED KVA BY PHASE	30.9 kVA	30.9 kVA	30.9 kVA					
	TOTAL CONNECTED AMPS BY PHASE	257 A	257 A	257.2 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	CALCULATED LOAD	PANELBOARD TOTALS	
CHILLER-1	92589 VA	100.00%	92589 VA	**TOTAL CONNECTED KVA**	92.6 kVA
				TOTAL CALCULATED KVA	92.6 kVA
				TOTAL CONNECTED AMPS	257 A
				TOTAL CALCULATED AMPS	257 A

NOTES:

EXISTING BRANCH PANEL TO REMAIN

BRANCH PANELBOARD: (E) D

LOCATION: ELECTRICAL ROOM
MOUNTING: SURFACE
ENCLOSURE: NEMA 1
FED FROM: MDP
VOLTAGE: 208/120 Wye
PHASE: 3
WIRE: 4
LUGS: Standard
MAIN DEVICE: MLO
BUS RATING: 225
NEUTRAL RATING: 100.00%
A.I.C. RATING: 10,000

FEDERAL PACIFIC AG-915609

CKT #	CKT BKR A / P		NOTES	CIRCUIT DESCRIPTION	KVA LOAD 'PHASE A'		KVA LOAD 'PHASE B'		KVA LOAD 'PHASE C'		CIRCUIT DESCRIPTION	NOTES	CKT BKR P / A		CKT #
1	20 A	1		LIGHTS CORR 17	0	0					LTS LOBBY 1		1	20 A	2
3	20 A	1		LIGHTS CORR 17			0	0			LTS BOILER RM		1	20 A	4
5	20 A	1		LIGHTS HALL 12					0	0	LTS COAT RM, RECEPT BOILER RM		1	20 A	6
7	20 A	1		LIGHTS TOILET RMS	0	0					LTS STOR 15		1	20 A	8
9	20 A	1		HD DRYER WOMENS			0	0			LTS STOR 15		1	20 A	10
11	20 A	1		HD DRYER MENS					0	0	RECEPT STOR 15, HALL 17, ASSEM 07		1	20 A	12
13	20 A	1		LIGHTS BK-STAGE, RECEPT HALL	0	0					RECEPT CAT 13		1	20 A	14
15	20 A	1		LIGHTS & RECEPT, BK STAGE			0	0			RECEPT CAT 13		1	20 A	16
17	20 A	1		LTS & RECEPT BK STAGE 18					0	0	RECEPT CAT 13		1	20 A	18
19	20 A	1		LTS & RECEPT PREP 9	0	0					LTS MECH EQUIP RM		1	20 A	20
21	20 A	1		LTS PREP 9			0	0			BOILER CONTRACTOR		1	20 A	22
23	20 A	1		TOILET ROOMS 10, 11					0	0	HTRS TOILET RM 11		1	20 A	24
25	20 A	1		REC PRINT RM 14	0	0					BOILER		1	20 A	26
27	20 A	1		REC & EXHAUST FAN RMS 14 & 15			0	0			EXH FAN PROJECTION RM		1	20 A	28
29	20 A	1		REC & FANS RM 1					0	0	ELEC EYE		1	20 A	30
31	20 A	1		TIME CLOCK FAN A	0	0					HTRS RM 21 & 23		1	20 A	32
33	20 A	1		LTS ELECTRIC RM			0	0			DOMS WATER PUMP		1	20 A	34
35	20 A	1		TELEPHONE EQUIP					0	0	JCS COMPRESSOR		1	20 A	36
37	20 A	1	N	TCP-1	0.2	--					SPACE		1	--	38
39	20 A	1	N	GLYCOL PUMP RECEPTACLE			0.2	--			SPACE		1	--	40
41	--	1		SPACE					--	--	SPACE		1	--	42
				TOTAL CONNECTED KVA BY PHASE	0.2 kVA		0.2 kVA		0 kVA						
				TOTAL CONNECTED AMPS BY PHASE	1.7 A		1.7 A		0 A						

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	CALCULATED LOAD	PANELBOARD TOTALS	
HVAC	180 VA	100.00%	180 VA		
Receptacle	180 VA	100.00%	180 VA	**TOTAL CONNECTED KVA**	0.4 kVA
				TOTAL CALCULATED KVA	0.4 kVA
				TOTAL CONNECTED AMPS	1 A
				TOTAL CALCULATED AMPS	1 A

NOTES:

NOTE:

ALL OUTAGES SHALL BE COORDINATED WITH OWNER'S REPRESENTATIVE A MINIMUM OF TWO WEEKS IN ADVANCE. THE MAXIMUM OUTAGE DURATION SHALL NOT EXCEED FOUR CONSECUTIVE HOURS AND SHALL BE PERFORMED ON AN OFF-SHIFT BASIS. INCLUDE ALL PREMIUM TIME IN BID PROPOSAL.

NOTE:

1. HANDWRITTEN BRANCH CIRCUIT PANELBOARD SCHEDULES ARE NOT ACCEPTABLE.
2. ALL CIRCUITS IN EXISTING PANELS MODIFIED WITH THE SCOPE OF WORK AND NEW PANELS SHALL HAVE TYPEWRITTEN CIRCUIT DIRECTORIES WITH SPECIFIC INFORMATION ON THE DEVICE AND ROOM(S) SERVED BY THE CORRESPONDING BREAKER.
3. INCLUDE A PRINTED THERMOGRAPHIC LABEL AT EACH BREAKER SPACE CORRESPONDING TO THE TYPEWRITTEN PANEL SCHEDULE.
4. ALL WIRING DEVICES SHALL HAVE A THERMOGRAPHIC LABEL ON EACH FACE PLATE INDICATING THE PANEL AND CIRCUIT NUMBER THE DEVICE IS SERVED BY.

LICENSED PROFESSIONAL ENGINEER
BRIAN R. KEPPLER
062-050306
EXPIRES: 11/30/27
STATE OF ILLINOIS

DATE: 04/03/2026

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Noble Center Chiller Replacement

1125 West Lake Avenue, Peoria IL

REVISIONS:

NO.	DESCRIPTION	DATE

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DESIGNED BY: SRB | CHECKED BY: BRK

PROJECT NO: 325-082

ISSUE DATE: 04/03/2026

ISSUANCE:
ISSUED FOR BIDDING

SHEET NAME:
ELECTRICAL PANEL & MATERIAL SCHEDULES

SHEET (30X42):
E500