



# **PROJECT MANUAL**

**CDB #321-055-138**

**REPLACE POWER PLANT**

**ELGIN MENTAL HEALTH CENTER**

**DEPARTMENT OF HUMAN SERVICES**

**ELGIN (KANE COUNTY), ILLINOIS**

**CDB BUILDING INV. NO. DHS055-0001 (New Power Plant)**

**CONTRACT: DESIGN-BUILD**

**State of Illinois**

## **CAPITAL DEVELOPMENT BOARD**

**USING AGENCY: ILLINOIS DEPARTMENT OF HUMAN SERVICES**

**BY: STANLEY CONSULTANTS, INC.  
8501 WEST HIGGINS ROAD, SUITE 730  
CHICAGO, IL 60631**

**DATE: April 22, 2021  
101% BRIDGING DOCUMENTS FOR REVIEW**

State of Illinois  
CAPITAL DEVELOPMENT BOARD

Stanley Consultants, Inc.  
8501 W. Higgins Road  
Chicago, IL 60631  
Phone: 773.693.9624

PROJECT MANUAL FOR

CDB-321-055-138

REPLACE POWER PLANT  
ELGIN MENTAL HEALTH CENTER  
DEPARTMENT OF HUMAN SERVICES  
ELGIN, KANE COUNTY, ILLINOIS

DATE: APRIL 22, 2021

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A handwritten signature of Mark D. Wagner in black ink.

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EXPIRES 11-30-21

A handwritten signature of Amanda Beck-Larkin in black ink.

END 00 01 10

**BIDDING & CONTRACT REQUIREMENTS**  
**00 01 15 - Drawings, Schedules and Details**

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**BIDDING & CONTRACT REQUIREMENTS**  
**00 01 15 - Drawings, Schedules and Details**

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All Drawings dated: April 22, 2021

END 00 01 15



DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS  
**Section 00 31 32 – Geotechnical Reporting**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design Build Contractor shall provide:

1.2 Geotechnical Data

- A. This document and its referenced attachments are for information and are not part of the Contract Documents.
- B. A geotechnical investigation report, prepared by Geo Services, Inc., dated September 18, 2020, is appended to this document.

END 00 31 32

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**GEOTECHNICAL REPORT**  
**Elgin Mental Health Center**  
**750 S. State Street**  
**Elgin, Illinois**

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**Prepared for:**

**Orion Engineering, LLC**  
**220 North Green Street**  
**Chicago, IL 60607**



**Prepared by:**

**Geo Services, Inc.**  
**805 Amherst Court**  
**Suite 204**  
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**(630) 305-9186**

**GSI Project No. 20104**

**September 18, 2020**

September 18, 2020

Orion Engineers, LLC  
328 South Jefferson Street  
Suite 950  
Chicago, IL 60661

Attn: Mr. John E. Naughton III, P.E.

Job No. 20104

Re: Geotechnical Engineering Services  
Elgin Mental Health Center  
750 South State Street  
Elgin, Illinois

Dear Mr. Naughton:

Please find enclosed the results of the geotechnical investigation performed at Elgin Mental Health Center located in Elgin, IL. The investigation was performed to determine soil conditions in the premises of a proposed health center slab-on-grade building. This report is based upon the subsurface information obtained from eight (8) soil borings (SB-1, SB-2, SB-3, SB-4, SB-5, SB-6, SB-7, SB-8). The site is located at 750 South State Street in Elgin, IL. The existing site is North of the Rehabilitation building and East of Assembly Hall.

Historical aerial photos of the site, as observed from Google Earth, indicate that a now demolished building used to occupy the site. The aerial photos indicate that the previous, now demolished building which inhabited the site was constructed before the year 1938. This structure was present at the site up until it was demolished sometime between 1999 and 2002. According to the historical aerial photos, after demolition of the property, the property remained devoid of structures up until the current day. This agrees with the environmental site assessment (ESA) report, titled "Phase I Environmental Site Assessment", conducted by Stanley Consultants in July, 2020.

According to engineers at Orion Engineers, LLC., the new building which has been planned to occupy the property at 750 South State Street in Elgin, IL is a 1-story building which will have 2<sup>nd</sup> story ceilings in select parts of the building. Orion also indicated that the current design for the foundation of the building is proposed for slab on grade construction.

## **SUBSURFACE INVESTIGATION PROCEDURES**

The soil borings were performed on September 4, 2020. Boring locations were finalized in the field by Geo Services, Inc. personnel after inspecting the field for drill rig

accessibility and utility line locations. Prior to this, Blood Hound Underground Utility Locators performed electromagnetic (EM) and ground penetrating radar (GRP) scans of 10 ft x 10 ft regions around each boring location to check for utility lines prior to drilling. Also, ground surface elevations were measured at the final locations for each borehole.

A truck mounted drill rig used to perform the eight (8) soil borings. One of the borings, SB-1, was drilled to an approximate depth of 20 feet, while the other borings were advanced to approximately 10 feet. Boreholes were advanced using hollow stem augers and representative samples were obtained employing split spoon sampling procedures in accordance with ASTM Specification D-1586. Samples obtained in the field were returned to our laboratory for further examination and testing.

Split spoon sampling involves driving a 2.0-inch outside diameter split-barrel sampler into the soil with a 140-pound weight falling freely through a distance of 30 inches. The number of blows required to advance the sampler the last 12 inches is termed the Standard Penetration Resistance (N) and is included on the boring logs. The N value is an indication of the relative density of the soil.

## **LAB TESTING PROGRAM**

The laboratory testing program consisted of performing water content and calibrated penetrometer tests on the cohesive samples recovered. The results of all testing performed, along with a visual classification of the material based upon both a textural analysis and the Unified Soil Classification System, are indicated on the boring logs. Furthermore, soil resistivity tests were conducted on soil samples in accordance with ASTM G-187 for three (3) boreholes, namely SB-01, SB-03, and SB-07. The soil sample for each of the aforementioned soil resistivity tests were obtained within 3 to 7 feet depth range below grade.

## **SOIL AND GROUNDWATER CONDITIONS**

Specific soil conditions encountered in the borings are indicated on the soil boring log included in the Attachments. The general trend of the borings indicates the top 2"-12" of soil is dark, brown topsoil. The SPT N-value corresponding to the top 5 feet of soil is 12 blows / foot. The average moisture content of the top 5-foot soil layer is 10.5%. Below this generally lies a 5-foot layer of silty clay fill, which has an average N-value of 55 blows / foot and a moisture content in the range of 1.0% - 3.0%. The last layer, which is found at depths ranging from 10-20 feet, is made up of sand, gravel, and cobbles. The moisture content of this layer is approximately 1.0% – 3.0%. This layer has an average N-value of 50 blows / foot. These layers are illustrated in the boring logs attached.

Groundwater was not encountered during or after drilling operations. The entirety of the soil borings exhibited brown soil, with no coloration change in the soil. Due to this, we

assume that the long-term water table to be greater than 20 feet below existing grade. Fluctuations in the amount of water accumulated and in the hydrostatic water table can be anticipated depending upon variations in precipitation, and surface runoff.

## **ANALYSIS AND RECOMMENDATIONS**

### **Shallow Foundations**

We recommend that the new proposed building be supported below the existing fill material, which lies in the range of 1 to 5.5 feet below existing grade, on conventional shallow spread footing foundations situated within the natural, medium dense to very dense sand, gravel, and cobble layer underlying the existing fill or on a pad of structural fill. The depths at which fill is found varies across the site. The depth of existing fill from existing grade is shown below in Table 1 for all of the borings performed at the site. We recommend that spread footings supported on the natural soils as described previously or on compacted structural fill placed at 95% maximum dry density (ASTM D-1557 Modified Proctor) be designed for a maximum net allowable bearing pressure of 4,000 pounds per square foot (psf). The net allowable soil bearing pressure refers to that pressure which may be transmitted to the foundation soils in excess of the final minimum surrounding overburden pressure.

**TABLE 1**  
**Soil Boring Fill Depth Information**

<b>Boring #</b>	<b>Ground Surface Elevation of Boring (ft.)</b>	<b>Existing Fill Depth (ft.)</b>
SB-01	738.457	5.5
SB-02	741.337	0.2
SB-03	740.312	5.5
SB-04	744.239	5.5
SB-05	740.715	3.0
SB-06	738.105	3.0
SB-07	743.103	5.5
SB-08	741.773	5.5

If soils with less than adequate bearing strength are noted at the foundation level during footing construction, the weaker soils encountered at the base of the footings should be undercut to reach suitable bearing soils, and the undercut area filled with lean concrete or a suitable compacted crushed stone structural fill material. Suitable crushed stone fill

materials include materials meeting the gradation requirements of IDOT CA-1, CA-7 and CA-6. Total settlement of shallow footing foundations situated within compacted stone fill is estimated to be less than 0.5".

Structural fill utilized to support footings should be extended at least 6 inches beyond the proposed footing limits and then one foot horizontally for each one foot of fill placed below the base of the footing. This new fill should consist of inorganic material free of debris and should be placed in maximum 9-inch loose lifts and compacted to a minimum of 95% of the maximum dry density obtained in accordance with ASTM Standard D-1557, modified Proctor method. If CA-1 or CA-7 crushed stone materials are used, they can be compacted by tamping with a backhoe bucket. If open-graded stone is used, a non-woven geotechnical fabric should be used between the structural fill and the bottom of undercut to prevent fine migration from the subgrade to the structural fill. The moisture content of the fill should be controlled within +2% of the optimum moisture content.

To provide adequate frost protection, we recommend that footing foundations in non-heated areas be situated at a minimum depth of 4 feet below final grade while the perimeter footings in heated areas should be situated at a minimum depth of 3.5 feet below final outside grade. Also, in order to prevent disproportionately small footings, we recommend that continuous wall footings have a minimum width of 1.5 feet and that isolated column footings have a minimum lateral dimension of 2.5 feet.

### **Slab-On-Grade Construction**

The borings indicate that the existing surface materials below the topsoil consists of silty clay fill, or a layer of sand, gravel, and cobbles over some thickness of dense to very dense sand, gravel, and cobbles. Assuming that the foundation will be done as slab-on-grade, the fill described in previous sections should be stripped and any organic, unsuitable or deleterious material should be removed. The subgrade should also be thoroughly proofrolled as described below prior to placing any new fill or base course for support of the floor slab and adjacent parking lot pavement.

Proofrolling of the resultant subgrade should be performed to locate unstable/unsuitable soils that should be stabilized /removed. During the proofrolling procedure, the soil stripped to design subgrade elevation is rolled with the heaviest piece of construction equipment available at the site, such as a heavily loaded tandem axle dump truck having a gross weight of not less than 25 tons. Areas exhibiting deflection or rutting should be removed (or disked, dried and recompacted) and the proofrolling continued until all unsuitable soils have been located and removed, or improved in-place.

Where new fill is required to reach the design slab or pavement subgrade elevation, we recommend that an approved inorganic material be utilized for structural fill. This material should consist of material that is free of organic matter, topsoil, and debris. Fill material used in pavement or slab-on-grade subgrade that may be exposed to freezing temperatures should also be non-frost susceptible. Provided they can be moisture

conditioned to facilitate proper compaction, the on-site clayey fill materials appear suitable for reuse as engineered fill below floor slabs and pavements. New fill should be placed in maximum 9-inch thick loose lifts and be compacted to a minimum of 90% of the maximum dry density obtained in accordance with ASTM Standard D-1557, modified Proctor method.

Beneath slab-on-grade areas, a minimum of 4 inches of granular base course material is recommended to facilitate fine grading and provide a capillary cut-off. Floor slabs should be isolated from foundations to permit relative displacement without cracking. Slabs should also be provided with adequate reinforcing and jointing to control minor slab cracking.

## **CONSTRUCTION CONSIDERATIONS**

All excavations that extend greater than 4 feet in depth should be designed in accordance with OSHA regulations with properly sloped or braced sides to prevent excavation instability. Excavation safety is the responsibility of the contractor; however, we recommend that excavation sides be sloped at 1-1/2H:1V or flatter above the water table for this purpose. Stockpiles of material or equipment should not be placed near the top of excavation slopes.

All soils which become softened or loosened at the base of foundation excavation areas or subgrade areas should be carefully recompacted or removed prior to placement of foundation concrete or fill material. No foundation concrete or structural fill should be placed in areas of ponded water or frozen soil.

## **GENERAL QUALIFICATIONS**

The analysis and recommendations presented in this report are based upon the data obtained from the soil boring performed at the indicated location and from any other information discussed in this report. This report does not reflect any variations that may occur between borings or across the site. In addition, the soil samples cannot be relied on to accurately reflect the strata variations that usually exist between sampling locations. The nature and extent of such variations may not become evident until construction. If variations appear evident, it will be necessary to reevaluate the recommendations of the report. In addition, it is recommended that Geo Services, Inc. be retained to perform construction observation and thereby provide a complete professional geotechnical engineering service through the observational method.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. In the event that any changes in the nature, design or location of the project as outlined in this report are planned, the conclusions and



recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report modified or verified in writing by the geotechnical engineer. Also note that Geo Services, Inc. is not responsible for any claims, damages, or liability associated with any other party's interpretation of this report's subsurface data or reuse of the report's' subsurface data or engineering analyses without the express written authorization of Geo Services, Inc.

If there are any questions regarding the information submitted herein, please do not hesitate to contact us.

Very truly yours,

GEO SERVICES, Inc.



Sean Kirwan  
Assistant Project Engineer



Andrew J. Ptak, P.E.  
Office Manager

Attachments:

- General Notes
- Site Location Map
- Boring Location Diagram
- Boring Logs

## ATTACHMENTS

## GENERAL NOTES

### CLASSIFICATION

Unified Soil Classification System used for soil classification.

#### Cohesionless Soils

<u>Relative Density</u>	<u>No. of Blows per foot N</u>
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	Over 50

#### TERMINOLOGY

**Streaks** are considered to be paper thick. **Lenses** are considered to be less than 2 inches thick. **Layers** are considered to be less than 6 inches thick. **Stratum** are considered to be greater than 6 inches thick.

#### Cohesive Soils

<u>Consistency</u>	<u>Unconfined Compressive Strength - qu (tsf)</u>
Very Soft	Less than 0.25
Soft	0.25 - 0.5
Medium Stiff	0.5 - 1.0
Stiff	1.0 - 2.0
Very Stiff	2.0 - 4.0
Hard	Over 4.0

### DRILLING AND SAMPLING SYMBOLS

SS: Split Spoon 1-3/8" I.D., 2" O.D.	HS: Housel Sampler
ST: Shelby Tube 2" O.D., except where noted	WS: Wash Sample
AS: Auger Sample	FT: Fish Tail
DB: Diamond Bit - NX: BX: AX	RB: Rock Bit
CB: Carboloy Bit - NX: BX: AX	WO: Wash Out
OS: Osterberg Sampler	

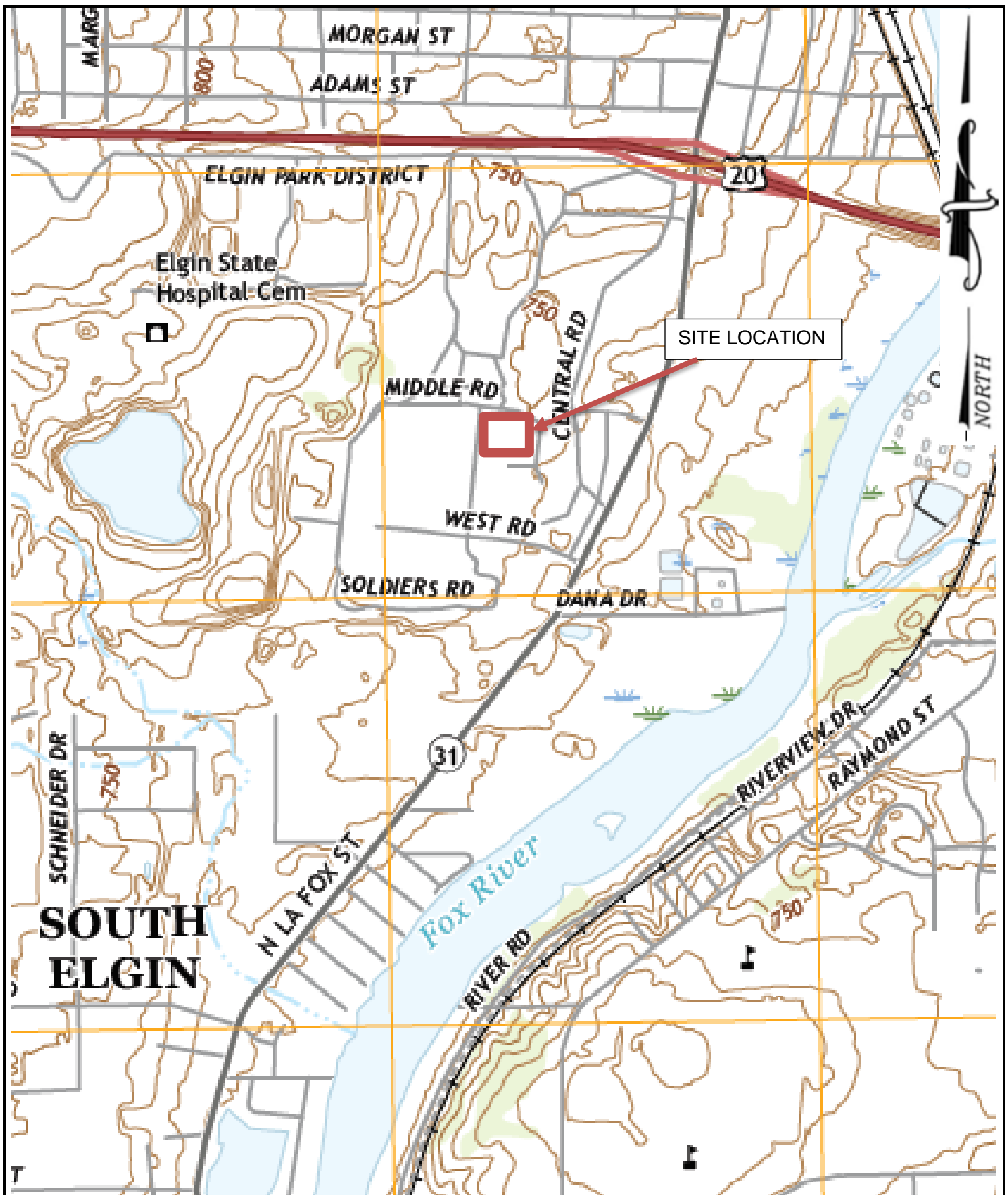
Standard "N" Penetration: Blows per foot of a 140 lb. hammer falling 30" on a 2" O.D. Split Spoon


### WATER LEVEL MEASUREMENT SYMBOLS

WL: Water	WD: While Drilling
WCI: Wet Cave In	BCR: Before Casing Removal
DCI: Dry Cave In	ACR: After Casing Removal
WS : While sampling	AB: After Boring

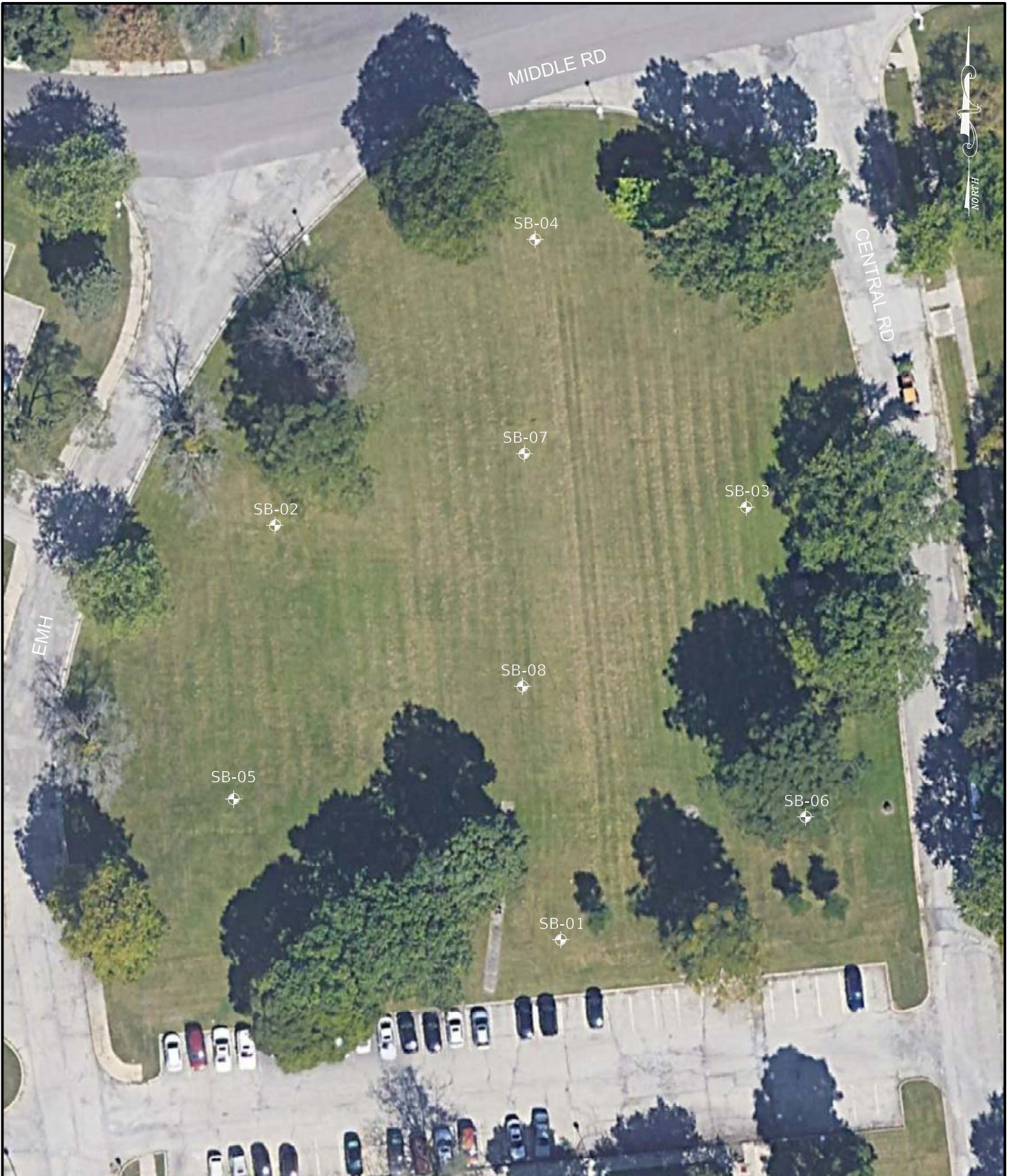
Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. In pervious soils, the indicated elevations are considered reliable ground water levels. In impervious soils, the accurate determination of ground water elevations is not possible in even several days observation, and additional evidence on ground water elevations must be sought.


# Site Map



SITE LOCATION MAP	 <p><b>Geo Services, Inc.</b>  Geotechnical, Environmental &amp; Civil Engineering  805 Amherst Court, Suite 204  Naperville, Illinois 60565  (630) 355-2838</p>	DRAWN BY	SWK
Elgin Mental Health Center		APPROVED BY	AJP
Middle Rd. and Soldiers Rd., Elgin, IL, 60123		DATE	September 18, 2020
		GSI JOB No.	20104
		SCALE	NTS

# Boring Location Map



SOIL BORING LOCATION DIAGRAM	 <b>Geo Services, Inc.</b> Geotechnical, Environmental & Civil Engineering 805 Amherst Court, Suite 204 Naperville, Illinois 60565 (630) 355-2838	DRAWN BY	RWC
Geotechnical Investigation For The Proposed Combined Heat & Power Plant Elgin Mental Health Center, 750 South State Street, Elgin, Illinois		APPROVED BY	AJP
		DATE	September 08, 2020
		GSI JOB No.	20104
		SCALE	1"=50'

# Boring Logs



# STRUCTURE FOUNDATION BORING LOG

PAGE 1 of 1

DATE 9/4/2020

LOGGED BY RJ

GSI JOB No. 20104

Project: Geotechnical Investigation For The Proposed Combined Heat & Power Plant

Location: Elgin Mental Health Center, 750 South State Street, Elgin, Illinois

County: Kane Drilling Method: 4.0" Hollow Stem Auger Hammer Type: CME Automatic

Client: Orion Engineers, LLC

BORING No.: SB-01

Northing: 1948287.771

Easting: 996749.16

Ground Surface Elev. 738.457

DEPTH (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST (%)	Surface Water Elev.	Stream Bed Elev.	DEPTH (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST (%)
				n/a	n/a				
				Groundwater Elevation:					
				First Encounter	Dry				
				Upon Completion	Dry				
				After _____ Hrs.					
12.0 "				TOPSOIL—dark brown					
	AS		8						
	6								
SILTY CLAY—dark brown— hard (CL) Fill	7								
	8	4.5+P	13						
SILTY SANDY CLAY with Stone— dark brown to black—medium dense Fill	8								
	11								
	-5 11		21			-25			
	12								
	21								
SAND, GRAVEL & COBBLES—brown— dense to very dense (GP)	17		2						
	17								
	26								
	-10 27		2			-30			
	12								
	14								
	19		2						
	15								
	23								
	-15 29		2			-35			
	18								
	34								
	41		2						
	28								
End Of Boring @ -20.0'									
Hollow Stem Augers	50/6"								
CME Automatic Hammer	-20		1			-40			

# STRUCTURE FOUNDATION BORING LOG

PAGE 1 of 1

DATE 9/4/2020

LOGGED BY RJ

GSI JOB No. 20104

Project: Geotechnical Investigation For The Proposed Combined Heat & Power Plant

Location: Elgin Mental Health Center, 750 South State Street, Elgin, Illinois

County: Kane Drilling Method: 4.0" Hollow Stem Auger Hammer Type: CME Automatic

Client: Orion Engineers, LLC

BORING No.: SB-02

Northing: 1948445.027

Easting: 996640.77

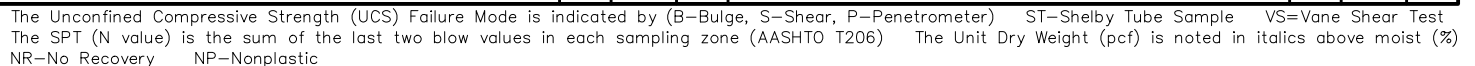
Ground Surface Elev. 741.337

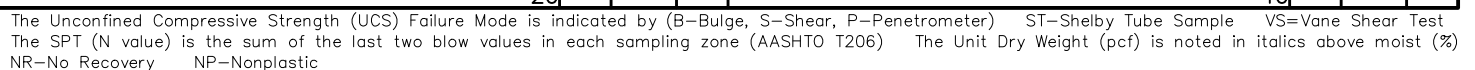
DEPTH (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)	Surface Water Elev. <u>n/a</u>	Stream Bed Elev. <u>n/a</u>	Groundwater Elevation:	First Encounter <u>Dry</u>	Upon Completion <u>Dry</u>	After _____ Hrs. _____	DEPTH (ft)	BLOW S (/6")	UCS Qu (tsf)	MOIST T (%)
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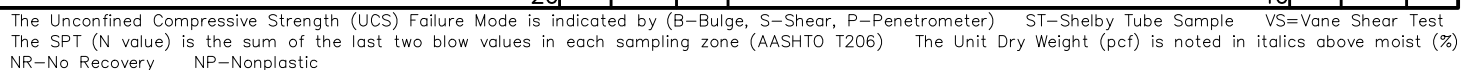
2.0" TOPSOIL—dark brown

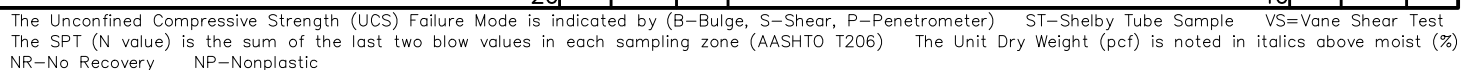
SAND, GRAVEL & COBBLES—brown—  
medium dense to very dense (GP)

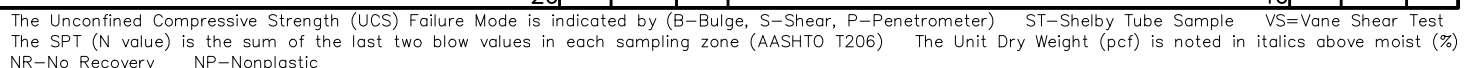
End Of Boring @ -10.0'  
Hollow Stem Augers  
CME Automatic Hammer

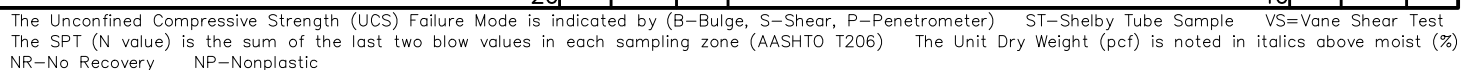














1. GENERAL

1.1 PROJECT INFORMATION

Project Identification: New Power Plant, CDB Project Number 321-055-138.

1. Project Location: Elgin Mental Health Center, Kane County, Elgin, Illinois.

Illinois Capital Development Board (CDB).

2. CDB's Representative: Abdulgaffar Shedbalkar, Project Manager, 312-814-4443, [A-gaffar.Shedbalkar@Illinois.gov](mailto:A-gaffar.Shedbalkar@Illinois.gov)

Using Agency: Elgin Mental Health Center, 750 South Stata Street, Elgin, Illinois 60123.

3. Using Agency's Representative: David Arvans, 847-613-8147, [DAVID.ARVANS@illinois.gov](mailto:DAVID.ARVANS@illinois.gov)

Architect: Stanley Consultants, Inc, 8501 W. Higgins Road, Chicago, IL 60631.

4. Architect's Representative: Mark Wagner, PE, PMP, Project Manager.

Architect's Consultants: Architect has retained the following design professionals, who have prepared designated portions of the Contract Documents:

5. Architectural: Primera Engineers.
  - a. Representative: Jill Deichmann, AIA, NCARB
6. Site Civil: Orion Engineers, LLC
  - a. Representative: Brett Butterfield, PE
7. Structural: Orion Engineers, LLC
  - a. Representative: Dana McKane, SE, PE
8. Site Utilities and Controls: CCJM Engineers, LTD
  - a. Representatives: Tom Kisiel, Wei Qian, PE
9. Fire Protection: Primers Engineers.

a. Representative: Amanda Beck Larkin, PE

## 1.2 WORK COVERED BY CONTRACT DOCUMENTS

### The Work of Project:

The Elgin Mental Health Center (EMHC) is a 53-building facility established in 1872. The North Campus is currently under the ownership of The City of Elgin which includes Middle Road. The current powerplant and support structures are located on five acres still under State ownership. The five acres are completely encompassed by property owned by The City of Elgin with the exception of a 66 foot wide easement that traverses from the existing power plant, south to Middle Road, where it traverses Middle Road onto the State's property.

The location for the new power plant will be located south of Middle Road and north of the Rehab Center on the curb surrounded lawn area. The existing power plant will be abandoned in place and no demolition will be required as part of this project. The proposed site for the new power plant included a hospital building. The building was demolished in 1997.

Elements of the project include constructing a new power plant on the Elgin campus which will provide sufficient power and steam to serve campus demand. The new power plant's equipment will provide a reliable and economical central heating and power facility. Components of this project will be reviewed for eligible grants or rebates from the utility company. Major design features will include the following elements:

1. New steam and electrical generation
2. Decommissioning of the existing power plant
3. Required infrastructure expansion or modification
4. Maintenance workspace and vehicle storage
5. On-site fuel for backup generation

Alternate features of the project include the following:

Alternate 1: Remote salt storage for road salt

Alternate 2: Asbestos abatement of the old power plant

DIVISION 20 – FACILITIES SERVICES  
**Section 01 10 00 – Project Summary**

Type of Contract: Design-Build consisting of the following trades:

1. General
2. Plumbing
3. Heating
4. Ventilation
5. Electrical
6. Fire Protection

Work Restrictions: Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Using Agency or others unless permitted under the following conditions and then only after arranging for temporary utility services according to requirements indicated:

7. Notify Using Agency not less than five days in advance of proposed utility interruptions.

END 01 10 00

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Not applicable.

B. Alternate Bids: Alternate 2

1. Design Build Contractor shall provide an IDPH licensed abatement contractor (AC).
2. Removal and disposal and patch/repair of all asbestos containing materials (ACM) as indicated on Asbestos Drawing ASB-1. Asbestos Survey Report is provided under separate cover.
3. Disposal of all asbestos waste shall be done on a daily basis. Due to the limited amount of asbestos removal identified for this project, asbestos waste bags shall be brought to the asbestos contractor's yard dumpster daily and properly manifested. Asbestos waste shall be disposed at an asbestos landfill after project is completed.

1.2 DEFINITIONS

A. Refer to Asbestos Hazardous Emergency Response Act (AHERA) Abatement Act, Section 3, and IDPH Rules and Regulations, Part 855.20.

1.3 REGULATORY REQUIREMENTS

A. Illinois Department of Public Health (IDPH) Rules and Regulations Asbestos Abatement Act.

B. Federal Requirements

1. NESHAP – National Emissions Standards for Hazardous Air Pollutants.
2. OSHA – Occupational Safety and Health Administration.
3. AHERA – Asbestos Hazard Emergency Response Act.

1.4 FIELD QUALITY CONTROL

A. Abatement Contractor:

1. Perform the duties and responsibilities specified in the IDPH Rules and Regulations.

DIVISION 02 – EXISTING CONDITIONS  
**Section 02 82 13 – Asbestos Abatement**

2. Employ the Air Sampling Professional (ASP) in accord with the IDPH Rules and Regulations.
  3. Provide air monitoring of own personnel.
- B. IDPH, Chicago Department of Public Health, CDB or the coordinating contractor may issue emergency stop work orders to the abatement contractor. IDPH may additionally assess fines and penalties in accord with IDPH Rules and Regulations, Part 855.610.

1.5 SUBMITTALS

- A. Make all submittals in accord with IDPH Rules and Regulations, Part 855.350 to A/E.
1. Submit documented evidence that each person performing asbestos work holds a valid IDPH License and accreditation certificate in accord with IDPH Rules and Regulations, Parts 855.20, 855.100 and 855.120.
  2. Submit documented evidence of current medical surveillance records.
  3. Submit documented evidence of respirator training, most recent fit testing and written respiratory protection program.
- B. Complete the State of Illinois Asbestos Project Notification form included herein. Ensure notification is postmarked or had delivered to IEPA and City of Chicago Department of Public Health at least ten working days prior to the start of construction.
- C. Forward a copy of each submittal to the CDB Project Manager prior to the start of abatement.

1.6 PROTECTION

- A. Provide protection for personnel and building in accord with IDPH Rules and Regulations.

1.7 SCHEDULING

- A. Coordinate sequence of work and schedule of operations with Using Agency occupancy/schedule, and to ensure that all asbestos work will be accomplished before other contractors begin their work.

2. PRODUCTS

2.1 MATERIALS AND EQUIPMENT

DIVISION 02 – EXISTING CONDITIONS  
**Section 02 82 13 – Asbestos Abatement**

- A. Use only materials and equipment complying with the IDPH Rules and Regulations, Parts 855.390.

3. EXECUTION

3.1 PREPARATION

- A. Perform all preparation work in accord with the IDPH Rules and Regulations.

3.2 PERFORMANCE

- A. Perform all asbestos work in accord with the IDPH Rules and Regulations.
- B. Patch/Repair Procedures. IDPH-licensed asbestos workers shall be utilized to patch and repair asbestos.
- C. Variances/Alternatives: Contractor may request variances or alternative abatement methods or procedures in accord with the IDPH Rules and Regulations, Part 855.25. Submit variance requests to A/E. Do not perform any work involving variances or alternative methods until written approval from IDPH and CDB is received. An RFPCO shall be issued for all variances issued after bidding to adjust the price of the project reflect any cost savings. The variances shall be signed by the Heating Contractor and Abatement Contractor.

D. Disposal

- 1. Identify all bags or containers containing asbestos debris.
- 2. Whenever trucks or dumpsters are being loaded or unloaded with asbestos waste, post signs in accord with the NESHAP STANDARD- DANGER, ASBESTOS DUST HAZARD, CANCER AND LUNG DISEASE HAZARD, AUTHORIZED PERSONNEL ONLY.
- 3. Transport all waste to an IEPA approved landfill. Complete a waste shipment record for each load of waste in accord with the NESHAP STANDARD. Return the record, signed by waste disposal site owner/operator to Heating Contractor within 10 days after completion of project.

3.3 CLEANUP

- A. Perform all cleanup operations daily in accord with the IDPH Rules and Regulations.

END 02 82 13

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DIVISION 03 – CONCRETE  
**Section 03 10 00 – Concrete Forming and Accessories**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build contractor shall provide all work as specified below.

1. All concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.

B. Alternate Bids: Alternate 1 (Remote Salt Storage)

1. All concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work for salt storage.

1.2 SUBMITTALS

A. Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.

B. Designer's Qualification Statement.

C. Design Data: As required by authorities having jurisdiction.

1.3 QUALITY ASSURANCE

A. Designer Qualifications: Design formwork under direct supervision of a Professional Structural Engineer experienced in design of concrete formwork and licensed in the State in which the Project is located.

2. PRODUCTS

2.1 FORMWORK

A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.

B. Design and construct concrete that complies with design with respect to shape, lines, and dimensions.

C. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.

D. Comply with relevant portions of ACI 347R, ACI 301, and ACI 318.

E. Form Materials: At the discretion of the Contractor.



DIVISION 03 – CONCRETE  
**Section 03 10 00 – Concrete Forming and Accessories**

3. EXECUTION

3.1 ERECTION - FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.

3.2 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Locate and set in place items that will be cast directly into concrete.

3.3 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.

3.4 FORMWORK TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI 117, unless otherwise indicated.

3.5 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

END 03 10 00

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build contractor shall provide all work as specified below.

1. All reinforcement required to accomplish cast-in-place concrete work.

B. Alternate Bids: Alternate 1 (Remote Salt Storage)

1. All reinforcement required to accomplish cast-in-place concrete work for  
slat storage.

1.2 SUBMITTALS

A. Shop Drawings: Comply with requirements of ACI SP-66. Include bar  
schedules, shapes of bent bars, spacing of bars, and location of splices.

B. Manufacturer's Certificate: Certify that reinforcing steel and accessories  
supplied for this project meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI 301.

2. PRODUCTS

2.1 REINFORCEMENT

A. Reinforcing Steel: ASTM A615, Grade 60, deformed.

B. Steel Welded Wire Reinforcement (WWR): ASTM A1064, plain.

3. EXECUTION

3.1 PLACEMENT

A. Place, support, and secure reinforcement against displacement. Do not  
deviate from required position.

END 03 20 00

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1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build contractor shall provide all work as specified below.

1. All concrete materials, mixture designs, and finishes required to accomplish cast-in-place concrete work.

B. Alternate Bids: Alternate 1 (Remote Salt Storage)

1. All concrete materials, mixture designs, and finishes required to accomplish cast-in-place concrete work for salt storage.

1.2 SUBMITTALS

A. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.

B. Design Mixes: Submit design mix for each concrete mix. Include field test data used to establish the required average strength in accordance with ACI 301.

1.3 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI 301 and ACI 318.

2. PRODUCTS

2.1 CONCRETE MATERIALS

A. Cement: ASTM C150, Type I - Normal Portland type.

B. Fine and Coarse Aggregates: ASTM C33.

C. Fly Ash: ASTM C618, Class C or F.

D. Slag Cement: ASTM C989, Grade 100 or 120.

E. Silica Fume: ASTM C1240, proportioned in accordance with ACI 211.1.

F. Water: ASTM C1602; clean, potable, and not detrimental to concrete.

2.2 ADMIXTURES

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Air Entrainment Admixture: ASTM C260.
- C. Water Reducing Admixture: ASTM C494 Type A.
- D. High Range Water Reducing Admixture: ASTM C494 Type F.

2.3 CONCRETE MIX DESIGN

- A. Normal Weight Concrete
  - 1. Compressive Strength (28 Days): 4,000 psi.

3. EXECUTION

3.1 PLACEMENT

- A. Place concrete in accordance with ACI 304R.

3.2 CONCRETE FINISHING

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- B. Concrete Slabs: Finish to requirements of ACI 302.1R. Do not wet concrete surfaces.

3.3 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

3.4 FIELD QUALITY CONTROL

- A. Testing: By Contractor-engaged agency.
- B. Special Inspections: By Contractor-engaged special inspector.

END 03 30 00

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide unit masonry as shown and herein specified.
- B. Alternate Bids: N/A

1.2 PERFORMANCE REQUIREMENTS

- A. Net-Area Compressive Strengths of Unit Masonry: As indicated.
- B. Determine net-area compressive strength of masonry by unit-strength method.

1.3 MATERIALS

- A. Brick: Building (common) brick.
- B. Reinforcement: Uncoated-steel reinforcing bars.
- C. Masonry-Joint Reinforcement:
  - 1. Interior Walls: Hot-dip galvanized, carbon steel.
  - 2. Exterior Walls: Hot-dip galvanized, carbon steel.
- D. Ties and Anchors: Galvanized steel.
  - 1. Corrugated-metal ties.
  - 2. Adjustable anchors for connecting to structural steel framing.
  - 3. Partition top anchors.
  - 4. Rigid anchors.
  - 5. Adjustable Masonry-Veneer Anchors: Screw attached and seismic.
- E. Embedded Flashing:
  - 1. All Flashing: Stainless steel.
  - 2. Partially Exposed Flashing: Stainless steel.
  - 3. Concealed (Flexible) Flashing: Stainless steel fabric
- F. Weep/Vent Holes: Wicking material.
- G. Cavity drainage material: Mortar deflector.

H. Reinforcing bar positioners.

I. Mortar:

1. Portland cement-lime or mortar cement mortar unless otherwise indicated.

1.4 INSTALLATION

A. Match existing masonry coursing, bonding, color, and texture.

B. Bond Pattern: Running bond.

C. Parge cavity face of backup wythe.

D. Clean masonry waste recycled as fill material.

1.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner engaged.

B. Inspections: Special inspections in accordance with Level 2 in TMS 402.

C. Testing: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area.

END 04 20 00

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide cast stone masonry as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 SUMMARY

- A. Trim units.
- B. Decorative elements.
- C. Accessories.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by PCI for Group A, Category AT.

1.4 MATERIALS

- A. Cast-Stone Units: ASTM C1364.
- B. Embedded Anchors: Hot-dip galvanized steel.
- C. Mortar: Portland cement and lime or mortar cement.

1.5 SOURCE QUALITY CONTROL

- A. Testing Agency: Contractor engaged to test according to ASTM C1364.

1.6 INSTALLATION

- A. Cast stone set in mortar.
- B. Mechanically anchored cast stone with sealant-filled joints.

END 04 72 00



1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build contractor shall provide all work as specified below.

1. All steel and connection material as required for the project shown on the drawings and specified herein.

1.2 SUBMITTALS

A. Shop Drawings:

1. Indicate profiles, sizes, spacing, locations of structural members, opening, attachments, and fasteners.
2. Indicate cambers and loads.
3. Indicate welded connections.

B. Fabricator Test Reports: Comply with ASTM A1011/A1011M.

C. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.

D. Welders Certificates: Certify welders employed on the project, verifying AWS qualification within the previous 12 months.

E. Fabricator's Qualification Statement.

F. Installer's Qualification Statement.

1.3 QUALITY ASSURANCE

A. Comply with provisions of AISC 303, ANSI/AISC 341, and ANSI/AISC 360.

B. Fabricator Qualifications: AISC-Certified Plant, Category BU or IAS Fabricator Inspection Program for Structural Steel.

C. Installer Qualifications: AISC-Certified Erector, Category ASCE.

2. PRODUCTS

2.1 MATERIALS

A. Angles, Channels, Plates, and Bars: ASTM A36.

DIVISION 05 – METALS  
**Section 05 12 00 – Structural Steel Framing**

- B. W, WT, and HP Shapes: ASTM A992 or ASTM A572, Grade 50.
- C. High Strength Bolts: ASTM A325, ¾” Diameter or ASTM A490, 1 ¼” Diameter.
- D. High Strength Nuts: ASTM A563.
- E. Washers: ASTM F346.
- F. Threaded Rods: ASTM A36.
- G. Anchor Rods: ASTM F1554, Grade 55.

2.2 COATINGS

- A. All steel shapes and plates permanently exposed to weather shall be hot-dip galvanized.
- B. All steel shapes and plates not permanently exposed to weather shall be primed and painted.
- C. All attachment bolts, nuts, and miscellaneous hardware shall be galvanized.

2.3 FABRICATION

- A. Shop fabricate to the greatest extent possible.

3. EXECUTION

3.1 ERECTION

- A. Erect structural steel in compliance with AISC 303.

3.2 FIELD QUALITY CONTROL

- A. Special Inspector: Contractor engaged.
- B. Testing Agency: Contractor engaged.

END 05 12 00

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build contractor shall provide all work as specified below.

1. All steel joists as required for the project shown on the drawings and specified herein.

1.2 SUBMITTALS

A. Shop Drawings: Indicate standard designations, joist coding, configurations, sizes, spacings, cambers, locations of joists, joist leg extensions, bridging, connections, and attachments.

B. Welders Certificates: Certify welders employed on the project, verifying AWS qualification within the previous 12 months.

C. Manufacturer's Qualification Statement.

D. Fabricator's Qualification Statement.

E. Installer's Qualification Statement.

1.3 QUALITY ASSURANCE

A. Perform Work, including that for headers and other supplementary framing, in accordance with SJI Code of Standard Practice for Steel Joists and Steel Joist Girders.

2. PRODUCTS

2.1 MATERIALS

A. Open Web Joists: Type LH Joists:

1. Minimum End Bearing: Comply with referenced SJI standards.
2. Bridging: Comply with referenced SJI standards.
3. End Arrangement: Square.
4. Top-Chord Arrangement: Parallel.
5. Finish: Shop primed.

B. Connections: Field welded, bolted.

3. EXECUTION

3.1 ERECTION

- A. Erect joists with correct bearing on supports.
- B. Allow for erection loads. Provide sufficient temporary bracing to maintain framing safe, plumb, and in true alignment.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor engaged.

END 05 21 00

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build contractor shall provide all work as specified below.

1. Steel roof and composite floor deck as required for the project shown on the drawings and specified herein.

1.2 SUBMITTALS

A. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.

B. Certificates: Certify that products furnished meet or exceed specified requirements.

C. Welders Certificates: Certify welders employed on the project, verifying AWS qualification within the previous 12 months.

D. Fabricator's Qualification Statement.

E. Installer's Qualification Statement.

1.3 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified steel fabricator that is accredited by the International Accreditation Service (IAS) Fabricator Inspection Program for Structural Steel in accordance with IAS AC172.

2. PRODUCTS

2.1 STEEL DECK

A. Steel Roof Deck: 1-1/2" 18-gauge, galvanized, Type B.

B. Composite Floor Deck: 1-1/2" 20-gauge steel deck.

3. EXECUTION

3.1 INSTALLATION

A. Mechanically fastened.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Contractor engaged.

END 05 31 00

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide metal fabrications as shown and herein specified.
- B. Alternate Bids: N/A

1.2 PRODUCTS

- A. Materials: Steel plates, shapes, and bars, Steel tubing, Steel pipe or Aluminum.
- B. Miscellaneous Framing and Supports: Primed using zinc-rich primer where indicated.
  - 1. Steel framing and supports for ceiling-hung toilet compartments, overhead doors, mechanical and electrical equipment, or applications where framing and supports are not specified in other Sections.
- C. Shelf angles primed using zinc-rich primer at exterior walls.
- D. Metal Ladders: Aluminum.
  - 1. Galvanized exterior ladders.
- E. Miscellaneous Steel Trim: Steel angle corner guards or steel.
  - 1. Galvanized exterior trim.
- F. Metal Bollards: Schedule 40 steel pipe
  - 1. Primed using zinc-rich primer.
- G. Loose bearing and leveling plates, galvanized.
- H. Loose steel lintels primed using zinc-rich primer at exterior walls.
- I. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts cast into concrete or built into unit masonry.
- J. Steel weld plates and angles not specified in other Sections, for casting into concrete.

END 05 50 00

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide sheet metal flashing and trim as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 SUMMARY

- A. Industrial Class stairs with steel-grating treads.
- B. Steel railings and guards attached to metal stairs.
- C. Steel handrails attached to walls adjacent to metal stairs.

1.3 PERFORMANCE REQUIREMENTS

- A. Engineering design of metal grating stairs, railings, and guards by Contractor.

1.4 STEEL-FRAMED STAIRS

- A. Stair Standard: NAAMM AMP 510, "Metal Stairs Manual," Industrial Class.
- B. Stringers: Steel channels.
- C. Metal Bar-Grating Treads: 1/2-inch (12-mm) maximum opening.
- D. Stair Railings: Comply with Section 05 52 13 "Pipe and Tube Railings."

END 05 51 19



1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design Build Contractor shall provide pipe and tube railings as shown and herein specified.

B. Alternate Bids: N/A

1.2 SUMMARY

A. Aluminum railings.

1.3 PERFORMANCE REQUIREMENTS

A. Engineering design of railings by Contractor.

1.4 FABRICATION

A. Changes in Direction of Members: By bending or by inserting prefabricated fittings.

B. Connections: Welded.

C. Toe boards.

1.5 FINISHES

A. Aluminum: Class II, clear anodic or Baked enamel or powder coat

END 05 52 13

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES  
**Section 06 10 53 – Miscellaneous Rough Carpentry**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide miscellaneous rough carpentry as shown and herein specified.
- B. Alternate Bids: N/A

1.2 MATERIALS

A. Wood Products, General:

- 1. Maximum Moisture Content of Lumber: 15 percent

B. Wood-Preservative-Treated Materials:

- 1. Preservative Treatment: AWPAC U1; Use Category UC2
  - a. Preservative Chemicals: Containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
- 2. Application: All miscellaneous carpentry. Items indicated and the following:
  - a. Items in contact with roofing or waterproofing.
  - b. Items in contact with concrete or masonry.
  - c. Framing less than 18 inches (460 mm) aboveground in crawlspaces.
  - d. Floor plates installed over concrete slabs-on-grade.

C. Fire-Retardant-Treated Materials:

- 1. Exterior type for exterior locations and where indicated.
- 2. Interior Type A, High Temperature (HT) for enclosed roof framing and where indicated.
- 3. Interior Type A unless otherwise indicated.
- 4. Application: All miscellaneous carpentry. Items indicated and the following:
  - a. Framing for raised platforms.
  - b. Concealed blocking.

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES  
**Section 06 10 53 – Miscellaneous Rough Carpentry**

- c. Roof framing and blocking.
- d. Items in contact with roofing.
- e. Plywood backing panels.

D. Miscellaneous Lumber:

- 1. Dimension Lumber: Construction or No. 2 grade any species
- 2. Concealed Boards: 15 percent maximum moisture content.
  - a. Mixed southern pine, No. 2
  - b. Hem-fir, Construction or No. 2 Common.
  - c. Spruce-pine-fir, Construction or 2 Common.
  - d. Eastern softwoods, No. 2 Common.
  - e. Northern species, No. 2 Common.
  - f. Western woods, Construction or No. 2 Common.

E. Plywood Backing Panels: Exterior, AC

- F. Fasteners: Hot-dip galvanized steel where exposed to weather, in ground contact, in contact with treated wood, or in area of high relative humidity.

G. Metal Framing Anchors:

- 1. Metal: Galvanized steel; hot-dip heavy galvanized steel for wood preservative treated lumber and where indicated.

1.3 INSTALLATION

- A. Furring to Receive Plywood or Hardboard Paneling: 1-by-3-inch nominal (19-by-63 mm actual) size furring at 24 inches (610 mm) 600 mm o.c.

END 06 10 53

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES  
**Section 06 41 16 – Plastic-Laminate-Clad Architectural Cabinets**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide plastic laminate clad architectural cabinets as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: AWI's Quality Certification Program licensed participant.

1.3 PLASTIC-LAMINATE-CLAD CABINETS

- A. Architectural Woodwork Standards Grade: Custom.
- B. Type of Construction: Face frame.
- C. Door and Drawer-Front Style: Flush overlay.
- D. Laminate Cladding for Exposed Surfaces:
  - 1. Horizontal Surfaces: Grade HGS.
  - 2. Post-formed Surfaces: Grade HGP.
  - 3. Vertical Surfaces: Grade HGS.
- E. Materials for Semi-exposed Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade VGS

1.4 MATERIALS

- A. Cabinet Hardware:
  - 1. Hinges: Butt, semi-concealed.
  - 2. Pulls: Wire.
  - 3. Adjustable shelf supports.
  - 4. Exposed Hardware Finishes: Satin stainless steel.

END 06 41 16

DIVISION 07 – THERMAL AND MOISTURE PROTECTION  
**Section 07 21 00 – Thermal Insulation**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide thermal insulation as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 MATERIALS

A. Insulation:

- 1. Polyisocyanurate Board: Glass-fiber-mat faced, Type II, Class 2.

B. Auxiliary Insulating Materials:

- 1. Insulation fasteners.
- 2. Adhesive.

END 07 21 00

DIVISION 07 – THERMAL AND MOISTURE PROTECTION  
**Section 07 26 00 – Vapor Retarders**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design Build Contractor shall provide vapor retarders as shown and herein specified.

B. Alternate Bids: N/A

1.2 MATERIALS

A. Polyethylene Vapor Retarders: 10-mil (0.25-mm-) thick sheet.

B. Reinforced-Polyethylene Vapor Retarders: 20 lb/1000 sq. ft. (9 kg/100 sq. m).

C. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: 20 lb/1000 sq. ft. (9 kg/100 sq. m).

END 07 26 00

DIVISION 07 – THERMAL AND MOISTURE PROTECTION  
**Section 07 54 23 – Thermoplastic-Polyolefin (TPO) Roofing**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Thermoplastic Polyolefin (TPO) roofing as shown and herein specified.
- B. All work and materials are to be in accordance with the Capital Development Board's Roofing Handbook.
- C. Alternate Bids: N/A.

1.2 WARRANTY

- A. Manufacturer's Materials and Workmanship Warranty: 20 years.
- B. Installer's Warranty: Two years.

1.3 PERFORMANCE REQUIREMENTS

- A. Wind Uplift Resistance:
  - 1. Zone 1 (Roof Area Field): 18.3 psf
  - 2. Zone 2(Roof Area Perimeter): 30.8 psf
  - 3. Zone 3(Roof Area Corners): 46.3 psf
- B. FM Approvals' RoofNav Listing: Class 1A-90
- C. SPRI's Directory of Roof Assemblies Wind Uplift Load Capacity Listing: 90 psf]
- D. Cool-Roof Performance: Energy Star/Cool Roof Rating Council/State of Illinois guidelines
- E. Exterior Fire-Test Exposure: Class A

1.4 MATERIALS

- A. Low-emitting adhesives and sealants.
- B. TPO Roofing: ASTM D6878/D6878M, internally fabric- or scrim-reinforced, self-adhering TPO sheet.
  - 1. Thickness: 60 mils (1.5 mm), nominal.
  - 2. Color: White

DIVISION 07 – THERMAL AND MOISTURE PROTECTION  
**Section 07 54 23 – Thermoplastic-Polyolefin (TPO) Roofing**

- C. Sheet Flashing: Same as TPO sheet.
- D. Substrate Board: Glass-mat, water-resistant gypsum substrate
- E. Vapor Retarder: Glass-fiber felts
- F. Roof Insulation: Polyisocyanurate board.
  - 1. Tapered Insulation: 1/4 inch per foot (1:48)
- G. Cover Board: Glass-mat, water-resistant gypsum substrate
- H. Walkways: Pads or Rolls

1.5 INSTALLATION

- A. Roof Insulation: Mechanically fasten the first layer of insulation and adhere subsequent layers.
- B. Membrane Roofing: Adhered

1.6 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor engaged.
  - 1. Flood testing
  - 2. Infrared thermography
  - 3. Electrical capacitance/impedance testing
  - 4. Low-voltage electrical conductance testing EFVM
  - 5. High-voltage spark testing

END 07 54 23



DIVISION 07 – THERMAL AND MOISTURE PROTECTION  
**Section 07 62 00 – Sheet Metal Flashing and Trim**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide sheet metal flashing and trim as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 PERFORMANCE REQUIREMENTS

- A. Sheet Metal Standard for Flashing and Trim: NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual.
- B. FM Approvals Listing: For windstorm classification, Class 1-90

1.3 MATERIALS

- A. Sheet Metals:
  - 1. Aluminum Sheet: Three-coat fluoropolymer
- B. Underlayment: Self-adhering, high-temperature sheet with rosin-sized slip sheet.

1.4 PRODUCTS

- A. Manufactured reglets with counterflashing.
- B. Formed Low-Slope Roof Fabrications: Including roof expansion-joint covers, base flashing, counterflashing, flashing receivers, roof-penetration flashing and roof-drain flashing.
- C. Miscellaneous Formed Fabrications: Including equipment support flashing.

END 07 62 00

DIVISION 07 – THERMAL AND MOISTURE PROTECTION  
**Section 07 71 00 – Roof Specialties**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide roof specialties as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 QUALITY ASSURANCE

- A. Mockups of typical roof edge.

1.3 WARRANTY

- A. Roofing-System Warranty: Roof specialties included in warranty provisions of roofing Section.
- B. Special Warranty on Painted Finishes: 20 years.

1.4 PERFORMANCE REQUIREMENTS

- A. Copings: FM Approvals listed.
  - 1. FM Windstorm Classification: Class 1-90
- B. Roof-Edge Flashings: FM Approvals listed.
  - 1. FM Windstorm Classification: Class 1-90.

1.5 PRODUCTS

- A. Reglets and Counterflashings:
  - 1. Reglets, Surface Mounted, Formed aluminum.
  - 2. Counterflashings: Formed aluminum.
- B. Finishes:
  - 1. Aluminum: Three-coat fluoropolymer

END 07 71 00

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide roof accessories as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 WARRANTY

- A. Painted Finishes: 20 years.

1.3 PRODUCTS

- A. Roof Curbs: Insulated with interior metal liner.
  - 1. Height: Minimum 18 inches
  - 2. Material: Aluminum
  - 3. Finish: Clear anodic aluminum
- B. Equipment Supports: Perimeter type, insulated, with interior metal liner.
  - 1. Height: Minimum 18 inches.
  - 2. Material: Aluminum
  - 3. Finish: Clear anodic aluminum
- C. Roof Hatches: Insulated with single walled curbs.
  - 1. Height: Minimum 18 inches.
  - 2. Hatch Lid: Opaque, single leaf.
  - 3. Material: Aluminum.
  - 4. Finish: Clear anodic aluminum.
- D. Hatch-Type Heat and Smoke Vents: Insulated with single-walled curbs; listed to comply with UL 793.
  - 1. Height: Minimum 18 inches
  - 2. Hatch Lid: Opaque, single leaf.

DIVISION 07 – THERMAL AND MOISTURE PROTECTION  
**Section 07 72 00 – Roof Accessories**

3. Material: Aluminum.
  4. Finish: Clear anodic aluminum
  5. Accessories: UL-listed fusible links
  6. Fall protection safety structure.
  7. Security grille where indicated.
- E. Gravity Ventilators:
1. Louvered Penthouse Style: Aluminum
  2. Turbine Style: Aluminum.
  3. Accessories: Bird and insect screens.
- F. Pipe Supports: Fixed-height cradle type
- G. Duct Supports: Extruded aluminum, urethane insulated.
- H. Pipe Portals: Insulated, curb-mounted type with TPO caps
- I. Preformed Flashing Sleeves: Exhaust vent flashing and vent stack flashing fabricated from aluminum sheet.

END 07 72 00

DIVISION 07 – THERMAL AND MOISTURE PROTECTION  
**Section 07 81 00 – Applied Fire Protection**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide applied fire protection as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 QUALITY ASSURANCE

- A. Mockups for each type of fire protection, substrate, and finish.

1.3 PRECONSTRUCTION TESTING

- A. Testing service engaged by Contractor.

1.4 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Design: Tested according to ASTM E119 or UL 263. Steel members are considered unrestrained and restrained.

1.5 SPRAYED FIRE-RESISTIVE MATERIALS

- A. Sprayed Fire-Resistive Material: Wet, cementitious type for interior use:
  - 1. Bond Strength: Minimum 150 lbf/sq. ft. (7.18 kPa)
  - 2. Compressive Strength: Minimum 100 lbf/sq. in. (689 kPa) according to ASTM E761.
  - 3. Fungus resistant.
  - 4. Finish: As selected by Architect from manufacturer's standard finishes
- B. Auxiliary Materials: According to fire-resistance designs indicated.
  - 1. Sealer.
  - 2. Topcoat: Cement based.

1.6 FIELD QUALITY CONTROL

- A. Special Inspections: Contractor engaged special inspector.

END 07 81 00

DIVISION 07 – THERMAL AND MOISTURE PROTECTION  
**Section 07 84 13 – Penetration Firestopping**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide penetration firestopping as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 QUALITY ASSURANCE

- A. Installer Qualifications: FM Approval approved or UL qualified.

1.3 PENETRATION FIRESTOPPING

- A. Penetrations in Fire-Resistance-Rated Walls: F-ratings per ASTM E814 or UL 1479.
- B. Penetrations in Horizontal Assemblies: F-, T-, and W-ratings per ASTM E814 or UL 1479.
- C. Penetrations in Smoke Barriers: L-ratings per UL 1479.

1.4 INSTALLATION

- A. Identification: Walls and penetrations.

1.5 FIELD QUALITY CONTROL

- A. Inspection of Installed Firestopping: By Contractor engaged agency according to ASTM E2174.

END 07 84 13

DIVISION 07 – THERMAL AND MOISTURE PROTECTION  
**Section 07 84 43 – Joint Firestopping**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design Build Contractor shall provide joint firestopping as shown and herein specified.

B. Alternate Bids: N/A.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: FM Approvals approved or UL qualified.

1.3 FIRE-RESISTIVE JOINT SYSTEMS

A. Joints in or between Fire-Resistance-Rated Construction: ASTM E1966 or UL 2079.

1.4 FIELD QUALITY CONTROL

A. Inspection of Installed Firestopping: By Contractor engaged agency according to ASTM E2393.

END 07 84 43

DIVISION 07 – THERMAL AND MOISTURE PROTECTION  
**Section 07 92 00 – Joint Sealants**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide joint sealants as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 PRECONSTRUCTION TESTING

- A. Preconstruction laboratory testing.
- B. Preconstruction field-adhesion testing.

1.3 WARRANTY

- A. Installer Warranty: Two years.
- B. Special Manufacturer's Warranty: Five years.

1.4 JOINT SEALANTS

- A. Silicone joint sealants.
- B. Non-staining silicone joint sealants.
- C. Urethane joint sealants.
- D. Immersible joint sealants.
- E. Silyl-terminated polyether joint sealants.
- F. Mildew-resistant joint sealants.
- G. Polysulfide joint sealants.
- H. Butyl joint sealants.
- I. Latex joint sealants.
- J. Joint sealant backing.

1.5 FIELD QUALITY CONTROL

- A. Field-adhesion testing.

END 07 92 00



DIVISION 08 – OPENINGS  
**Section 08 11 13 – Hollow Metal Doors and Frames**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide hollow metal doors and frames as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 PERFORMANCE REQUIREMENTS

- A. Fire-rated assemblies.
- B. Windborne-debris-impact-resistant doors and frames.

1.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2.
  - 1. Face: Uncoated steel sheet, minimum thickness of 0.042 inch (1.0 mm).
  - 2. Edge Construction: Model 1, Full Flush.
  - 3. Core: Polystyrene and Vertical steel stiffener.
  - 4. Frames: Full profile welded; uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
  - 5. Exposed Finish: Prime.

1.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2.
  - 1. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch (1.0 mm).
  - 2. Edge Construction: Model 1, Full Flush.
  - 3. Core: Polystyrene and Vertical steel stiffener.
  - 4. Frames: Full profile welded; metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
  - 5. Exposed Finish: Prime.

1.5 INSTALLATION

- A. Masonry and Concrete Walls: Frames filled with insulation or grout.

DIVISION 08 – OPENINGS  
**Section 08 11 13 – Hollow Metal Doors and Frames**

END 08 11 13

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design Build Contractor shall provide overhead coiling doors as shown and herein specified.

B. Alternate Bids: N/A.

1.2 DOOR ASSEMBLY

A. Insulated Service Door: Door curtain of galvanized steel with vision panels.

B. Operation Cycles: 50,000.

C. Design Wind Load: As indicated on the drawings.

D. STC Rating: 26.

E. Hood: Galvanized steel.

F. Electric Door Operator: Heavy duty with emergency manual crank operation.

1. Obstruction-detection device.

1.3 MAINTENANCE SERVICE

A. Initial Maintenance Service: 12 months.

1.4 DEMONSTRATION

A. Factory-authorized representative to train Owner's personnel.

END 08 33 23

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide aluminum windows as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 WARRANTY

- A. Windows: 10 years from date of Substantial Completion.
- B. Glazing Units: 20 years from date of Substantial Completion.
- C. Aluminum Finish: 20 years from date of Substantial Completion.

1.3 WINDOW PERFORMANCE REQUIREMENTS

- A. Product Standard: AAMA/WDMA/CSA 101/I.S.2/A440.
- B. Thermal Transmittance: 0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K) maximum.
- C. Solar Heat-Gain Coefficient: 0.38 maximum.
- D. Condensation Resistance Factor (CRF): NFRC 500 Minimum CRF of 61 (Frame) and 65 (Glass).
- E. Windborne-Debris Resistance: Passing ASTM E1886 and requirements of authorities having jurisdiction.

1.4 ALUMINUM WINDOWS

- A. Frames and Sashes: Thermally improved aluminum extrusions.
- B. Glazing:
  - 1. Glass: Clear, insulating, with low-E coating
  - 2. Glazing System: Manufacturer's standard
- C. Accessories: Subsills, Interior trim, Panning trim and Receptor system.
- D. Insect Screens: At each operable exterior sash, with aluminum frames and without wickets.
- E. Aluminum Finish: Baked enamel.

1.5 FIELD QUALITY CONTROL

A. Testing Agency: Contractor engaged.

END 08 51 13

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide door hardware as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 WARRANTY

- A. Materials and Workmanship: Three years.

1.3 PRODUCTS

- A. Antifriction bearing hinges.
  - 1. Base Metal:
    - a. Exterior Hinges: Stainless steel with stainless steel pin
    - b. Interior Hinges: Stainless steel with stainless steel pin.
    - c. Hinges for Fire-Rated Assemblies: Stainless steel with stainless steel pin.
  - B. Mechanical Locks and Latches: Mortise locks
  - C. Surface Bolts: Half-round interlocking and fire-rated surface bolts.
  - D. Flush Bolts: Self-latching flush bolts; dustproof strikes.
  - E. Exit Devices and Auxiliary Items:
    - 1. Panic and combination exit devices.
    - 2. Automatic-latching two-point bolts.
    - 3. Extension flush bolt sets.
    - 4. Outside trim.
    - 5. Through-bolt fasteners.
  - F. Lock Cylinders:[Standard.
    - 1. Construction cores.
  - G. Keying System:

1. To match facilities keying system.
  2. Cylinders keyed alike.
  3. Keys: Brass.
- H. Key Control System:
1. Key Control Cabinet: Wall mounted.
- I. Operating Trim: Stainless steel
1. Push-pull plate.
- J. Accessories for Pairs of Doors:
1. Coordinators.
  2. Overlapping-with-gasket astragals.
- K. Surface Closers: Modern type, with cover
- L. Concealed Closers: Concealed in head frame (overhead).
- M. Closer holder release devices.
- N. Mechanical Stops and Holders:
1. Combination Floor Stop and Holder: Manual hold open.
  2. Wall Bumper: Convex type.
- O. Door Gasketing:
1. Adhesive-backed perimeter gasketing.
  2. Overlapping astragals for meeting stiles.
  3. Door sweeps.
  4. Door shoes.
  5. Automatic door bottoms.
- P. Thresholds:
1. Saddle Thresholds: Stainless steel.

1.4 MAINTENANCE SERVICE

A. Full-Maintenance Service: 12 months.

1.5 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: Contractor engaged.

B. Occupancy Adjustment: After six months.

END 08 71 00



1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide glazing as shown and herein specified.
- B. Alternate Bids: N/A.

1.2 QUALITY ASSURANCE

- A. Install glazing in mockups specified in other Division 08 Sections.

1.3 WARRANTY

- A. Coated-Glass Products: 10 years.
- B. Laminated Glass: 10 years.
- C. Insulating Glass: 10 years.

1.4 PERFORMANCE REQUIREMENTS

- A. Engineering design of glass by Contractor.
- B. Windborne-Debris-Impact Resistance of Exterior Glazing: Wind Zone 4.

1.5 MATERIALS

- A. Silicone Glazing Sealants: Neutral curing, Class 100/50
- B. Glazing Tapes: Expanded-cellular type.

1.6 MONOLITHIC GLASS SCHEDULE

- A. Clear fully tempered float glass.
- B. Tinted fully tempered float glass.

1.7 INSULATING GLASS SCHEDULE

- A. Low-E-Coated, Clear Insulating Glass Type:
  - 1. Outdoor Lite: Fully tempered float glass.
  - 2. Indoor Lite: Fully tempered float glass.
- B. Low-E-Coated, Tinted Insulating Glass Type:
  - 1. Outdoor Lite: Tinted fully tempered float glass.

2. Indoor Lite: Clear fully tempered float glass.

END 08 80 00

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Fixed Louvers as shown and herein specified.
- B. Alternate Bids: N/A

1.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Contractor to design louvers.
- B. Wind Loads: Indicated on Drawings
- C. Windborne-Debris-Impact Resistance: Louvers located within 30 feet (9.1 m) of grade pass basic protection, when tested according to AMCA 540.

1.3 PRODUCTS

- A. Fixed Extruded-Aluminum Louvers:
  - 1. Horizontal Drainable-Blade Louver: 6 inches (150 mm) deep with exposed mullions.
  - 2. Horizontal, Wind-Driven-Rain-Resistant Louver: 8 inches (200 mm) deep.
- B. Blank-Off Panels: Insulated.
- C. Finishes:
  - 1. Aluminum: Three-coat fluoropolymer.

END 08 91 19

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Ceramic Tiling as shown and herein specified.
- B. Alternate Bids: N/A

1.2 TILE PRODUCTS

- A. Porcelain Tile Type: Unglazed.
  - 1. Composition: Vitreous or impervious natural clay or porcelain
  - 2. Size: 12 by 12 inches minimum.
  - 3. Trim Shapes: Base cove, Surface bullnose base cap, Bead (bullnose) wainscot cap, Bead (bullnose) external corner, Coved internal corner and Tapered transition.
- B. Wall Tile Type: Glazed:
  - 1. Size: 4-1/4 by 4-1/4 inches (108 by 108 mm).
  - 2. Face Size Variation: Rectified.
  - 3. Trim Shapes: Straight base, Bullnose wainscot cap, Surface bullnose wainscot cap, Bullnose external corner and Surface bullnose external corner.

1.3 ACCESSORY MATERIALS

- A. Thresholds: Granite.
- B. Tile Backing Panels: Cementitious backer units.
- C. Waterproof Membrane: Urethane waterproofing and tile-setting adhesive.
- D. Crack Isolation Membrane: Urethane crack isolation membrane and tile-setting adhesive.
- E. Metal edge strips.

1.4 INTERIOR TILE INSTALLATION SCHEDULE

- A. Interior Floors on Concrete:

DIVISION 09 – FINISHES  
**Section 09 30 13 – Ceramic Tiling**

1. TCNA F125A: Thinset mortar on crack isolation membrane. High-performance grout.
- B. Interior Walls, Masonry or Concrete:
1. TCNA W202: Thinset mortar. High-performance grout.
- C. Shower Receptor and Walls, Concrete or Masonry:
1. TCNA B414: Cement mortar bed over vapor-retarder membrane. High-performance grout.

END 09 30 13

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Acoustical Tile Ceilings as shown and herein specified.
- B. Alternate Bids: N/A

1.2 QUALITY ASSURANCE

- A. Mockups for each form of construction.

1.3 PERFORMANCE REQUIREMENTS

- A. Engineering design of seismic restraints by Contractor.
- B. Flame-Spread Index: Class A.
- C. Smoke-Developed Index: 50.

1.4 PRODUCTS

- A. Acoustical Tiles:
  - 1. Type III: Mineral base with painted finish.
  - 2. Pattern: CE (perforated, small holes and lightly textured)
  - 3. LR: Not less than 0.90
  - 4. CAC: Not less than 35.
  - 5. NRC: Not less than 0.75.
  - 6. Thickness: 3/4 inch (19 mm).
  - 7. Modular Size: 24 x 24 inches
- B. Metal Suspension System:
  - 1. High-humidity finish.
  - 2. Direct Hung, Double Web, Heavy duty.
  - 3. Access: Upward and end pivoted.
  - 4. Attachment Devices: Post-installed expansion.
  - 5. Seismic perimeter stabilizer bars, struts, and clips.

DIVISION 09 – FINISHES  
**Section 09 51 23 – Acoustical Tile Ceilings**

C. Metal Edge Moldings and Trim: Extruded aluminum.

**1.5 ERECTION TOLERANCES**

A. Main and Cross Runners: Level to within 1/8 inch in 12 feet (3 mm in 3.6 m).

B. Moldings and Trim: Level to within 1/8 inch in 12 feet (3 mm in 3.6 m).

**1.6 FIELD QUALITY CONTROL**

A. Special Inspection: Contractor engaged special inspector for seismic design.

B. Testing Agency: Contractor engaged.

END 09 51 23

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Interior Painting as shown and herein specified.
- B. Alternate Bids: N/A

1.2 SUMMARY

- A. Primers.
- B. Finish coatings.
- C. Floor sealers and paints.

1.3 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor engaged.

1.4 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Nontraffic Surfaces:
  - 1. Institutional low-odor/VOC latex system.
  - 2. Water-based light-industrial coating system.
  - 3. Concrete stain system.
- B. Concrete Substrates, Traffic Surfaces:
  - 1. Solvent-based concrete floor sealer system.
- C. Cement Board Substrates:
  - 1. Institutional low-odor/VOC latex system.
  - 2. Alkyd system.
- D. CMU Substrates:
  - 1. Institutional low-odor/VOC latex system.
  - 2. High-performance architectural latex system.
  - 3. Alkyd system.



E. Steel Substrates:

1. Institutional low-odor/VOC latex system.
2. High-performance architectural latex system.
3. Alkyd dry fall over quick-drying primer system.

F. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Institutional low-odor/VOC latex system.
2. High-performance architectural latex system.

END 09 91 23

DIVISION 10– SPECIALTIES  
**Section 10 14 23.16 – Room Identification Panel Signage**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Room Identification panel signage as shown and herein specified.
- B. Alternate Bids: N/A

1.2 SIGNS

- A. Room Identification Sign: Sign with exposed edges.
  - 1. Laminated-Sheet Sign: Photopolymer sheet with raised graphics.
  - 2. Mounting: Surface mounted with concealed anchors
  - 3. Text and Typeface: Accessible raised characters and Braille.

END 10 14 23.16

DIVISION 10– SPECIALTIES  
**Section 10 21 13.17 – Phenolic-Core Toilet Compartments**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Phenolic-Core toilet compartments as shown and herein specified.
- B. Alternate Bids: N/A

1.2 SUMMARY

- A. Phenolic-core toilet compartments configured as toilet enclosures and urinal screens.
  - 1. Toilet-Enclosure Style: Floor and ceiling anchored.
  - 2. Urinal-Screen Style: Floor anchored.

1.3 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: ASTM E84.
  - 1. Flame-Spread Index: 75 or less.
  - 2. Smoke-Developed Index: 450 or less.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for toilet compartments designated as accessible.

1.4 COMPONENTS

- A. Door, Panel and Screen Construction: Solid phenolic-core panel material with melamine facing on both sides, with no-sightline system.
- B. Urinal-Screen Post: Square, aluminum tube, satin finish.
- C. Brackets (Fittings):
  - 1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.
- D. Phenolic-Panel Finish:
  - 1. Facing Sheet Finish: One color and pattern in each room.

DIVISION 10– SPECIALTIES

**Section 10 21 13.17 – Phenolic-Core Toilet Compartments**

2. Color and Pattern: As selected by Architect from manufacturer's full range, with manufacturer's standard through-color core matching face sheet.
3. Edge Color: Through-color matching facing sheet color.

1.5    **HARDWARE AND ACCESSORIES**

- A. Hardware and Accessories: Stainless steel finish.
- B. Hardware and Accessories: Manufacturer's heavy-duty stainless steel operating hardware and accessories.

END 10 21 13.17

DIVISION 10– SPECIALTIES

**Section 10 21 16.17 – Phenolic-Core Shower and Dressing Compartments**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Phenolic-Core shower and dressing compartments as shown and herein specified.
- B. Alternate Bids: N/A

1.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics:
  - 1. Flame-Spread Index: 75 or less.
  - 2. Smoke-Developed Index: 450 or less.

1.3 COMPARTMENTS

- A. Configuration: Shower and dressing compartments
- B. Enclosure Style: Floor and ceiling anchored.
- C. Phenolic Panels and Doors: Solid phenolic-core with through-color matching face sheet
- D. Brackets (Fittings):
  - 1. Full-Height (Continuous) Type: Clear-anodized aluminum.
- E. Hardware and Accessories: Stainless steel.
- F. Shower Compartment Openings: Provide with curtain rod with hooks and curtain.
- G. Seats: Folding benches mounted on wall.

END 10 21 16.17

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Toilet and bath accessories as shown and herein specified.
- B. Alternate Bids: N/A

1.2 WARRANTY

- A. Silver Spoilage for Mirrors: 10 years.
- B. Toilet-Compartment Occupancy-Indicator System: Five years.
- C. Hand Dryers: 10 years.

1.3 PRODUCTS

- A. Public-Use Washroom Accessories:
  - 1. Toilet tissue (jumbo-roll) dispenser.
  - 2. Combination towel (folded) dispenser/waste receptacle.
  - 3. Soap dispenser.
  - 4. Grab bars.
  - 5. Sanitary-napkin disposal unit.
  - 6. Seat-cover dispenser.
  - 7. Mirror unit with shelf.
  - 8. Hook.
- B. Toilet-compartment occupancy-indicator system.
- C. Public-Use Shower Room Accessories:
  - 1. Shower curtain rod.
  - 2. Shower curtain.
  - 3. Folding shower seat.
  - 4. Soap dish.
  - 5. Robe hook.

DIVISION 10– SPECIALTIES  
**Section 10 28 00 – Toilet and Bath Accessories**

6. Grab bars

D. Hand Dryers:

1. Warm-air dryer.

E. Under lavatory guards.

F. Custodial Accessories:

1. Utility shelf.

2. Mop and broom holder.

END 10 28 00

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design Build Contractor shall provide Fire Extinguishers as shown and herein specified.

B. Alternate Bids: N/A

1.2 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.3 WARRANTY

A. Materials and Workmanship: Six years.

1.4 PERFORMANCE REQUIREMENTS

A. Fire Extinguishers: Complying with NFPA 10

1.5 PRODUCTS

A. Portable Hand-Carried Fire Extinguishers:

1. Multipurpose dry-chemical type.

B. Mounting brackets.

END 10 44 16



1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Phenolic-Core toilet compartments as shown and herein specified.
- B. Alternate Bids: N/A

1.2 PRODUCTS

A. Panel Material:

- 1. Decorative papers impregnated with the melamine resin on faces with a clear protective overcoat and integrally compression molded within a core consisting of solid phenolic impregnated Kraft papers.
- 2. Panel Material shall be in Class B fire rating (ASTM E 84). Select from either option.
- 3. Core or panel material shall meet fire resistance per ASTM E84 (Class B).
- 4. Colors:
  - a. Core: Black
- 5. Color to be selected from the manufacturing standard colors.

B. Doors:

- 1. Material: 1/2" (13mm) thick solid phenolic composite material.
- 2. Corners: Rounded
- 3. Edges: Standard profile is straight edge no profile.
- 4. Door Fastening: Through Bolted.

C. Locker Bodies

- 1. Exposed edges: Straight profile; eased edges to remove sharpness; machine polished and free from tooling imperfections.
- 2. Tops, bottoms, and intermediate shelves: 1/2" (13mm) thick solid phenolic composite material with ventilation holes.
- 3. Locker backs: +/- 1/4" (6mm) thick solid composite material.

DIVISION 10– SPECIALTIES  
**Section 10 73 13 – Solid Phenolic Lockers**

4. Locker Sides: 3/8" (10mm) thick solid phenolic composite material.
- D. Ancillary Panels: Finished end panels and closures shall be 1/2" (13mm) thick solid phenolic composite material.
- E. Hardware
  1. Hinges:
    - a. Material: 304-grade stainless steel.
    - b. Quantity: Three (3) for full height doors and two (2) for multi-tier units.
  2. Interior hooks:
    - a. Material: Stainless steel.
    - b. Top Hook: Two prong: one per opening for 1 and 2 tiers at Men's & Women's restroom.
    - c. Side Hook: Single prong: two per opening for 1, 2, and "Z" tiers.
  3. Fasteners: Exposed fasteners shall be 304 stainless steel
  4. Fastener Application: Apply directly into or through the material.
  5. Other Reinforcement: Aluminum or metal profiles for reinforcements shall not be permitted.
  6. Door Identification (identification plates): Sequential numbering
- F. Ventilation
  1. Interior Vent: Provide six 3/8" (10mm) diameter ventilation holes on tops, bottoms, and intermediate shelves. Provide three 3/8" (10mm) diameter ventilation holes on "Z" type intermediary shelves.
  2. Door Vent: Provide minimum of 20 squares inches opening of front ventilation for full tier 12" wide x 72" high.
- G. Size
  1. Overall Height: 71-3/4".
  2. Overall Width: 12"
  3. Overall Depth: 15"

H. Accessories and Options

1. Locking System: Cam preparation for padlock.
2. Locker Top: ½” top shall be Sloped width ¼” (6mm) thick solid phenolic composite material.
3. Door Identification:
  - a. Number Plates: Identification plates to be Stainless Steel Disk 1-1/2” diameter with permanent adhesive.
  - b. Fonts to be a minimum 1/2” high and up to four alphanumeric characters

End 15 51 23

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design Build Contractor shall provide Awnings as shown and here-in specified.

B. Alternate Bids: N/A

1.2 WARRANTY

A. Materials and Workmanship: Five years.

1.3 AWNINGS

A. Fixed Awning: Aluminum frame.

1. Aluminum Finish: Baked-enamel or powder-coat.

END 10 73 13

DIVISION 12– FURNISHINGS  
**Section 12 36 23.13 – Plastic-Laminate-Clad Countertops**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design Build Contractor shall provide Plastic-laminate-clad countertops as shown and herein specified.

B. Alternate Bids: N/A

1.2 QUALITY ASSURANCE

A. Fabricator Qualifications: AWI's Quality Certification Program licensed participant.

1.3 PLASTIC-LAMINATE COUNTERTOPS

A. Grade: Custom.

B. High-Pressure Decorative Laminate: General-purpose type.

C. Core Material: Particleboard or MDF

D. Core Material at Sinks: MDF made with exterior glue

E. Core Thickness: 3/4 inch (19 mm).

1.4 MATERIALS

A. Fire-retardant-treated materials.

END 12 36 23.13

DIVISION 12– FURNISHINGS  
**Section 12 48 13 – Entrance Floor Mats and Frames**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design Build Contractor shall provide Entrance floor mats and frames as shown and herein specified.

B. Alternate Bids: N/A

1.2 COMPONENTS

A. Roll-up, Vinyl-Rail Hinged Mats: Slotted or perforated aluminum hinges.

1. Tread Inserts: Textured surface

B. Recessed Frames: Extruded aluminum.

END 12 48 13

DIVISION 20 – FACILITIES SERVICES  
**Section 20 05 13 – Common Work Results For  
Facility Services Piping**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Pipe materials.
- b. Fittings, unions, flanges, and couplings.
- c. Welding fittings.
- d. Pipe sleeves and seals.
- e. Tie rods.
- f. Pipe joining methods.
- g. Cleaning and protection.
- h. Leakage tests.
- i. Thrust restraints.

1.2 DEFINITIONS

- A. Pipe Class Specifications define pipe materials, dimensional standards, and wall thickness. Also defined are other components of piping system, including fittings, joints, flanges, and connection methods as applicable. Maximum allowable working pressure and associated temperature are provided for reference. Some Pipe Class Specifications also include notes and comments that provide additional direction on use, limitations, and installation of piping system.

1.3 INFORMATIONAL SUBMITTALS

A. Quality assurance data:

- 1. Certificates of compliance with standards specified for pipe, fittings, accessories, and specialties.
- 2. Welding procedure specifications and welding operator performance qualifications in accordance with ASME “Boiler and Pressure Vessel Code”, Section IX, upon request.

## 1.4 QUALITY ASSURANCE

### A. Regulatory requirements:

1. Piping construction criteria shall conform to requirements of ASME B31 as applicable. Work shall also comply with applicable state and local codes.
2. Piping connected to pressure parts under jurisdiction of ASME "Boiler and Pressure Vessel Code": In accordance with ASME "Boiler and Pressure Vessel Code" and state and local codes.
3. Piping not covered by ASME "Boiler and Pressure Vessel Code": In accordance with ASME B31 "Code for Pressure Piping" and state and local codes.

### B. Certifications: New materials and equipment shall bear manufacturer's name, model number, or other identification marking.

### C. Pipe spools shall contain piece identification mark on each end of spool.

### D. Piping material shall be new. Materials showing signs of scaling or rust will be rejected.

### E. Welding requirements:

1. Qualification of welding procedures to be used and welding operators shall be in accordance with ASME "Boiler and Pressure Vessel Code," Section IX.
2. Welding materials and procedures for piping shall conform to ASME B31 and applicable state and local regulations.
3. Employ certified welders in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, and AWS D1.1.
4. Welding inspection personnel shall be qualified in accordance with AWS QC1.
5. Maintain records in accordance with requirements of ASME B31.

## 2. PRODUCTS

### 2.1 DESIGN REQUIREMENTS

#### A. Pipe, fittings, valves, and accessory material as necessary for complete piping system with connections to equipment. Provide drains required



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to drain low points in piping and vents required to vent high points in piping. Provide piping for testing, startup, cleaning, and operation of system.

- B. Provide pipe, fittings, valves, and accessory material necessary for following piping not shown on Drawings:
  - 1. Vents and drains for equipment to which piping connections are made or which are installed under this Contract. Provide piping to drains from equipment including, but not limited to, level alarms, meter bodies, transmitters, steam trap blow connections.
  - 2. Piping, not shown on Drawings, but required for proper operation of piping system and equipment, including drain valves required to drain all low points in piping and vent valves required to vent all high points in piping for testing, start-up, and operation.
  - 3. Flanges, unions, bolting material, gaskets, reducing fittings, bushings, and adapters required to connect piping to equipment, valves, in line specialties, etc.
  - 4. Temporary piping and accessories required for placing equipment and piping into initial service including, but not limited to, cleaning and hydrostatic testing.
  - 5. Blind flanges, caps, or plugs of appropriate class to close unused openings in equipment or piping provided by others.
  - 6. Flanges as required for connection to equipment by others.
- C. Piping arrangement: Contractor shall provide for access, clearances, and thermal expansion. Field-fabricate and erect to provide workable arrangement with convenient access to valves and specialty items. Piping arrangement shall allow for thermal expansion and clearance after insulation is installed.
  - 1. For equipment, valves, etc. with connections less than line size; locate reducers at equipment or valves to minimize length of reduced diameter piping.
  - 2. Contractor shall note on record drawings modifications made to piping systems.
- D. Provide pipe, fittings, accessories, and appurtenances required by each Pipe Class Specification.

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- E. Maintain a minimum of 3” (75 mm) clearance between pipes. For insulated piping, clearance shall be from outside surface of insulation.

**2.2 PIPE MATERIALS**

- A. Pipe materials, pressure class, schedule, and type of joints shall conform to Pipe Class Specifications referenced in Pipe Schedule.
- B. If pipe wall thickness specified is not available, use next heavier wall thickness.
- C. Comply with ASME B31 and, where applicable, ASME “Boiler and Pressure Vessel Code.”

**2.3 FITTINGS - GENERAL**

- A. Material, wall thickness, and pressure class: As specified in article "Pipe Materials," unless otherwise noted.
- B. Use long radius fittings, except where noted to use short radius fittings.

**2.4 UNIONS, FLANGES, AND COUPLINGS**

- A. Pressure class, material, and facing: As specified in article "Pipe Materials."
- B. Where union, flanges, and couplings are not specified in Pipe Class Specification, provide as follows:
  - 1. Pipe size 2" (50 mm) and smaller: Malleable iron unions for threaded ferrous piping; cast bronze or wrought copper unions for copper piping with soldered or brazed joints. For non metallic piping provide unions of same material as pipe.
  - 2. Pipe size 2-1/2" (64 mm) and larger: Forged steel weld neck or slip-on flanges for ferrous piping; bronze flanges for copper piping. For non-metallic piping, provide flanges of same material as pipe. Provide 1/8" (3 mm) thick preformed synthetic fiber gaskets.

**2.5 WELDING FITTINGS**

- A. Material and wall thickness: As specified in article "Pipe Materials."
- B. Use welding tees for socket-welded piping and for field-fabricated branch tees in butt-welded piping.

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**Section 20 05 13 – Common Work Results For  
Facility Services Piping**

- C. Nozzle-welded branches or "Weldolets" and "Threadolets" will be permitted instead of butt welding tees for shop-fabricated steel piping provided that such nozzles are fabricated in accordance with ASME B31. Use tees for branches in non-steel piping.
- D. Mitering of pipe to form elbows, notching straight pipe to form tees, and similar construction is not permitted.

**2.6 PIPE SLEEVES**

- A. Provide sleeves for piping passing through building structure, except where otherwise shown on Drawings.
- B. Through footings: Service weight cast iron.
- C. Other locations below grade: Cast iron or standard weight wrought iron pipe.
- D. Above grade: Steel pipe, sheet steel not lighter than 16 U.S. Standard Gauge, or fiberglass with 1/4" (6 mm) minimum wall thickness; or thermoplastic construction.
- E. Size:
  - 1. Foundations and footings: 4" (100 mm) larger than carrier pipe plus insulation where piping system is to be insulated.
  - 2. Walls and floors: 2" (50 mm) larger than carrier pipe plus insulation where piping system is to be insulated.
  - 3. Floors: Extend 4" (100 mm) above floor.

**2.7 PIPE SLEEVE SEALS**

- A. General purpose:
  - 1. Construction:
    - a. Pressure plate: Reinforced nylon polymer.
    - b. Bolts and nuts: Galvanized steel.
    - c. Sealing element: EPDM.
  - 2. Temperature limits: -40°F to 250°F.
- B. High temperature/fire rated:

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1. Construction:
  - a. Pressure plate: Galvanized steel.
  - b. Bolts and nuts: Galvanized steel.
  - c. Sealing element: Silicone.
2. Temperature limits: -67°F to 400°F.
3. 1-hour fire rated.

C. Hydrocarbon services:

1. Construction:
  - a. Pressure plate: Reinforced nylon polymer.
  - b. Bolts and nuts: Galvanized steel.
  - c. Sealing element: Nitrile.
2. Temperature limits: -40°F to 210°F.

2.8 TIE RODS

- A. Install to restrain movement of pressure piping when required.
- B. Steel plate and rods: ASTM A36.
- C. Steel bolts: ASTM A325.

2.9 PIPE SCHEDULE

Service	Pipe Description	Piping Class Specification <sup>(1)</sup>	Design Temp. (°F)	Operating Temp. (°F)	Design Pressure (psig)	Operating Pressure (psig)	Test Pressure (psig)	Testing Method <sup>(2)</sup>
Steam	ASTM A53 Gr. B or A106 Gr. B Steel	BCS1			175	150	263	Hydrostatic
Condensate	ASTM A53 Gr. B Steel	ACS2			30	15	45	Hydrostatic
Pumped Condensate / Boiler Feed Water	ASTM A53 Gr. B Steel or A106 Gr. B Steel	BCS1						Hydrostatic
Compressed Air	ASTM B88 Hard-Drawn Copper,	ACU1	---	---	150	100	---	Initial service testing

**DIVISION 20 – FACILITIES SERVICES**  
**Section 20 05 13 – Common Work Results For**  
**Facility Services Piping**

Service	Pipe Description	Piping Class Specification <sup>(1)</sup>	Design Temp. (°F)	Operating Temp. (°F)	Design Pressure (psig)	Operating Pressure (psig)	Test Pressure (psig)	Testing Method <sup>(2)</sup>
Potable Water Upstream of Backflow Preventer	AWWA C151 Cement-lined Ductile Iron	ADI1						Hydrostatic
Potable Water:	ASTM B88 Hard-Drawn Copper	ACU1						Hydrostatic
Refrigerant liquid and gas (except ammonia)	ASTM B280 ACR Copper	ACU3						
Refrigerant Vents	ASTM A53 Gr. B Steel	ACS2						
Relief Vents	ASTM A53 Gr. B Steel	ACS2						
Heating Water:								Hydrostatic
	ASTM B88 Hard-Drawn Copper	ACU1						
	ASTM A53 Gr. B Steel	ACS6						
Drain Piping Including Sanitary Drains, Sewers, Vents, Stacks, Storm Drains, Plenum Drains, and Coil Condensate Drains:								
	ASTM B306 Hard-Drawn Copper	ACU4						
	ASTM D2665 DWV PVC (Do not use PVC above suspended ceiling or in air plenums)	APV1						
Sewer and Drain Piping Including Sanitary Drains, Sewers, Vents, Stacks, Roof Drains, Plenum Drains, and Coil Condensate Drains (Buried Interior/Exterior):								
	ASTM B306 Hard-Drawn Copper	ACU4						
	ASTM D2665 DWV PVC	APV1						
Fuel Oil	ASTM A53 Gr. B Steel	ACS2						
Natural Gas	ASTM A53 Gr. B Steel	ACS2						

DIVISION 20 – FACILITIES SERVICES  
**Section 20 05 13 – Common Work Results For**  
**Facility Services Piping**

Notes:

<sup>(1)</sup> Where multiple Pipe Class Specifications are specified, selection of material is at Contractor's option.

<sup>(2)</sup> Testing in accordance with ASME B31 unless noted otherwise.

END 20 05 13



**Stanley Consultants** INC.

## PIPE CLASS SPECIFICATION - ACS2

MAW	TEMP, °F	100	200	300	400	500	600	650	700	750	775
	PRESS, PSIG	200	200	200	200	170	140	125	110	95	87
PIPE	MATERIAL, ASTM				1/2" - 26"		A53 GR B TYPE E OR S				
					28" - 48"		API5L GR B TYPE E OR S				
	NOMINAL PIPE SIZES AND SCHEDULE				1/2" - 2"			XS			
					2-1/2" - 38"			STD			
					40" - 48"			XS			
JOIN	TYPE			THREADED		SOCKET WELD		BUTT WELD		FLANGED	
	USE FOR PIPE SIZES			1/2" - 2"		1/2" - 2"		2-1/2" - 48"		NONE	
FITTINGS	MATERIAL, ASTM			A105		A105		A234 WPB			
	PRESS CL, ASME B16.11			2000		3000					
	MINIMUM WALL THICKNESS							MATCH PIPE			
	WELDING END							ASME B16.25			
	UNIONS			GROUND JOINT		GROUND JOINT		NONE			
FLANGES	MATERIAL, ASTM			A105 OR A516 GR 70							
	PRESS CL, ASME B16.5, B16.47A			150							
	FACING			1/16" RF SERRATED							
	GASKETS ASME B16.20		WITH WELD NECK FLANGES: 304 SS SPIRAL WOUND FLEXITALLIC FLEXICARB STYLE CG OR EQUAL, UNLESS SPECIFIED OTHERWISE. WITH SLIP-ON FLANGES: 1/16" SYNTHETIC FIBER WITH NBR BINDER, KLINGER C-4400 OR EQUAL, UNLESS SPECIFIED OTHERWISE.								
	ASME B16.21										
	BOLTS & NUTS		A193 GR B7 STUD BOLTS & A194 GR 2H HEAVY HEX NUTS								
GENERAL NOTES & COMMENTS:											
1. BACKING RINGS NOT PERMITTED.											
2. BUTT WELD END PREPARATIONS A. NOMINAL PIPE WALL THICKNESSES 0.375" AND LESS: CONFORM TO ASME B16.25, FIGURE 2, DETAIL (A). B. NOMINAL PIPE WALL THICKNESS GREATER THAN 0.375": CONFORM TO ASME B16.25, FIGURE 2, DETAIL (A), OR FIGURE 5 OR 6 AS APPLICABLE.											
3. FURNISH FLAT FACED FLANGES AND USE FULL-FACED GASKETS WHERE REQUIRED FOR CONNECTION TO CAST IRON FLANGES.											
4. 300°F AND BELOW: FLANGES SHALL BE WELD NECK OR SLIP-ON. ABOVE 300°F: FLANGES SHALL BE WELD NECK.											
5. BUTT WELD FITTINGS MAY BE WPB SEAMLESS OR WPBW WELDED.											
6. ALL THREADED PIPE SHALL BE SEAMLESS (TYPE S).											
								ASME CLASS 150			
2	SCHEDULE CHANGES			1-Oct-08	DDB	MSW	MAE	TYPE E OR S CARBON STEEL			
1	REV. GASKET & NOTES 2, 4			5-Jan-05	JSM	JC	MAE	NO.  <b>ACS2</b>			
0	REVISION 0			9-Dec-04	JSM	JC	MAE				
NO.	REVISION			DATE	DESIGN	CHECK	APVD				

M-1801



**Stanley Consultants** INC.

## PIPE CLASS SPECIFICATION - ACU3

<b>MAW</b>	TEMP, °F	100	150	200	250						
	PRESS, PSIG	285	250	235	235						
<b>TUBING</b>	MATERIAL	ASTM B88 HARD DRAWN COPPER									
	TUBING SIZE AND WALL THICKNESS	THRU 4"							TYPE K		
<b>JOINT</b>	TYPE	SOLDERED, FLANGED WHERE REQUIRED									
	SOLDER	AWS A5.8 BCuP SILVER BRAZE									
<b>FITTINGS</b>	MATERIAL	UNS C10200, C12000, C12200 OR C23000									
	TYPE	ASME B16.22 WROUGHT COPPER AND COPPER ALLOY									
<b>FLANGES</b>	MATERIAL	ASTM A105 WITH WROUGHT COPPER SOLDER JOINT TUBE ADAPTER									
	PRESSURE CLASS	ASME B16.5 150									
	FACING	1/16" RF SERRATED									
	GASKET (1)	1/16" COMPRESSED NON-ASBESTOS									
	BOLTS & NUTS	A307 GRADE B STUD BOLTS & A194 GRADE 2H HEX NUTS									
<b>GENERAL NOTES &amp; COMMENTS:</b>											
1. MATERIAL SHALL BE SUITABLE FOR REFRIGERATION SERVICE.											
2. THIS PIPE CLASS SPECIFICATION SHALL NOT BE USED FOR AMMONIA REFRIGERATION SYSTEMS.											
							ASME CLASS 150				
							HARD DRAWN COPPER				
							NO.				
0	REVISION 0		14-Dec-04	AAM	AGP	MAE	<b>ACU3</b>				
NO.	REVISION		DATE	DESIGN	CHECK	APVD					

M-1910





**Stanley Consultants** INC.

## PIPE CLASS SPECIFICATION - ACU1

<b>MAW</b>	TEMP, °F	100	150	200	250						
	PRESS, PSIG	150	150	135	125						
<b>TUBING</b>	MATERIAL				ASTM B88 HARD DRAWN COPPER						
	TUBING SIZE AND WALL THICKNESS				THRU 6"			TYPE K			
					8"			TYPE L			
<b>JOINT</b>	TYPE		SOLDERED, FLANGED WHERE REQUIRED								
	SOLDER		ASTM B32 GRADE Sb5 (95-5 TIN ANTIMONY)								
<b>FITTINGS</b>	TYPE		ASME B16.18 CAST COPPER ALLOY								
			ASME B16.22 WROUGHT COPPER AND COPPER ALLOY								
	CONNECTIONS TO FERROUS PIPING OR EQUIPMENT		DIELECTRIC UNIONS OR FLANGES								
<b>GENERAL NOTES &amp; COMMENTS:</b>											
1. THIS PIPE CLASS SPECIFICATION SHALL NOT BE USED FOR STEAM OR CONDENSATE, OR FOR FLAMMABLE OR TOXIC LIQUIDS OR GASSES. USE FOR COMPRESSED AIR SHALL BE LIMITED TO 3" NOMINAL SIZE AND LESS.											
2. SOLDER SHALL BE "LEAD-FREE" (LESS THAN OR EQUAL TO 0.2% LEAD).											
							ASME CLASS 125				
							HARD DRAWN COPPER				
1	ADDED NOTE 2	26-May-06	TJL	MRF	MAE	NO.	<b>ACU1</b>				
0	REVISION 0	14-Dec-04	AAM	AGP	MAE						
NO.	REVISION	DATE	DESIGN	CHECK	APVD						

M-1725



**Stanley Consultants** INC.

## PIPE CLASS SPECIFICATION - ACU3

<b>MAW</b>	TEMP, °F	100	150	200	250						
	PRESS, PSIG	285	250	235	235						
<b>TUBING</b>	MATERIAL	ASTM B88 HARD DRAWN COPPER									
	TUBING SIZE AND WALL THICKNESS	THRU 4"							TYPE K		
<b>JOINT</b>	TYPE	SOLDERED, FLANGED WHERE REQUIRED									
	SOLDER	AWS A5.8 BCuP SILVER BRAZE									
<b>FITTINGS</b>	MATERIAL	UNS C10200, C12000, C12200 OR C23000									
	TYPE	ASME B16.22 WROUGHT COPPER AND COPPER ALLOY									
<b>FLANGES</b>	MATERIAL	ASTM A105 WITH WROUGHT COPPER SOLDER JOINT TUBE ADAPTER									
	PRESSURE CLASS	ASME B16.5 150									
	FACING	1/16" RF SERRATED									
	GASKET (1)	1/16" COMPRESSED NON-ASBESTOS									
	BOLTS & NUTS	A307 GRADE B STUD BOLTS & A194 GRADE 2H HEX NUTS									
<b>GENERAL NOTES &amp; COMMENTS:</b>											
1. MATERIAL SHALL BE SUITABLE FOR REFRIGERATION SERVICE.											
2. THIS PIPE CLASS SPECIFICATION SHALL NOT BE USED FOR AMMONIA REFRIGERATION SYSTEMS.											
							ASME CLASS 150				
							HARD DRAWN COPPER				
							NO.				
0	REVISION 0		14-Dec-04	AAM	AGP	MAE	<b>ACU3</b>				
NO.	REVISION		DATE	DESIGN	CHECK	APVD					

M-1910



**Stanley Consultants** INC.

## PIPE CLASS SPECIFICATION - ACU4

TUBI	MATERIAL		ASTM B306 COPPER	
	TUBING SIZE AND WALL THICKNESS		1-1/4" THRU 6"	STD
JOIN	TYPE		SOLDERED	
	SOLDER		ASTM B32 GRADE Sb5, (95-5 TIN ANTIMONY)	
FITTI	TYPE		ASME B16.23 CAST COPPER SOLDER JOINT DRAINAGE	
	MATERIAL		ASTM B62 ALLOY C83600	

### GENERAL NOTES & COMMENTS:

1. FOR ABOVE GROUND USE ONLY.

						DWV
						COPPER DRAINAGE TUBE
						NO.
0	REVISION 0	14-Dec-04	AAM	AGP	MAE	<b>ACU4</b>
NO.	REVISION	DATE	DESIGN	CHECK	APVD	

M-1772



**Stanley Consultants** INC.

## PIPE CLASS SPECIFICATION - ADI1

<b>MAW</b>	TEMP, °F	120									
	PRESS, PSIG	150									
<b>PIPE</b>	MATERIAL	DUCTILE IRON ANSI/AWWA C151/A21.51									
	SIZES (INCLUSIVE)	3" THRU 48"									
	MINIMUM THICKNESS	CLASS 53 ANSI/AWWA C150/A21.50									
<b>JOINT</b>	TYPE	THREADED FLANGE ANSI/AWWA C115/A21.15									
	RATED WORKING PRESSURE	250 PSI MINIMUM ANSI/AWWA C115/A21.15									
<b>FITTINGS</b>	TYPE	FLANGED ANSI/AWWA C110/A21.10									
	MATERIAL	DUCTILE IRON OR GRAY IRON									
	RATED WORKING PRESSURE	150 PSI MINIMUM ANSI/AWWA C110/A21.10									
	GASKETS	FULL FACE, 1/16" RED RUBBER (SBR) ANSI/AWWA C111/A21.11									
	BOLTS	ASTM A307 GR B									
	NUTS	ASTM A194 2H HEAVY HEX									
<b>GENERAL NOTES &amp; COMMENTS:</b>											
1.	PROVIDE CEMENT-MORTAR LINING AND SEAL COAT PER ANSI/AWWA C104/A21.4.										
						150 PSIG AT 120 °F					
						DUCTILE IRON PIPE					
						NO.					
0	REVISION 0	14-Dec-04	AAM	AGP	MAE	<b>ADI1</b>					
NO.	REVISION	DATE	DESIGN	CHECK	APVD						

M-1730



**Stanley Consultants** INC.

## PIPE CLASS SPECIFICATION - APV1

PIPE	MATERIAL	ASTM D1784 POLY (VINYL CHLORIDE), PVC DWV	
	CELL CLASS	12454	
	PIPE	ASTM D2665	
	NOMINAL PIPE SIZE	1 1/4" - 24" SCHEDULE 40	
JOINTS & FITTINGS	TYPE	SOCKET	FABRICATED
	STANDARD	F2135, D2665, D3311	F1866
	USE FOR SIZES	1 1/4" - 24"	4" - 24"
	JOINTS	SOLVENT WELD TYPE WITH SOLVENT CEMENT.	
	SOLVENT	ASTM D2564	

### GENERAL NOTES & COMMENTS:

1. INSTALL IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
2. INSTALL IN ACCORDANCE WITH LOCAL PLUMBING CODE.
3. PIPING INSTALLED IN CEILING PLENUM SHALL BE PERMITTED PER NFPA 90A, IF IT EXHIBITS A FLAME SPREAD INDEX OF 25 OR LESS AND A SMOKE DEVELOPMENT INDEX OF 50 OR LESS WHEN TESTED IN ACCORDANCE WITH ASTM E84.
4. CONNECT TO TRAPS USING THREADED TRAP ADAPTERS.
5. FOR CONNECTIONS TO SCREW-TYPE CLOSET FLANGES, INSTALL SCREW-TYPE CLOSET FLANGES IN THE DRAINAGE SYSTEM BY MEANS OF A THREADED CONNECTION.
6. FOR CONNECTIONS TO CAULK-TYPE CLOSET FLANGES, SEE TRANSITIONS TO BELL-AND-SPIGOT PIPE.
7. FOR CONNECTIONS TO NONPLASTIC PIPE, USE FITTINGS AND ADAPTERS DESIGNED FOR THE SPECIFIC TRANSITION INTENDED.
8. FOR TRANSITIONS TO BELL-AND-SPIGOT PIPE, USE MECHANICAL COMPRESSION JOINTS OR CAULKED JOINTS. PACK CAULK JOINT WITH OAKUM OR HEMP AND FILL WITH MOLTEN LEAD.
9. FOR USE IN NON-PRESSURE APPLICATIONS WHERE THE OPERATING TEMPERATURE WILL NOT EXCEED 140 °F.
10. USE FOR DRAINAGE AND VENTING OF SEWAGE AND CERTAIN OTHER LIQUID WASTES. NOT FOR VENTING OF COMBUSTION GASES.
11. PIPE AND FITTING SHALL BE CERTIFIED TO THE NSF/ANSI 14 - PLASTIC PIPING SYSTEM COMPONENTS AND RELATED MATERIALS AND NSF/ANSI DMV.

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						DWV
2	GENERAL	31-Mar-17	JJO	JC	MAE	PVC PIPE
1	FORMAT & GENERAL	28-Apr-06	AGP	JJJ	MAE	NO.  <b>APV1</b>
0	REVISION 0	14-Dec-04	AAM	AGP	MAE	
NO.	REVISION	DATE	DESIGN	CHECK	APVD	

M-1779



**Stanley Consultants** INC.

## PIPE CLASS SPECIFICATION - BCS1

MAW	TEMP, °F	100	200	300	400	500	600	650	700	750	775
	PRESS, PSIG	740	680	655	635	605	570	550	530	505	458
PIPE	MATERIAL, ASTM				A53 GR B TYPE S OR A106 GR B						
	NOMINAL PIPE SIZES AND SCHEDULE				1/2" - 2"			XS			
					2-1/2"-10"			STD			
					12"-14"			XS			
					16" - 24"			SCH 60			
JOIN	TYPE			THREADED		SOCKET WELD		BUTT WELD		FLANGED	
	USE FOR PIPE SIZES			NONE		1/2" - 2"		2-1/2" - 24"		NONE	
FITTINGS	MATERIAL, ASTM					A105		A234 WPB			
	PRESS CL, ASME B16.11					3000					
	MINIMUM WALL THICKNESS							MATCH PIPE			
	WELDING END							ASME B16.25			
	UNIONS					NONE		NONE			
FLANGES	MATERIAL, ASTM			A105							
	PRESS CL, ASME B16.5			300							
	FACING			1/16" RF SERRATED							
	GASKETS ASME B16.20		304 SS SPIRAL WOUND FLEXITALLIC FLEXICARB STYLE CG OR EQUAL, UNLESS SPECIFIED OTHERWISE.								
	BOLTS & NUTS		A193 GR B7 STUD BOLTS & A194 GR 2H HEAVY HEX NUTS								
GENERAL NOTES & COMMENTS:											
1. THREADED JOINTS NOT ALLOWED UNLESS SPECIFIED OTHERWISE.											
2. THREADED JOINTS ALLOWED FOR INSERTION TYPE TEMPERATURE WELLS. WELLS SHALL BE SEAL WELDED. USE CLASS 3000 A105 FITTINGS.											
3. BACKING RINGS NOT PERMITTED.											
4. BUTT WELD END PREPARATIONS A. NOMINAL PIPE WALL THICKNESSES 0.375" AND LESS: CONFORM TO ASME B16.25, FIGURE 2, DETAIL (A). B. NOMINAL PIPE WALL THICKNESS GREATER THAN 0.375": CONFORM TO ASME B16.25, FIGURE 5 OR 6.											
5. FURNISH FLAT FACED FLANGES AND USE FULL-FACED GASKETS WHERE REQUIRED FOR CONNECTION TO CAST IRON FLANGES.											
6. FLANGES SHALL BE WELD NECK.											
7. FITTINGS SHALL BE SEAMLESS.											
								ASME CLASS 300			
								SEAMLESS CARBON STEEL			
1	SIZE, SCHEDULE CHANGES			1-Oct-08	DDB	MSW	MAE	BCS1			
0	REVISION 0			9-Dec-04	JSM	JC	MAE				
NO.	REVISION			DATE	DESIGN	CHECK	APVD				

M-1811, M-1812, M-1820

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:
  - a. Meters.
  - b. Pressure Gages and Tank Gages.

1.2 INFORMATIONAL SUBMITTALS

A. Product Data, include:

1. Materials of construction.
2. Pressure limits.
3. Basis of operation.
4. Schedules of equipment furnished.

2. PRODUCTS

2.1 NUTATING DISC METERS

- A. Casing: Bronze.
- B. Disc: Reinforced synthetic polymer.
- C. Service: Condensate Pumps.

2.2 VORTEX FLOW METERS

- A. Meter location: Pipe.
- B. Accuracy: 1% of rate.
- C. Repeatability: 0.2%
- D. Electrical connection: 1/2" NPT.
- E. Body: Type 316 stainless steel.
- F. Shedding element: Type 316 stainless steel.

- G. Output: 4-20 mA dc.
- H. Electronics mounting: Integral.
- I. Fluid: Chilled water.
- J. Indicator: LCD field set to read actual flow rate.

### 2.3 PRESSURE GAGES

- A. Accuracy: ANSI B40.1, Grade B, 2% of span at midpoint of scale.
- B. Size: 2-1/2" dial.
- C. Connections: 1/4" NPT male thread.
- D. Movement: Bourdon tube assembly with recalibration screw.

### 2.4 TANK GAGES

- A. Type: Hydrostatic level gage.
- B. Actuation: Compressed air.
- C. Fluids measured:
  - 1. No. 2 fuel oil.
- D. Components:
  - 1. Gage.
  - 2. Bubbling chamber.
  - 3. Needle valve.
  - 4. Tank fitting.
  - 5. Pressure pipe.
  - 6. Gage line tubing.
  - 7. Pressure fitting.

END 20 05 19



DIVISION 20 – FACILITIES SERVICES  
**Section 20 05 23 – General Duty Valves and Accessories**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Valves as required.
- b. Valves not shown on Drawings including:
  - 1.) Vent and drain valves for equipment installed under this Contract.
  - 2.) Piping high-point vents and low-point drains.
  - 3.) Connections to metering instruments and controls including pressure gages, transmitters, controllers, traps, and appurtenances required for proper functioning of instruments and controls.
  - 4.) Temporary valves and accessories required for placing equipment into initial service.
  - 5.) Valves inherent to operation or protection of equipment installed under this Contract.
  - 6.) Plumbing isolation valves for each restroom group.
- c. Accessories.

1.2 ACTION SUBMITTALS

A. Shop Drawings:

- 1. Certified drawings for each type and size of valve. As a minimum, Drawings shall contain:
  - a. Valve tag numbers (if shown on drawings).
  - b. Materials of construction.
  - c. Valve end-to-end and envelope dimensions with operators.
  - d. Valve weight including operator if applicable.
  - e. Weld end preparation details.

DIVISION 20 – FACILITIES SERVICES  
**Section 20 05 23 – General Duty Valves and Accessories**

- f. Operator information.
- g. Special features such as vacuum service, locking device, limit switches, etc.
- h. Design conditions.

2. Wiring diagrams for field installation of components.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Valves shall be of same manufacturer for each class of piping and insofar as practicable for entire Project.
- B. Design and construct Steel and iron valves in accordance with ASME B16.10 and ASME B16.34.
- C. Valves in potable water service shall comply with applicable requirements of state and local plumbing codes including, but not limited to, NSF 61 requirements.

2. PRODUCTS

2.1 DESIGN CRITERIA

- A. Valve schedule contains requirements for valves. The following valves are specified elsewhere:
  - 1. HVAC Control valves are contained within Section 23 09 13.
  - 2. Plumbing stop valves at fixtures are specified in Section 22 40 00.
  - 3. Valves serving fire suppression systems are specified in Section 21 05 53.
- B. Pressure class ratings shown in valve schedule are anticipated pressure classes only. Lower intermediate pressure class or special pressure class valves are acceptable provided their ratings meet or exceed design pressure and design temperature of system as specified in Valve Schedule.
- C. Verify that valves meet or exceed design pressure and design temperature specified in Valve Schedule.

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**Section 20 05 23 – General Duty Valves and Accessories**

- D. Provide high-point vent valves and low-point drain valves not shown on Drawings. Conform to following table unless indicated otherwise on Drawings.

Service	Pipe Size	Vent/Drain Size
Vents	1/2" and smaller	Line size
Vents	3/4" and larger	3/4"
Drains	1/2" and smaller	Line size
Drains	3/4" to 2"	3/4"
Drains	2-1/2" to 4"	1"
Drains	6" to 10"	1-1/2"
Drains	12" and larger	2"

- E. Valve body materials shall be equivalent to piping material, unless noted otherwise.

Piping Material	Valve Body Material
Carbon steel	ASTM A105, ASTM A216 Grade WCB or ASTM A216 Grade WCC
1-1/4 chromium-molybdenum	ASTM A182 Grade F11
2-1/4 chromium-molybdenum	ASTM A182 Grade F22 or ASTM A217 Grade WC9
9 chromium-molybdenum	ASTM A182 Grade F9 or ASTM A217 Grade C12
Stainless steel Type 304 or 304L	ASTM A182 Grade F304 or F304L or ASTM A351 Grade CF3 or Grade CF8
Stainless steel Type 316 or 316L	ASTM A182 Grade F316 or F316L. Grade CF3M or Grade CF8M
Copper ASTM B88 Type K	Bronze ASTM B584-C84400, or equivalent
CPVC F441	CPVC ASTM D1784 Cell Classification 23447
PVC ASTM D1785	PCV ASTM D1784 Cell Classification 12454

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Piping Material	Valve Body Material
Ductile iron	ASTM A126 B cast iron, ASTM A395 or ASTM A536 ductile iron

- F. Valves shall be suitable for operator mounting (handwheel, bevel gear, motor operator, air actuator) with valve in any position without external support.
- G. Check valves shall be suitable for operation in horizontal and vertical flow up piping arrangements.

**2.2 WATER PRESSURE REDUCING VALVES**

- A. Service: Hydronic system automatic fill valves, potable water pressure reducing valves.
- B. Type: Pressure reducing, self-contained.
- C. Body: Bronze or iron construction.
- D. Connections: Soldered, threaded, or flanged. Coordinate with Pipe Class Specification.
- E. NSF certified for potable water service.

**2.3 CALIBRATED BALANCING VALVES**

- A. Service: Hydronic system balancing valves, hot water recirculation.

**2.4 CHECK VALVES - SILENT**

- A. Body:
  - 1. Material: ASTM B26 ductile iron or cast steel.

**2.5 GAGE COCKS**

- A. Service: Pressure gage isolation for low pressure air applications.

**2.6 PLUG VALVES**

- A. Service: Natural gas.
  - 1. Type: Lubricated plug, wrench-operated.
- B. Service: Water.

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**Section 20 05 23 – General Duty Valves and Accessories**

1. Type: Nonlubricated, eccentric plug.
2. Install valves with seat on inlet side. Where possible install valves with shaft in horizontal position with plug rotating up in open position.

2.7 NEEDLE VALVES

- A. Service: Pressure gage isolation or flow throttling and pulsation dampening for intermediate or high pressure applications.

2.8 ACCESSORIES

A. Hand wheels and levers:

1. Provide unless noted otherwise. Levers shall be multiposition with positive locking device.
2. Valves installed in areas inaccessible to platforms shall be provided with chain wheels. Provide chain wheel operators for manual valves with hand wheel operators in horizontal plane located more than 6'-6" (2 m) above floor, unless noted otherwise. Provide sufficient chain to bring operation down to 6'-6" (2 m) above floor.
3. Hand wheels shall not exceed 24" (600 mm) diameter unless noted otherwise.

B. Gear operators:

1. Gates, globes, plug, and angle valves: Provide bevel gear manual operators on following valves.

Valve Pressure Class	Valve Size
150	8" (200 mm) and larger
300	6" (150 mm) and larger
600	4" (100 mm) and larger
900	4" (65 mm) and larger
1500	3" (80 mm) and larger
2500 and above	2 1/2" (65 mm) and larger

2. Quarter turn valves: Worm gear or screw operator on valve sizes 6" (150 mm) and larger.
3. Maximum operator rim pull force required to stroke valve against maximum differential pressure: 75 lb (34 kg).

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4. Design valve operators to withstand hydrostatic test without damage.

C. Locking devices:

1. Allow for locking in closed or open positions with standard chain and padlock.
2. User will furnish padlocks.

D. Vacuum service: Where indicated in Valve Schedule, valves shall have packing designed to minimize air leakage into valve with external pressures of 15 psia (105 kPa a) and full vacuum on valve interior.

E. Direct-buried valve operators:

1. Provide valve box for each buried valve. Valve box shall be complete, assembled unit consisting of adjustable box and extension stem with 2" (50 mm) square operating nut.
2. Arrange entire assembly to prevent dirt and grit from entering valve box assembly.
3. Lid shall have directional arrow for open rotation.

2.9 BACKPRESSURE REGULATOR

- A. Service: Pump minimum flow protection.
- B. Type: Pressure bypass valve.
- C. Size and connection: Up to 2" (50 mm), threaded.
- D. Body and connection: Iron.

2.10 STEAM PRESSURE REDUCING VALVES

- A. Type: Pilot-operated, pressure reducing valves.
1. Main valve:
    - a. Size and connections:
      - 1.) Up to 2" (50 mm): Threaded.
      - 2.) 2 1/2" (65 mm) to 6" (150 mm): Flanged.
    - b. Body: ASTM A126, Class B, cast iron.

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**Section 20 05 23 – General Duty Valves and Accessories**

- c. Seat and plug: ASTM A314, stainless steel, replaceable.
  - d. Gaskets: ASTM D1170, nonasbestos fibers.
  - e. Pressure class: 250 psig (1725 kPa g) at 450°F (232°C).
2. Pilot valve:
- a. Type: Spring pilot.
  - b. Body: ASTM A126, Class B, cast iron.
  - c. Components: Stainless steel.
  - d. Gaskets: ASTM D1170 nonasbestos fibers.
3. Connect pilot operator control line downstream far enough to sense true pressure.
4. Rate relief valves for station upstream steam pressure. Size for full installed capacity of reducing station. Set valve to relieve at not more than 20% above reduced pressure.
- B. Type: Self-contained pressure reducing valve:
- 1. Size and connections: Up to 1" (25 mm).
  - 2. Body: Cast iron.
  - 3. Pressure class: 250 psig (1725 kPa g) at 450°F (232°C).

2.11 AUTOMATIC RECIRCULATION VALVES

- A. Design: Self-contained valve with bolted bonnet, integral check valve, flow sensing element, bypass control valve, bypass actuator, and multistage pressure letdown valve. Provide remote back pressure regulator as required for specified design conditions.

2.12 FLOAT VALVES

- A. Type: Heavy-duty, lever-actuated float valve.
- B. Service: Tank fill, cooling tower make-up.

2.13 RELIEF VALVES

- A. Service: Steam.
- 1. Body: Carbon steel.

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2. Packed lever.

B. Service: Water.

1. Body: Carbon steel.

2. Packed lever.

2.14 VALVE SCHEDULE

<b>VALVE SCHEDULE</b>		
<b>SERVICE</b>	<b>VALVE TYPE</b>	<b>DATA SHEET</b>
Steam		
2" and smaller	Gate	DS-4
2-1/2" and larger	Gate	DS-4
Condensate		
2" and smaller	Ball or Gate	DS-4
2-1/2" thru 20"	Resilient Seat Butterfly or Gate	DS-3
Pumped Condensate		
2" and smaller	Ball or Gate	DS-4
2-1/2" thru 20"	Resilient Seat Butterfly or Gate	DS-3
Compressed Air		
1/2" thru 3"	Ball or Gate	DS-4
4" thru 20"	Resilient Seat Butterfly or Gate	DS-3
Potable Water Upstream of Backflow Preventer		
3" and smaller	Ball or Gate	DS-4
4" thru 20"	Resilient Seat Butterfly	DS-3
Potable Water		
3" and smaller	Ball or Gate	DS-4
4" thru 20"	Resilient Seat Butterfly	DS-3
Chemical Treatment		
2" and smaller	PVC or CPVC Ball	Paragraph this section
2-1/2" and larger	PVC or CPVC Butterfly	Paragraph this section
HVAC and Plumbing Pump Discharge		
Check valves all sizes	Silent Check Valves	Paragraph this section
Heating Water		
1/2" thru 3"	Ball	DS-4
4" thru 20"	Resilient Seat Butterfly	DS-3
Fuel Oil		
2" and smaller	Ball	DS-2



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**Section 20 05 23 – General Duty Valves and Accessories**

<b>VALVE SCHEDULE</b>		
<b>SERVICE</b>	<b>VALVE TYPE</b>	<b>DATA SHEET</b>
2-1/2" and larger	Gate	DS-4
Natural Gas 1/2" thru 4"	Ball or Plug	DS-3 or paragraph this section
6" and larger	Gate	DS-4

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<b>BALL VALVES – STEEL</b>			<b>DATA SHEET - DS-2</b>	
Service		Steam service with design temp greater than 300°F (149°C)	Oil and Natural Gas	Water, Steam, Gas, or Air service with design temp less than 300°F (149°C)
Pressure Class		600 and above	300 and below	300 and below
MATERIALS	Body	Equivalent to pipe	Equivalent to pipe	Equivalent to pipe
	Ball:		Stainless steel	Stainless steel
	Class 1500 and below	410SS coated or A182-410 / Ram31		
	Class 2500 and above	Inconel 718 or A182-410/Ram31		
	Stems Class 1500 and below Class 2500 and above	A276 Gr. 431 Nitrided or A638 Gr. 660/H.F. 431SS or A638 Gr. 660/H.F.	Stainless steel	Stainless steel
	Seats:  Class 1500 and below Class 2500 and above	  410SS coated or A182-F22 CL3/H.F. Inconel 718 or A182-F22 CL3/H.F.	Nylon with seat ring and emergency gasket	PTFE or RPTFE
	Seat Ring		Equivalent to pipe	Equivalent to pipe
	Seals: Body Stem		TFE TFE with emergency backup seal	PTFE or RPTFE  PTFE or RPTFE
STRUCTURE	Valve Style	Unibody	3-piece	Design Pressure less than or equal to 150

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<b>BALL VALVES – STEEL</b>		<b>DATA SHEET - DS-2</b>	
Service	Steam service with design temp greater than 300°F (149°C)	Oil and Natural Gas	Water, Steam, Gas, or Air service with design temp less than 300°F (149°C)
Pressure Class	600 and above	300 and below	300 and below
			psig- 2 piece unless noted otherwise; Above 150 psig- 3 piece
	Design	Fire tested in accordance with API-607.	
	Bore Size	Full	Full
	Valve end type	Welded	2" and less-Threaded 2.5" and larger-Flanged

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<b>BUTTERFLY VALVES</b>			<b>DATA SHEET - DS-3</b>		
Type	Resilient Seat		AWWA	High Performance	
Service	Water 250°F (121°C) and lower and air 200°F (93°C) and lower		Water 250°F (121°C) and lower	Water above 250°F (121°C) and steam	
Size	2" through 12" (50 mm – 300 mm)	14" through 20" (350 mm – 500 mm)	Exposed - 24" (600 mm) and larger, Direct Buried – all sizes	All sizes	
Pressure rating	200 psi bi-directional minimum disc, 250 psi body	150 psi bi-directional minimum disc, 200 psi body	AWWA C504 Class 150 or 250	ASME CL 150 & 300	ASME CL 600 & 900
<b>MATERIALS</b>	Body	Ductile Iron	Ductile Iron for Class 250, Cast Iron for Class 150	Equivalent to pipe (carbon steel or stainless steel)	
	Disc	Aluminized Bronze for water service, Ductile Iron for air service	Ductile Iron	Stainless steel as required for service	
	Shaft	416 Stainless Steel	304 Stainless steel	Stainless steel	
	Soft Seat	EPDM for water service, BUNA for air service	EPDM or BUNA	Synthetic rubber, metal, or fire safe as required for service	
	Hard Seat		316 Stainless steel	Stellite Gr. 21 Weld Overlay	
	Shaft Seal	Manufacturer's standard	Chevron V-type packing or bronze packing gland with TFE impregnated Teflon packing	Teflon or graphite packing as required for service	
	Coating	Not required for ductile iron body, manufacturer's standard acceptable	Manufacturer's standard		
<b>CONSTRUCTION</b>	Body	Extended neck Lugged unless noted otherwise	Provide mechanical joints for ductile iron piping systems and flanged joints otherwise	Lugged - Double offset unless noted otherwise	Lugged – Triple offset unless noted otherwise

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<b>BUTTERFLY VALVES</b>				<b>DATA SHEET - DS-3</b>	
	Shaft and Disc Connection	Shaft keyed to disk – pinned connection not allowed	Shaft keyed to disc preferred – stainless steel taper pins acceptable	Stainless steel taper pins	Stainless steel taper pins
	Position indicator	Required		Required	Required
Hydrostatic and seat leakage		Factory test at 110% pressure rating		AWWA C504	FCI 70-2 or API 598

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<b>BRONZE AND IRON VALVES</b>		<b>DATA SHEET - DS-4</b>			
		Gate, Globe, and Checks		Ball	
Size		2" (50 mm) and Less	2-1/2" (65 mm) and Larger	4" (100 mm) and Less	
Pressure class		150 psig (1035 k Pa g)at 220°F (104°C)	125 psig at 220°F (104°C)	125 psig (860 k Pa g)	
<b>MATERIALS</b>	Body	Bronze	ASTM A126 Class B Cast Iron	Bronze	
	Ball	n/a	n/a	Bronze	
	Gate valve wedge	Bronze	Cast iron with bronze face rings	n/a	
	Globe valve disc	TFE	Renewable Bronze	n/a	
	Check valve disc	Bronze	Ductile Iron	n/a	
	Stems	Silicon Brass	ASTM B16 Brass	Bronze	
	Seats and Seals	Steam service- TFE Water, oil, gas- Buna-N	Bronze, ASTM B61	RPTFE	
	Internals	Bronze	Renewable Bronze		
<b>CONSTRUCTION</b>	Stem	Inside screw with rising stem	Outside screw and yoke with Rising Stem	Blowout proof	
	Packing	Aramid fibers with graphite	Aramid fibers with graphite	PTFE	
	Bore Size	Full	Full	Full	
	Ball valve body	n/a	n/a	2 piece	
	Valve end type	Threaded, unless noted otherwise	Flanged, unless noted otherwise	<u>Pipe Material</u> Copper Steel	<u>End Type</u> Solder Threaded

END 20 05 23

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Tapped saddles.
- b. Expansion tanks.
- c. Air separators.
- d. Strainers.
- e. Thermowells.
- f. Pressure and temperature test ports.
- g. Air vents.
- h. Flexible hose section.
- i. Water treatment chemical batch feeder.
- j. Heat transfer fluid.

1.2 ACTION SUBMITTALS

A. Shop Drawings. Data shall include:

- 1. Manufacturer.
- 2. Model.
- 3. Application.
- 4. Materials of construction.
- 5. Dimensions.
- 6. Rough in requirements.
- 7. Pressure rating (pressure and vacuum).
- 8. Temperature rating.

9. For cooling tower basin cleaning systems provide factory designed basin educator layout plans.

B. Product Data: MSDS sheets.

### 1.3 QUALITY ASSURANCE

- A. Expansion tanks and air separators indicated to be constructed to ASME requirements shall be stamped with "U" symbol denoting compliance with ASME Section VIII, Construction of Unfired Pressure Vessels.
- B. Comply with applicable requirements of state and local plumbing codes including, but not limited to, NSF 61 requirements for devices used in potable water systems and other governmental agency under whose jurisdiction Work is being performed.

## 2. PRODUCTS

### 2.1 TAPPED SADDLES

- A. Type: 2-piece with single wide strap completely encircling pipe.
- B. Construction:
  1. Body casting: Ductile iron, epoxy coated.
  2. Strap: Type 304 stainless steel; single strap.
  3. Nuts and bolts: Type 304 stainless steel.
  4. Gasket: Molded NBR or EPDM.
- C. Saddles shall be suitable for service intended.

### 2.2 EXPANSION TANKS

- A. Type: ASME bladder.
  1. Construction:
    - a. Shell: Carbon steel, epoxy-coated after fabrication. For potable water applications coating shall be FDA-approved.
    - b. Base: Carbon steel, epoxy-coated after fabrication for tanks 10-gallon and larger.



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c. Bladder: Replaceable heavy-duty butyl rubber. FDA-approved for domestic water applications.

d. System connection:

1.) Domestic water application: Stainless steel, brass, copper or bronze.

2.) Heating and cooling application: Carbon steel.

B. Type: NonASME bladder.

1. Construction:

a. Shell: Carbon steel, epoxy-coated after fabrication. For potable water applications coating shall be FDA-approved.

b. Base: Carbon steel, epoxy-coated after fabrication for tanks 10 gallons and larger.

c. Bladder: Replaceable heavy-duty butyl rubber. FDA-approved for domestic water applications.

C. Type: ASME diaphragm.

1. Construction:

a. Shell: Carbon steel, epoxy-coated after fabrication. For potable water applications coating shall be FDA-approved.

b. Diaphragm: heavy-duty butyl rubber. FDA-approved for domestic water applications.

D. Type: NonASME diaphragm.

1. Construction:

a. Shell: Carbon steel, epoxy-coated after fabrication. For potable water applications coating shall be FDA-approved.

b. Diaphragm: heavy-duty butyl rubber. FDA-approved for domestic water applications.

E. Accessories:

1. Provide 0.302" (7.7 mm) x 32 threads per inch "Schrader valve" for field charging of tank

2. Lifting lugs.

### 2.3 AIR SEPARATOR

#### A. Type: Tangential.

1. Construction: Welded steel or cast iron construction, rated for 125 psig (8.62 bar) working pressure, and stamped in accordance with ASME Section VIII, Division 1.
2. Accessories:
  - a. Removable stainless steel strainer.
  - b. Blowdown connection on bottom of vessel.
  - c. Air vent connection on top of vessel
  - d. Base ring for floor mounted units.
  - e. Lifting lugs.

#### B. Type: In-line.

1. Construction. One-piece cast iron.

### 2.4 STRAINERS

#### A. Type: "Y".

1. Construction:
  - a. Body:
    - 1.) 2" (50 mm) and smaller: Bronze body, 125 class construction, screwed ends with removable plug screen retainer, and blow-down connection.
    - 2.) 2 1/2" (64 mm) and larger: Cast iron, 125 class construction, flanged ends with bolted screen retainer, and off-center blow-down connection.
    - 3.) For potable water applications provide FDA-approved epoxy coating on internal and external surfaces.
  - b. Strainer basket:

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- 1.) Monel, suitable for service intended. For potable water applications provide stainless steel.

B. Type: Simplex basket.

1. Construction:

a. Body:

- 1.) 2" (50 mm) and smaller: Bronze body, 125 class construction, screwed ends with quick release cover.
- 2.) 2-1/2" (64 mm) and larger: Cast Iron, 125 class construction, flanged ends with bolted cover.
- 3.) For potable water applications provide FDA-approved epoxy coating on internal and external surfaces.

b. Basket:

- 1.) Stainless steel suitable for service intended.

2.5 THERMOWELLS

- A. Construction: Type 304 stainless steel, threaded 3/4" (19 mm) NPT.
- B. Length: Suitable for pipe diameter with extended necks as required for pipe insulation.

2.6 PRESSURE AND TEMPERATURE TEST PORT

- A. Construction: Brass body, 1/4" (6 mm) NPT connection with EPDM self-closing valve and protective cap. Attach cap to body with strap or chain. Port shall accept 1/8" (3 mm) OD temperature or pressure probe.
- B. Accessories
1. Provide extensions to bring test port cap above insulation thickness specified.

2.7 AIR VENTS

- A. Type: Automatic.
1. Float-actuated, air vent automatically venting air and other gases from process piping without loss of liquid.

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2.8 FLEXIBLE HOSE SECTIONS

- A. Vacuum rating: Full.
- B. Maximum working pressure: 150 psi (10.3 bar).

2.9 WATER TREATMENT CHEMICAL BATCH FEEDER TANK

- A. Construction: Cast iron or welded steel.
- B. Furnish isolation valves for each connection.

END 20 05 26

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**Section 20 05 29 – Supports and Anchors for  
Facility Services Piping and Equipment**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Design of pipe support systems, equipment support systems and supplementary support steel.
- b. Fabrication and installation of:
  - 1.) Pipe and equipment supports.
  - 2.) Supplementary support steel.

1.2 ACTION SUBMITTALS

A. Shop Drawings:

- 1. Piping plans and elevations drawings showing pipe support systems designed by Contractor. Drawings shall show pipe support (by use of symbol), support identification number and locations. Pipe support identification numbers shall use same format as that used by Engineer. Submittal required for all engineered pipe supports.
- 2. Details for semi-engineered supports. Support details shall show localized stiffening of support steel at support connection, where applicable.
- 3. Details for each completely-engineered support containing information specified in MSS SP-58, article "Pipe Hanger Assembly Drawings." Drawings shall show supplementary steel and localized stiffening of support steel at support connection, where applicable.

B. Quality assurance data:

- 1. Published pre-engineered standard pipe support components utilized on project. Include allowable loads.
- 2. Pre-engineered standard support certifications
- 3. Equipment supports, associated supplementary support steel (if required) and support loads. Contractor shall obtain written

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confirmation from entity responsible for design of existing steel receiving supports that imposed loads are accepted.

4. Computations for design of supplementary steel and stiffening of existing building steel for support loads, if requested by Engineer.

1.3 QUALITY ASSURANCE

- A. Pipe hangers and supports, fabrication, and installation practices shall be in accordance with MSS SP-58.

2. PRODUCTS

2.1 PIPE SUPPORT SYSTEM DESIGN

- A. Pipe support system shall result in pipe stress conforming to requirements of ASME B31.
- B. Where possible, pipe support locations shall be located to prevent individual structural members from being excessively loaded to point that global stiffening of member is required.
- C. Locate supports for pipe connected to equipment to limit equipment reactions to allowable reactions specified by equipment manufacturer.
- D. Supports for pipe that terminate at existing pipe connections shall accommodate thermal movement and loads imposed by existing pipe.

2.2 EQUIPMENT SUPPORT DESIGN

- A. Design equipment support system, supports, and associated supplementary support steel.
- B. Base equipment support design upon following parameters:
  1. Support loads.
  2. Equipment movements at supports.
  3. Equipment manufacturer's requirements.
- C. Equipment support selection and application: MSS SP-58.
- D. Equipment support design: MSS SP-58.
- E. Where equipment supports are designed by entity other than equipment supplier, obtain equipment supplier's approval of support system.

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- F. Support design should account for possible occasional loading observed during operation.

2.3 PIPE AND EQUIPMENT SUPPORTS

- A. Materials and manufacture: MSS SP-58 and ASME B31.1.
- B. Supports and accessory items shall have manufacturer's standard shop-applied primer and standard finish coat, unless specified otherwise.
- C. Provide insulation protection shields of sufficient size and gage to prevent crushing of insulation at supports.
- D. Hot duct, flue, and breeching supports:
  - 1. Slide bearing plates:
    - a. Size to accommodate loads and thermal movements of duct, flue, or breeching. Conform to requirements of manufacturer.
    - b. Type: Bronze alloy or Teflon suitable for bearing pressures, movements, and temperatures.
    - c. Extend upper sliding surface to maintain 1" (25 mm) minimum beyond edge of lower sliding surface through full range of movements.
  - 2. Springs:
    - a. Constant-support type to maintain support of duct, flue, or breeching through full ranges of vertical and horizontal movements.
    - b. Size to take dead weight of duct, flue, or breeching including insulation, lagging, appurtenances, and one half of expansion joints.
    - c. Construction: Helical spring(s) mounted in carbon (structural) steel housing and having linkage arranged to permit maintenance of constant load throughout movement range. Provide with movement indicator dial to facilitate initial set and adjustment.
  - 3. Anchors and seismic restraints:
    - a. Structural plate (ASTM A36) anchor supports where indicated and required.

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- b. Seismic restraints shall limit movement of individual duct, flue, or breeching sections to control movements in expansion joints to acceptable limits without damage to expansion joint or attached and adjacent equipment and construction.
    - c. Locate to minimize effects of differential movement and torsion on supports.
  - 4. Supports for duct, flue, or breeching at universal-type expansion joint arrangements shall be reviewed and approved by expansion joint manufacturer.
  - 5. Supports for duct, flue, or breeching shall include:
    - a. Weight of breeching plate, stiffeners, insulation, lagging, appurtenances, and miscellaneous materials.
    - b. Loads for attached platforms, pipe, conduit, or equipment.
- E. Supports for pipe designed to receive anti-sweat insulation shall be sized to allow vapor barrier and insulation to be continuous through support. Provide insulation saddles sized to prevent insulation damage at each support.
- F. Beam clamps:
  - 1. For pipe sizes 6” and less, and/or piping loads under 600 lbs: Acceptable.
  - 2. For pipe sizes 8” and larger, and/or piping loads greater than 600 lbs: Subject to approval.
- G. Neither chains nor straps shall be used as permanent pipe supports.
- H. Provide variable and constant spring cans, snubbers, and struts with load/travel scales or name plates on both side of support component, and orientated such that the tag information is easily accessed and read.
- I. Pipe support component in contact with pipe shall be compatible with pipe material so that neither have a deteriorating action on each other. For piping under 150°F (66°C) a neoprene liner may be used to isolate piping from clamp-on pipe support component.
- J. Stainless steel pipe in contact with carbon steel pipe support component shall be wrapped with a neoprene liner to prevent dielectric corrosion.



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2.4 SUPPLEMENTARY SUPPORT STEEL

- A. Shapes: ASTM A6.
- B. Design of supplementary support steel shall be in accordance with AISC "Specification for Structural Steel Buildings - Allowable Stress Design"
- C. Supplementary support steel that induces torsion in support member is not permitted, except where shown on Drawings.
- D. Design supplementary support steel as necessary to prevent excessive loads in existing steel members due to pipe support loads.
- E. Furnish supplementary support steel with loose clip angles for attachment to structure. Bolt connections to existing columns or other existing steel insofar as practicable. Where connections are common connections with existing steel, new bolts, washers, and nuts shall be supplied under this contract.
- F. Supplementary support steel shall conform to requirements of Section 05 50 00.
- G. Welding to beam flanges permitted only where welds are parallel to and directly opposite webs.

END 20 05 29

MINIMUM NOMINAL INSULATION THICKNESS (INCHES) (NOTE 2)								
FLUID TEMPERATURE RANGES	39°F & BELOW	40°F TO 60°F	61°F TO 104°F	105°F TO 140°F	141°F TO 200°F	201°F TO 250°F	251°F TO 350°F	351°F TO 400°F
NOMINAL PIPE SIZE								
LESS THAN 1	0.5	0.5	0.5	1.0	1.5	2.5	3.0	4.5
1 - 1.25	1.0	0.5	0.5	1.0	1.5	2.5	4.0	5.0
1.5 - 3	1.0	1.0	1.0	1.5	2.0	2.5	4.5	5.0
4 - 6	1.0	1.0	1.0	1.5	2.0	3.0	4.5	5.0
8 & LARGER	1.5	1.0	1.0	1.5	2.0	3.0	4.5	5.0

**NOTES:**

1. INSULATION THICKNESSES ARE BASED ON ANSI/ASHRAE/IESNA STANDARD 90.1 - 2016.
2. ON OUTDOOR EQUIPMENT AND PIPING, THE INSULATING THICKNESS SHOWN ABOVE SHALL BE INCREASED 0.5".
3. INSULATION THICKNESSES SHOWN ARE MINIMUM THICKNESSES AND DO NOT INCLUDE FINISHING OR SEALING COATS.
4. THE MINIMUM INSULATION THICKNESSES ARE BASED ON INSULATION WITHIN THE FOLLOWING CONDUCTIVITY RANGES.


CONDUCTIVITY MEAN RATING TEMPERATURE	50°F	75°F	100°F	125°F	150°F	200°F	250°F
CONDUCTIVITY (BTU-IN/HR FT-°F)	0.20 - 0.26	0.21 - 0.27	0.22 - 0.28	0.25 - 0.29	0.27 - 0.30	0.29 - 0.32	0.32 - 0.34

FOR INSULATION WITH CONDUCTIVITY VALUES OUTSIDE THE GIVEN RANGES, THE MINIMUM INSULATION THICKNESS SHALL BE ADJUSTED BASED ON THE FOLLOWING FORMULA.

$$T = r \cdot \left[ \left( 1 + \frac{t}{r} \right)^{\frac{K}{k}} - 1 \right]$$

**WHERE:**

- T = MINIMUM INSULATION THICKNESS IN INCHES.  
r = ACTUAL OUTSIDE PIPE RADIUS IN INCHES  
t = MINIMUM THICKNESS FROM ABOVE TABLE.  
K= CONDUCTIVITY OF ALTERNATE MATERIAL AT MEAN RATING TEMPERATURE INDICATED FOR THE APPLICABLE FLUID TEMPERATURE IN BTU-IN/HR FT-°F  
k = THE UPPER VALUE OF THE CONDUCTIVITY RANGE LISTED IN THE ABOVE TABLE FOR THE APPLICABLE FLUID TEMPERATURE.

6- 2016 UPDATE	JJB	JDJ	TJL	8/13/2019	 <b>Stanley Consultants INC.</b>	SCALE: NONE	
5- 2013 UPDATE	JJB	JDJ	TJL	8/13/2019			
4- GENERAL	TJL	JJB	MAE	5/20/2011			
REVISIONS	DES	CHK	APP	DATE			
<b>MECHANICAL STANDARD INSULATION</b>					<b>PIPING AND EQUIPMENT INSULATION THICKNESS</b>	NO.	
						<b>M-1008</b>	
							<b>6</b>

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Insulating and jacketing, including, but not limited to:
  - 1.) Air ducts not supplied with factory- or shop-applied liner.
  - 2.) Piping systems.
  - 3.) Equipment insulation not otherwise insulated by equipment manufacturer.

1.2 ACTION SUBMITTALS

A. Product Data:

- 1. Schedule for insulating materials, including adhesives, fastening methods, fitting materials, etc. and intended use.
- 2. Catalog sheets indicating conformance to ASTM Standards, density, thermal characteristics, jacket, surface burning characteristics, water vapor permeability.
- 3. Submit manufacturers published literature indicating proper installation procedures.
- 4. MSDS and additional safety procedures required for installation.
- 5. Provide warranty information on materials
- 6. Provide VOC content information for all adhesive and sealants to be applied inside building.

1.3 QUALITY ASSURANCE

A. Regulatory requirements:

- 1. Insulation shall meet requirements of ASHRAE 90.1.
- 2. Products shall conform to NFPA 90A and 90B with special regard to fire hazard classification requirements of NFPA 255, including vapor barriers and adhesives.

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3. Products shall possess flame spread rating of not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50 except as allowed by International Mechanical Code.
4. Insulation materials used in contact with austenitic stainless steel shall meet requirements of ASTM C795.
5. Materials shall be asbestos-free, fire-retardant, moisture-resistant, mildew-resistant and vermin proof.
6. Adhesives, sealants, mastics and other coatings: Compatible to mechanical surfaces, insulations, and jackets to which applied in both wet and dry state. Suitable for temperature of systems to which applied.

2. PRODUCTS

2.1 PIPE INSULATION SYSTEMS

A. Calcium silicate:

1. Insulation:

- a. Type: ASTM C533, Type I.
- b. Formed pipe insulation or block, as required.
- c. Temperature rating: 1,200°F (649°C).
- d. Density: 14.5 lb/cu ft.
- e. Conductivity: ASTM C533.

2. Accessories:

- a. Reinforcing mesh:
  - 1.) Description: High-strength, open-weave, resin treated fiber glass cloth.
  - 2.) Tread count: 10 strands by 10 strands per square inch.
- b. Tie-wire: 0.048” (1.2 mm) stainless steel, twisted ends; 12” (300 mm) oc.
- c. Finishing cement: ASTM C449 compatible with insulation.

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- d. Adhesives, sealants and other mastic coatings: Compatible with insulation as recommended by insulation manufacturer.

**B. Mineral fiber:**

1. Insulation:

- a. Type: ASTM C547, Type I.
- b. Temperature rating: -20 to 850°F (-29°C to 454°C).
- c. Density: 3 to 6 lb/cu ft.
- d. Conductivity: Not more than 0.24 Btu-in/hr-sq ft-°F at mean temperature of 75°F (24°C).

2. All-service vapor retarder jacket (ASJ) with self-sealing lap:

- a. Factory applied to insulation.
- b. Finish: White vinyl or white Kraft suitable for painting.
- c. Bench puncture resistance: 50 units minimum, test method ASTM D781.
- d. Permeance: 0.02 perms, maximum, test method ASTM E96, Proc. A.
- e. Jacket temperature rating: -20 to 150°F (-29°C to 65.5°C).

3. Accessories: Adhesives, sealants, mastics and other coatings compatible with insulation system as recommended by insulation manufacturer.

**C. Elastomeric:**

1. Insulation:

- a. Type: ASTM C534, Type I, Grade 1.
- b. Size: Up to 1" (25 mm) thick.
- c. Temperature rating: -40 to 180°F (-40°C to 82°C).
- d. Flame spread rating: No more than 25 tested by ASTM E84.
- e. Smoke developed rating: No more than 50 tested by ASTM E84.

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- f. Conductivity: Not more than 0.28 Btu-in/hr-sq ft-°F at mean temperature of 75°F (24°C).
    - g. Permeance: Not more than 0.10 perms per inch, test method ASTM E96, Proc. A.
    - h. Water absorption by volume: Not more than 0.20%.
  - 2. Accessories: Adhesives and sealants compatible with insulation system as recommended by insulation manufacturer.
- D. Polyisocyanurate (low-density):
  - 1. Insulation:
    - a. Type: ASTM C591, Grade 2, Type IV.
    - b. Formed pipe insulation or block, as required.
    - c. Temperature rating: -297 °F to 300°F (-183°C to 149°C).
    - d. Density (min): 2.0 lb/cu ft.
    - e. Compressive strength (min): 22 psi, ASTM D1621.
    - f. Conductivity: ASTM C591.
  - 2. Factory-applied vapor retarder film:
    - a. Type: ASTM C1136, Type 1.
    - b. Factory applied to insulation.
    - c. Thickness: 4 mils
    - d. Permeance: 0.02 perms, maximum, test method ASTM E96, Proc. A.
  - 3. Accessories: Adhesives and sealants compatible with insulation system as recommended by insulation manufacturer.
- E. Polyisocyanurate (high-density):
  - 1. Insulation:
    - a. Type: ASTM C591, Grade 2, Type VI.
    - b. Formed pipe insulation or block, as required.

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- c. Temperature rating: -297°F to 300°F (-183°C to 149°C).
  - d. Density: 6 lb/cu ft.
  - e. Compressive strength (min): ASTM D1621, 125 psi.
  - f. Conductivity: ASTM C591.
2. Factory-applied vapor retarder film:
- a. Type: ASTM C1136, Type 1.
  - b. Factory applied to insulation.
  - c. Thickness: 4 mils.
  - d. Permeance: 0.02 perms, maximum, test method ASTM E96, Proc. A.
3. Accessories: Adhesives, and Sealants compatible with insulation system as recommended by insulation manufacturer.

2.2 DUCT AND EQUIPMENT INSULATION SYSTEMS

A. Calcium silicate block:

- 1. Insulation:
  - a. ASTM C533, Type I.
  - b. Temperature rating: 1,200°F (649°C).
  - c. Density: Not less than 14.5 lb/cu ft.
- 2. Accessories:
  - a. Reinforcing mesh:
    - 1.) Description: High-strength, open-weave, resin-treated fiber glass cloth.
    - 2.) Tread count: 10 strands x 10 strands per square inch.
  - b. Tie-wire: 0.048” (1.2 mm) stainless steel, twisted ends; 12” (300 mm) oc.
  - c. Finishing cement: ASTM C449 compatible with insulation.

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**Section 20 07 00 – Mechanical Insulation**

- d. Adhesives, sealants and other mastic coatings: Compatible with insulation as recommended by insulation manufacturer.

**B. Mineral fiber board:**

**1. Insulation:**

- a. Type: ASTM C612.
- b. Density: 3.0 lb/cu ft.
- c. Temperature rating: 0°F to 450°F (-17°C to 232°C).
- d. Conductivity: Not more than 0.24 Btu-in/hr-sq ft-°F at mean temperature of 75°F (24°C).

**2. All-service vapor retarder jacket (ASJ):**

- a. Factory applied to insulation.
- b. Finish: White vinyl or white Kraft suitable for painting.
- c. Bench puncture resistance: 50 units minimum, test method ASTM D781.
- d. Permeance: 0.02 perms, maximum, test method ASTM E96, Proc. A.
- e. Jacket temperature rating: -20°F to 150°F (-29°C to 65.5°C).
- f. Joints and seams: 6" (150 mm) wide glass cloth, 2 coats mastic.

**3. Reinforced aluminum foil jacket (FRK):**

- a. Factory applied to insulation.
- b. Finish: foil.
- c. Bench puncture resistance: 25 units minimum, test method ASTM D781.
- d. Permeance: 0.02 perms, maximum, test method ASTM E96, Proc. A.
- e. Jacket temperature rating: -20 to 150°F (-29°C to 65.5°C).
- f. Joints and Seams: 3" (75 mm) wide tape.



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4. Accessories: Adhesives and sealants compatible with insulation system as recommended by insulation manufacturer.

**C. Mineral fiber blanket:**

1. Insulation:

- a. Type: ASTM C553, Type III.
- b. Density: 1.5 lb/cu ft.
- c. Temperature rating: 0°F to 450°F (-17°C to 232°C).
- d. Conductivity: Not more than 0.24 Btu-in/hr-sq ft-°F at mean temperature of 75°F (24°C).

2. All-service vapor retarder jacket (ASJ):

- a. Factory applied to insulation.
- b. Finish: White vinyl or white Kraft suitable for painting.
- c. Bench puncture resistance: 50 units minimum, test method ASTM D781.
- d. Permeance: 0.02 perms, maximum, test method ASTM E96 Proc. A.
- e. Jacket temperature rating: -20 to 150°F (-29°C to 65.5°C).
- f. Joints and seams: 3" (75 mm) wide tape.

3. Reinforced aluminum foil jacket (FRK):

- a. Factory applied to insulation.
- b. Finish: foil.
- c. Bench puncture resistance: 25 units minimum, test method ASTM D781.
- d. Permeance: 0.02 perms, maximum, test method ASTM E96, Proc. A.
- e. Jacket temperature rating: -20 to 150°F (-29°C to 65.5°C).
- f. Joints and seams: 3" (75 mm) wide tape.

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4. Accessories: Adhesives and sealants compatible with insulation system as recommended by insulation manufacturer.

D. Elastomeric sheet:

1. Insulation:

- a. Type: ASTM C534, Type II, Grade 1.
- b. Size: up to 2" (50 mm) thick.
- c. Temperature rating: -40 to 180°F (-40°C to 82°C).
- d. Flame spread rating: No more than 25 tested by ASTM E84.
- e. Smoke developed rating: No more than 50 tested by ASTM E84.
- f. Conductivity: Not more than 0.3 Btu-in/hr-sq ft-°F at mean temperature of 75°F.
- g. Permeance: Not more than 0.10 perms, test method ASTM E96 Proc. A.
- h. Water absorption by volume: Not more than 0.20%.

2. Accessories: Adhesives and sealants compatible with insulation system as recommended by insulation manufacturer.

2.3 FIELD APPLIED JACKETS

A. PVC jacket:

1. Material: ASTM D1784, Cell Class 16354.
2. Minimum thickness: 0.030" (0.76 mm).
3. Use preformed fittings for sizes available from manufacturer. Other fittings may be mitered.
4. Use pre-curved jackets for available sizes.
5. Ultraviolet rating: Rated for outdoor use in high-UV applications and indoor applications.
6. Solvent weld adhesives: As recommended by PVC jacket manufacturer.

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7. Tape: 5 mils minimum. As recommended by PVC jacket manufacturer.

8. Tacks: Stainless steel.

**B. Aluminum jacket:**

1. Material: ASTM C1729, Type I, 0.016" (0.4 mm) thick, smooth finish, Type 3105 or 3003 aluminum.
2. Jacket cut to size with 2" (50 mm) overlap. Banded 12" (300 mm) oc; seam calked with aluminum color silicon sealant.
3. Banding with insulation less than 13" (330 mm) diameter: Type 304 stainless steel, 1/2" x 0.020" (13 mm x 0.5 mm).
4. Banding with insulation larger than 13" (330 mm) diameter, but less than 6'-0" (1.8 m) diameter: Type 304 stainless steel, 3/4" x 0.020" (19 mm x 0.5 mm).

**2.4 PIPE INSULATION SCHEDULE**

Service	Insulation	Field Applied Jacket	Thickness
Potable Hot Water Piping (140°F)	Mineral Fiber	PVC	M-1008
Potable Cold Water Piping (45°F)	Elastomeric	PVC	1/2" (13 mm)
Heating Water Piping (180°F)	Mineral Fiber	PVC	M-1008
Roof Drain Piping (20°F)	Polyisocyanurate Elastomeric	PVC	1/2" (13 mm)
Refrigerant Suction Piping (35°F)	Polyisocyanurate Elastomeric	PVC	M-1008
Steam (353°F)	Calcium Silicate Mineral Fiber	Aluminum	M-1008
Condensate Return (250°F)	Calcium Silicate Mineral Fiber	Aluminum	M-1008

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**2.5 DUCT AND EQUIPMENT INSULATION SCHEDULE**

Item	Insulation <sup>1</sup>	Jacket Type	Insulation Thickness
Outside Air and Mixed Air Ductwork Exposed	Mineral Fiber Board (ASJ)	---	---
Outside Air and Mixed Air Ductwork Concealed	Mineral Fiber Board (FRK)	---	1"
Exposed Supply Ducts in Equipment Room	Mineral Fiber Board (ASJ)	---	1"
Concealed Supply Ducts	Mineral Fiber Blanket (FRK)	---	1-1/2"
Ducts exterior to building or outside conditioned space	Mineral Fiber board (ASJ)	Aluminum	3"
Return and Relief Ducts in Equipment Room	Mineral Fiber Board (ASJ)	---	1"
Engine Exhaust Pipe and Muffler	Calcium Silicate	---	3-1/2"
Air Separators	Mineral Fiber Board (ASJ)	---	2-1/2"
Expansion Tanks	Mineral Fiber Board (ASJ)	---	1"
Heat Exchangers	Mineral Fiber Board (ASJ)	---	3-1/2"
Storage Tanks	Mineral Fiber Board (ASJ)	---	2"
Pump Heads	Mineral Fiber Board (ASJ) Elastomeric	---	1-1/2"

<sup>1</sup>Letters in parenthesis indicate factory applied jacket.

END 20 07 00

DIVISION 21 – FIRE PROTECTION  
**Section 21 05 18 – Escutcheons for Fire-Suppression Piping**

1 - GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Escutcheons for fire-suppression piping as shown and herein specified.
- B. Alternate Bids: N/A

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

- A. Section Includes:
  - 1. Escutcheons.
  - 2. Floor plates.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange.

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**Section 21 05 18 – Escutcheons for Fire-Suppression Piping**

- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
- b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or stamped-steel type with polished, chrome-plated finish.
- c. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or stamped-steel type with polished, chrome-plated finish.
- d. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or stamped-steel type with polished, chrome-plated finish.
- e. Bare Piping in Equipment Rooms: One-piece, cast-brass or stamped-steel type polished, chrome-plated finish.

- C. Install floor plates for piping penetrations of equipment-room floors.

- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END 21 05 18

**Section 21 05 18 – General-Duty Valves for Water-Based Fire-Suppression Piping**

1 - GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide General-duty Valves for water-based fire-suppression piping as shown and herein specified.
- B. Alternate Bids: N/A

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

- A. Section Includes:
  - 1. Two-piece ball valves with indicators.
  - 2. Bronze butterfly valves with indicators.
  - 3. Iron butterfly valves with indicators.
  - 4. Check valves.
  - 5. Bronze OS&Y gate valves.
  - 6. Iron OS&Y gate valves.
  - 7. Trim and drain valves.

1.4 DEFINITIONS

- A. OS&Y: Outside screw and yoke.
- B. SBR: Styrene-butadiene rubber.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.

**Section 21 05 18 – General-Duty Valves for Water-Based Fire-Suppression Piping**

2. Protect threads, flange faces, and weld ends.
  3. Set 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.
- D. Protect flanges and specialties from moisture and dirt.

**2 - PRODUCTS**

**2.1 SOURCE LIMITATIONS**

- A. Obtain each type of valve from single manufacturer.

**2.2 PERFORMANCE REQUIREMENTS**

- A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:
1. Fire Main Equipment: HAMV - Main Level
    - a. Ball Valves, System Control: HLUG - Level 3
    - b. Butterfly Valves: HLXS - Level 3
    - c. Check Valves: HMER - Level 3
    - d. Gate Valves: HMRZ - Level 3
  2. Sprinkler System & Water Spray System Devices: VDGT - Main Level
    - a. Valves, Trim and Drain: VQGU - Level 1
- B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:
1. Automated Sprinkler Systems:
    - a. Valves.



**Section 21 05 18 – General-Duty Valves for Water-Based Fire-Suppression Piping**

- 1) Gate valves.
- 2) Check valves
- 3) Miscellaneous valves.

C. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B31.9 for building services piping valves.

D. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

E. NFPA Compliance for valves:

1. Comply with NFPA 13, NFPA 14, NFPA 20, and NFPA 24.

F. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher, as required by system pressures.

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

H. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

**2.3 TWO-PIECE BALL VALVES WITH INDICATORS**

A. Description:

1. UL 1091, except with ball instead of disc and FM Global approved for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum Pressure Rating: 175 psig.
3. Body Design: Two piece.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.

**Section 21 05 18 – General-Duty Valves for Water-Based Fire-Suppression Piping**

7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear
10. Supervisory Switch: Internal.
11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
12. End Connections for Valves NPS 2-1/2: Grooved ends.

**2.4 BRONZE BUTTERFLY VALVES WITH INDICATORS**

**A. Description:**

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
2. Minimum: Pressure rating: 175 psig.
3. Body Material: Bronze.
4. Seat Material: EPDM.
5. Stem Material: Bronze or stainless steel.
6. Disc: Stainless steel with EPDM coating.
7. Actuator: Worm gear.
8. Supervisory Switch: Internal.
9. Ends Connections for Valves NPS 1 through NPS 2: Threaded ends.
10. Ends Connections for Valves NPS 2-1/2: Grooved ends.

**2.5 IRON BUTTERFLY VALVES WITH INDICATORS**

**A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:**

1. Anvil International.
2. Kennedy Valve Company; a division of McWane, Inc.
3. NIBCO INC.
4. Tyco by Johnson Controls Company.

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5. Victaulic Company.

**B. Description:**

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig .
3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM or SBR coated.
7. Actuator: Worm gear.
8. Supervisory Switch: Internal or external.
9. Body Design: Grooved-end connections.

**2.6 CHECK VALVES**

**A. Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. Anvil International.
2. Kennedy Valve Company; a division of McWane, Inc.
3. NIBCO INC.
4. Reliable Automatic Sprinkler Co., Inc. (The).
5. Shurjoint; a part of Aalberts Integrated piping Systems.
6. Tyco by Johnson Controls Company.
7. Victaulic Company.
8. Viking Corporation.

**B. Description:**

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.

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2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

**2.7 BRONZE OS&Y GATE VALVES**

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

1. Milwaukee Valve Company.
2. NIBCO INC.
3. Zurn Industries, LLC.
4. Or approved equal

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Bronze or brass.
4. Wedge: One-piece bronze or brass.
5. Wedge Seat: Bronze.
6. Stem: Bronze or brass.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.

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9. End Connections: Threaded.

**2.8 IRON OS&Y GATE VALVES**

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Kennedy Valve Company; a division of McWane, Inc.
2. NIBCO INC.
3. Victaulic Company.
4. Zurn Industries, LLC.

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.

**2.9 TRIM AND DRAIN VALVES**

A. Ball Valves:

1. Description:
  - a. Pressure Rating: 175 psig .
  - b. Body Design: Two piece.
  - c. Body Material: Forged brass or bronze.
  - d. Port size: Full or standard.

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- e. Seats: PTFE.
- f. Stem: Bronze or stainless steel.
- g. Ball: Chrome-plated brass.
- h. Actuator: Handlever.
- i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
- j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

**B. Angle Valves:**

**1. Description:**

- a. Pressure Rating: 175 psig.
- b. Body Material: Brass or bronze.
- c. Ends: Threaded.
- d. Stem: Bronze.
- e. Disc: Bronze.
- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron, bronze, or aluminum.

**C. Globe Valves:**

**1. Description:**

- a. Pressure Rating: 175 psig.
- b. Body Material: Bronze with integral seat and screw-in bonnet.
- c. Ends: Threaded.
- d. Stem: Bronze.
- e. Disc Holder and Nut: Bronze.
- f. Disc Seat: Nitrile.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

**Section 21 05 18 – General-Duty Valves for Water-Based Fire-Suppression Piping**

3 - EXECUTION

3.1 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.

3.2 INSTALLATION, GENERAL

- A. Comply with requirements in the following Sections for specific valve-installation requirements and applications:
  - 1. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply, except from fire-department connections. Install permanent identification signs, indicating portion of system controlled by each valve.
- C. Install double-check valve assembly in each fire-protection water-supply connection.
- D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above the pipe center.
- F. Install valves in position to allow full stem movement.
- G. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the

**Section 21 05 18 – General-Duty Valves for Water-Based Fire-Suppression Piping**

piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END 21 05 23



**Section 21 05 18 – Identification for Fire-Suppression Piping and Equipment**

1 - GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Identification for Fire-suppression piping and equipment as shown and herein specified.
- B. Alternate Bids: N/A

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Stencils.
  - 5. Valve tags.
  - 6. Warning tags.

2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal 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.

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- f. emedco.
    - g. Kolbi Pipe Marker Co.
    - h. LEM Products Inc.
    - i. Marking Services, Inc.
  - 2. Material and Thickness: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
  - 3. Letter Color: White.
  - 4. Background Color: Red.
  - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 6. 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-fourths the size of principal lettering.
  - 7. Fasteners: Stainless-steel self-tapping screws.
  - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. 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. emedco.
    - g. Kolbi Pipe Marker Co.
    - h. LEM Products Inc.

**Section 21 05 18 – Identification for Fire-Suppression Piping and Equipment**

- i. Marking Services, Inc.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
3. Letter Color: White.
4. Background Color: Red.
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-fourths the size of principal lettering.
8. Fasteners: Stainless-steel self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. 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.
- D. 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.

**2.2 WARNING SIGNS AND 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.

**Section 21 05 18 – Identification for Fire-Suppression Piping and Equipment**

4. Champion America.
  5. Craftmark Pipe Markers.
  6. emedco.
  7. LEM Products Inc.
  8. Marking Sevices Inc.
  9. National Marker Company.
  10. Seton Identification Products.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
- C. Letter Color: White.
- D. Background Color: Red.
- 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-fourths the size of principal lettering.
- H. Fasteners: Stainless-steel self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information, plus emergency notification instructions.

**2.3 PIPE LABELS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  2. Brady Corporation.
  3. Brimar Industries, Inc.

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4. Carlton Industries, LP.
  5. Champion America.
  6. Craftmark Pipe Markers.
  7. emedco.
  8. Kolbi Pipe Marker Co.
  9. LEM Products Inc.
  10. Marking Services 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. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, 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.
- F. Pipe-Label Colors:
1. Background Color: Safety Red.
  2. Letter Color: White.

**2.4 STENCILS**

- A. Stencils for Piping:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brimar Industries, Inc.

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- b. Carlton Industries, LP.
  - c. Champion America.
  - d. Craftmark Pipe Markers.
  - e. Kolbi Pipe Marker Co.
- 2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
  - 3. Stencil Material: Brass.
  - 4. Stencil Paint: Safety Red, exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form.
  - 5. Identification Paint: White, exterior, acrylic enamel. Paint may be in pressurized spray-can form.

**2.5 VALVE TAGS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  - 2. Brady Corporation.
  - 3. Brimar Industries, Inc.
  - 4. Carlton Industries, LP.
  - 5. Champion America.
  - 6. Craftmark Pipe Markers.
  - 7. emedco.
  - 8. Kolbi Pipe Marker Co.
  - 9. LEM Products Inc.
  - 10. Marking Services 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 thick, with predrilled holes for attachment hardware.

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2. Fasteners: Brass beaded chain.
  3. Valve-Tag Color: Safety Red.
  4. Letter Color: White.
- 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.

**2.6 WARNING 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. emedco.
  7. Kolbi Pipe Marker Co.
  8. LEM Products Inc.
  9. Marking Services Inc.
- B. Description: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
1. Size: 3 by 5-1/4 inches minimum.
  2. Fasteners: Brass grommet and wire.
  3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  4. Color: Safety Yellow background with black lettering.

**Section 21 05 18 – Identification for Fire-Suppression Piping and Equipment**

3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Stenciled Pipe-Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
  - 1. Identification Paint: Use for contrasting background.
  - 2. Stencil Paint: Use for pipe marking.
- 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. 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.



**Section 21 05 18 – Identification for Fire-Suppression Piping and Equipment**

4. At access doors, manholes, and similar access points that permit a 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.

**3.5 VALVE-TAG INSTALLATION**

- A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
  1. Valve-Tag Size and Shape: 2 inches round.

**3.6 WARNING-TAG INSTALLATION**

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END 21 05 53

DIVISION 21 – FIRE PROTECTION  
**Section 21 11 19 – Fire Department Connections**

1 - GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design Build Contractor shall provide Fire department connections as shown and herein specified.
- B. Alternate Bids: N/A

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

- A. Section Includes:
  - 1. Flush-type fire-department connections.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

2 - PRODUCTS

2.1 FLUSH-TYPE FIRE-DEPARTMENT CONNECTION

- A. Standard: UL 405.
- B. Type: Flush, for wall mounting.
- C. Pressure Rating: 250 psig minimum.
- D. Body Material: Corrosion-resistant metal.
- E. Inlets: 4" Storz with 30-degree downturn
- F. Caps: Brass, lugged type, with gasket and chain.
- G. Escutcheon Plate: circular, brass, wall type.
- H. Outlet: With pipe threads.

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- I. Body Style: 30-degree downturn
- J. Number of Inlets: One
- K. Escutcheon Plate Marking: Similar to "AUTO SPKR."
- L. Finish: Polished chrome plated or as otherwise approved by architect

3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.
- B. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-type fire-department connections.
- B. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

END 21 11 19

1 - GENERAL

1.1 WORK INCLUDES

Base Bid: Design Build Contractor shall provide Wet-pipe sprinkler systems as shown and herein specified.

A. Alternate Bids: N/A

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Specialty valves.
3. Sprinklers.
4. Alarm devices.
5. Pressure gauges.

B. Related Requirements:

1. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 230523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.

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**Section 21 13 13 – Wet-Pipe Sprinkler Systems**

2. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

**1.5 INFORMATIONAL SUBMITTALS**

A. Coordination Drawings: Sprinkler systems, or BIM model, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.

B. Qualification Data: For qualified Installer.

C. Design Data:

1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Welding certificates.

E. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

2. Fire-hydrant flow test report.

F. Field quality-control reports.

**1.6 CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

**1.7 MAINTENANCE MATERIAL SUBMITTALS**

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

2 - PRODUCTS

2.1 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. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.

C. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.

1. Sprinkler system design shall be approved by authorities having jurisdiction.

- a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

- b. Sprinkler Occupancy Hazard Classifications: per drawings

2. Minimum Density for Automatic-Sprinkler Piping Design: per drawings

E. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7. See Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

2.2 STEEL PIPE AND FITTINGS

- A. Standard-Weight, Galvanized- and Black-Steel Pipe: ASTM A53/A53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 10, Black-Steel Pipe: ASTM A135/A135M or ASTM A795/A795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 plain end.
- C. Black-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
- D. Galvanized- and Uncoated-Steel Couplings: ASTM A865/A865M, threaded.
- E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- F. Malleable- or Ductile-Iron Unions: UL 860.
- G. Cast-Iron Flanges: ASME 16.1, Class 125.
- H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
  - 1. Pipe-Flange Gasket Materials: EPDM rubber gasket.
    - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
    - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
  - 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- I. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
  - 1. 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.
- J. Grooved-Joint, Steel-Pipe Appurtenances:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International.
    - b. National Fittings, Inc.

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- c. Shurjoint; a part of Aalberts Integrated piping Systems.
  - d. Smith-Cooper International.
  - e. Tyco by Johnson Controls Company.
  - f. Victaulic Company.
- 2. Pressure Rating: 175-psig minimum.
  - 3. Painted Grooved-End Fittings for Steel Piping: ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
  - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

**2.3 SPECIALTY VALVES**

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating:
  - 1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Automatic (Ball Drip) Drain Valves:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Reliable Automatic Sprinkler Co., Inc. (The).
    - b. Tyco by Johnson Controls Company.
  - 2. Standard: UL 1726.
  - 3. Pressure Rating: 175-psig minimum.
  - 4. Type: Automatic draining, ball check.



5. Size: NPS 3/4.
6. End Connections: Threaded.

## 2.4 AIR VENT

### A. Manual Air Vent/Valve:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AGF Manufacturing, Inc.
  - b. National Fittings, Inc.
  - c. Shurjoint; a part of Aalberts Integrated piping Systems.
  - d. Victaulic Company.
2. Description: Ball valve that requires human intervention to vent air.
3. Body: Forged brass.
4. Ends: Threaded.
5. Minimize Size: 1/2 inch.
6. Minimum Water Working Pressure Rating: 300 psig.

### B. Automatic Air Vent:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AGF Manufacturing, Inc.
  - b. CLA-VAL.
  - c. Engineered Corrosion Solutions.
  - d. Metraflex Company (The).
2. Description: Automatic air vent that automatically vents trapped air without human intervention.
3. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler systems.
4. Vents oxygen continuously from system.

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5. Float valve to prevent water discharge.
6. Minimum Water Working Pressure Rating: 175 psig.

C. Automatic Air Vent Assembly:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AGF Manufacturing, Inc.
  - b. Engineered Corrosion Solutions.
  - c. Potter Electric Signal Company, LLC.
  - d. South-Tek Systems, LLC.
2. Description: Automatic air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a pre-piped assembly.
3. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler system.
4. Vents oxygen continuously from system.
5. Float valve to prevent water discharge.
6. Minimum Water Working Pressure Rating: 175 psig.

2.5 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings below not permitted:

1. Type: Mechanical-tee and -cross fittings
2. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.

B. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AGF Manufacturing, Inc.
  - b. Tyco by Johnson Controls Company.
  - c. Victaulic Company.

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- d. Viking Corporation.
- 2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- 3. Pressure Rating: 175-psig minimum.
- 4. Body Material: Cast- or ductile-iron housing with sight glass.
- 5. Size: Same as connected piping.
- 6. Inlet and Outlet: Threaded.

**2.6 SPRINKLERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Reliable Automatic Sprinkler Co., Inc. (The).
  - 2. Tyco by Johnson Controls Company.
  - 3. Victaulic Company.
  - 4. Viking Corporation.
- B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- D. Automatic Sprinklers with Heat-Responsive Element:
  - 1. Early-Suppression, Fast-Response Applications: UL 1767.
  - 2. Nonresidential Applications: UL 199.
  - 3. Residential Applications: UL 1626.
  - 4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- E. Sprinkler Finishes: Chrome plated, bronze and painted.
- F. Special Coatings: nickel-teflon or equivalent.
- G. Sprinkler Guards:

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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Reliable Automatic Sprinkler Co., Inc. (The).
  - b. Tyco by Johnson Controls Company.
  - c. Victaulic Company.
  - d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

**2.7 ALARM DEVICES**

**A. Alarm-device types shall match piping and equipment connections.**

1. Strobe/Horn:
  - a. Standard: UL 464.
  - b. Tone: Selectable, steady, Temporal-3 (T-3) in accordance with ISO 8201 and ANSI/ASA S3.41, 2400 Hz, electromechanical, broadband.
  - c. Voltage: 120 V ac, 60 Hz.
  - d. Effective Intensity: 110 cd.
  - e. Finish: Red, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire."

**B. Water-Flow Indicators:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Potter Electric Signal Company, LLC.
  - b. System Sensor.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.

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4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

C. Pressure Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Potter Electric Signal Company, LLC.
  - b. System Sensor.
  - c. Tyco by Johnson Controls Company.
2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

D. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Fire-Lite Alarms; Honeywell International, Inc.
  - b. Potter Electric Signal Company, LLC.
  - c. System Sensor.
2. Standard: UL 346.
3. Type: Electrically supervised.

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4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.
6. 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.

**2.8 PRESSURE GAUGES**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  1. AGF Manufacturing, Inc.
  2. Ashcroft Inc.
  3. Brecco Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gauge Range: 0- to 250-psig minimum.
- E. Label: Include "WATER" label on dial face.

**3 - EXECUTION**

**3.1 PREPARATION**

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

**3.2 SERVICE-ENTRANCE PIPING**

- A. Connect sprinkler piping to water-service piping for service entrance to building.
- B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-service piping.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
  - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

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- M. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.
- N. Fill sprinkler system piping with water.
- O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

**3.4 JOINT CONSTRUCTION**

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. 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.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.



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1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

**3.5 VALVE AND SPECIALTIES INSTALLATION**

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
  1. Install valves in vertical position for proper direction of flow, in main supply to system.
  2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
  3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
- E. Air Vent:
  1. Provide at least one air vent at high point in each wet-pipe sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping.

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**Section 21 13 13 – Wet-Pipe Sprinkler Systems**

2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.
3. Pipe from outlet of air vent to drain.

**3.6 SPRINKLER INSTALLATION**

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

**3.7 IDENTIFICATION**

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

**3.8 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  1. Leak Test: After installation, charge systems 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.
  3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
  4. Energize circuits to electrical equipment and devices.
  5. Coordinate with fire-alarm tests. Operate as required.
  6. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.11 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded joints or grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- B. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
  - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  - 2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  - 3. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  - 4. Schedule 10 black-steel pipe with plain ends; welding fittings; and welded joints.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
  - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  - 2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

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3. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  5. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
  6. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  7. Schedule 10 black-steel pipe with plain ends; welding fittings; and welded joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:
1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  3. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  5. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
  6. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  7. Schedule 10 black-steel pipe with plain ends; welding fittings; and welded joints.

**3.12 SPRINKLER SCHEDULE**

- A. Use sprinkler types in subparagraphs below for the following applications:

DIVISION 21 – FIRE PROTECTION  
**Section 21 13 13 – Wet-Pipe Sprinkler Systems**

1. Rooms without Ceilings: Upright sprinklers.
  2. Rooms with Suspended Ceilings: Concealed sprinklers.
  3. Wall Mounting: Sidewall sprinklers.
  4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
  2. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
  3. Upright Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; nickel-teflon coated where exposed to acids, chemicals, or other corrosive fumes.

END 21 13 13

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

a. Plumbing system pumps including:

1.) Domestic hot water circulation

1.2 INFORMATIONAL SUBMITTALS

A. Shop Drawings including:

1. Pump curves.
2. Materials of construction.
3. Schedule of pumps.
4. Performance characteristics.
5. Data concerning physical dimensions.
6. Motor drive assemblies.
7. Bearings.
8. Seals.
9. Impellers capacities.
10. Weights.
11. Ratings.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Comply with applicable requirements of state and local plumbing codes including, but not limited to, NSF 61 requirements for devices used in potable water systems, and any other governmental agency under whose jurisdiction Work is being performed.

- B. Throughout project, use products of same manufacturer to greatest extent possible.

## 2. PRODUCTS

### 2.1 DESIGN REQUIREMENTS

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1,750 rpm unless otherwise noted.
- D. Pumps shall be capable of operating continuously over full operating range without overheating cavitating, excessive noise or vibration, surging or instability when operating in single or in parallel with other pumps.

### 2.2 WATER CIRCULATION PUMP

- A. Service: Domestic hot water circulation.
- B. Type: In-line circulating.
- C. Casing: Bronze or stainless steel, rated for 150 psi (1034 kPa) working pressure at 225°F (107°C).
- D. Impeller: Noryl.
- E. Shaft: Ceramic with carbon bearings lubricated by circulating fluid.
- F. Motor: Nonoverloading with impedance protection.

END 22 10 23

DIVISION 22 – PLUMBING  
**Section 22 15 19.13 – General Service Packaged  
Air Compressors**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor to provide rotary screw air compressors and accessories to serve pneumatic tools in the vehicle bays and atomizing air for the boilers' fuel oil system.

1.2 QUALITY ASSURANCE

- A. Air receivers shall meet requirements of ASME Code for Unfired Pressure Vessels and carry ASME approval stamp.

1.3 INFORMATIONAL SUBMITTALS

A. Product Data:

1. Manufacturer's catalog data marked to indicate materials furnished.
2. Instruction, operation, and maintenance manuals.
3. Complete manufacturer's parts manual, service manual, and wiring schematics.

B. Shop Drawings:

1. Certified outline and installation drawings for equipment installed.

C. Quality assurance data:

1. Inspector's certificate for air receiver for inclusion in operating and maintenance manuals.
2. ASME Code stamp certification for air receiver.
3. Noise level measurement test results.
4. Equipment performance data.

2. PRODUCTS

2.1 ROTARY SCREW AIR COMPRESSOR

- A. Type: Rotary screw, oil-flooded, single-stage.



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**Section 22 15 19.13 – General Service Packaged  
Air Compressors**

- B. Provide air capacity and quality as required by boiler manufacturer to continuously operate at full load on diesel fuel.
- C. Provide two units each rated at 50% total capacity.
- D. Compressor, controls, control panel, and accessories shall be completely piped and components preassembled and mounted on solid, heavy-gage steel base.
- E. Accessories:
  - 1. Disconnect switch and starter.
  - 2. Intake and discharge silencers, as required to meet noise level requirements.
  - 3. Inlet air filter.
  - 4. Sound attenuation enclosure.
  - 5. Pressure relief valve.
  - 6. Air-cooled oil cooler.
  - 7. Oil pump as required.
  - 8. Cooling fans as required.
- F. Controls:
  - 1. Microprocessor with finger-touch panel and LCD display.
  - 2. Provide interface with plant distributed control system for monitoring of status.
  - 3. Provide control power transformer for supplying power to controls.
- G. Noise requirements: Sound attenuation enclosure and silencers shall maintain noise levels below 85 dBA measured 5'-0" from unit.

END 22 15 19.13

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Cleanouts and cleanout access covers.
- b. Water hammer arresters.
- c. Thermostatic mixing valves.
- d. Drains.
- e. Trap primers.
- f. Wall hydrants.
- g. Hose bibbs.
- h. Backflow preventers.
- i. Acid waste neutralization tanks.
- j. Oil interceptors.

1.2 INFORMATIONAL SUBMITTALS

A. Product Data:

- 1. Include appropriate identification, model number, dimensions, materials of construction, connection locations and sizes, options, and wiring diagrams.
- 2. Manufacturer's installation instructions and maintenance manuals.

B. Quality assurance data: Backflow preventer test reports.

1.3 QUALITY ASSURANCE

- A. Comply with applicable requirements of state and local plumbing codes, and any other governmental agency under whose jurisdiction Work is being performed.
- B. Pressure vessels shall carry ASME stamp where required by Code.

- C. Natural gas and electric controls shall be UL-approved.
- D. Exposed piping and fittings in finished areas: Chromium-plated brass with polished finish.
- E. Throughout Project, use products of same manufacturer to greatest extent possible.
- F. Throughout project, use products of same manufacturer to greatest extent possible.

## 2. PRODUCTS

### 2.1 DESIGN REQUIREMENTS

- A. Coordinate drain outlets with joint types allowed by each pipe class specification. In general compression type outlets are acceptable for below grade outlets and no-hub type outlets are acceptable for above grade outlets.
- B. Drains shall have bottom outlet unless noted otherwise.

### 2.2 CLEANOUTS AND CLEANOUT ACCESS COVERS

- A. Floor-mounted cleanout:
  - 1. Access cover:
    - a. Unfinished areas: Round with nickel-bronze scored frames and plates.
    - b. Finished areas: Round with depressed center section to accommodate floor finish. Provide cleanout markers in carpeted areas.
- B. Wall-mounted cleanout:

- 1. Access cover.

### 2.3 WATER HAMMER ARRESTERS

- A. Description: Stainless steel bellows-type water hammer arresters installed on water lines connected to solenoid valves, flush valves, and fixture or group fixtures complete with an accessible isolation valve.
- B. Size: In accordance with PDI WH-201 and requirements of plumbing code.

2.4 FLOOR DRAINS

A. Description: Coated cast-iron body.

1. Strainer: Adjustable, standard weight, round, vandalproof.
2. Finish: Nickel bronze.
3. Provide 1/2" (13 mm) connection for trap primer.

2.5 TRENCH DRAIN

A. Description: 12" (300 mm) wide cast-iron multiple section trench drain with flange.

B. Grate: Heavy-duty ductile iron loose set.

2.6 AREA DRAINS

A. Description: Coated cast-iron area drain with flashing clamping flange, and weep holes..

B. Grate: Loose set ductile iron tractor-type.

C. Provide 1/2" (13 mm) connection for trap primer.

2.7 ROOF DRAIN

A. Description: Coated cast-iron body.

B. Strainer: Large cast-iron beehive locking dome-type.

C. Provide Under deck clamp for securing drain to roof deck and extension to allow for insulation thickness.

2.8 TRAP PRIMER VALVES

A. Description: Lead free all bronze primer valve with removable operating parts and integral vacuum breaker.

B. Size: 1/2" (13 mm).

2.9 WALL HYDRANTS

A. Designation on Drawings: WH.

1. Description: Freezeless-type concealed box-type with concealed hose connection, hinged latching cover, integral vacuum breaker, pressure relief valve, bronze casing and operating parts, 3/4" (19

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**Section 22 30 00 – Plumbing Equipment**

mm) female or 1" (25 mm) male NPT inlet connection and loose tee key for valve operation.

2. Hydrant casing shall extend into building 2" (50 mm) past inside face of wall. Contractor shall determine wall thickness.
3. Exterior finish: Chrome-plated.

2.10 HOSE BIBBS

- A. Designation on Drawings: HB.
- B. Description: Hose bibb with wheel handle, vacuum breaker, and rough brass finish.

2.11 BACKFLOW PREVENTERS

- A. Designation on Drawings: BFP.
  1. Description: Reduced pressure type.
  2. ¾" through 2" (19 mm through 50 mm):
    - a. Construction:
      - 1.) Reduced pressure assembly: Consists of differential pressure relief valve located between 2 independently acting "Y" pattern check valves, 2 full ported ball valve shut-offs, and 4 test cocks.
      - 2.) Mainline valve body and caps, including relief valve body and cover: Bronze with stainless steel internals.
      - 3.) Check valves: Center stem guided.
      - 4.) Seat discs: Reversible.
      - 5.) Relief valve: Provide with removable seat ring.
    - b. Assembly: Certified in compliance with ASSE 1013, AWWA C511-89, CAN/CSA B64.4, and approved by Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California.
  3. 2-1/2" through 10" (64 mm through 250 mm):
    - a. Construction:

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- 1.) Reduced pressure assembly: Consists of differential pressure relief valve located between 2 independently acting check valves, 2 resilient seated nonrising stem (NRS) shut-offs and 4 test cocks.
  - 2.) Main body: No threads tapped directly into body, uni-body, ductile iron-type construction with 100% fusion epoxy coating.
  - 3.) No special tools shall be required for maintenance.
- b. Assembly: Certified in compliance with ASSE 1013, AWWA, CSA B64.4 and approved by Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California.

**B. Designation on Drawings: BFP.**

1. Description: Double check valve type.
2. ½” through 2” (13 mm through 50 mm):
  - a. Construction:
    - 1.) Double check valve assembly: Consists of 2 independently acting check valves, 2 ball-type shutoff valves, and 4 test cocks.
    - 2.) Main body: Cast bronze.
  - b. No special tools shall be required for maintenance.
  - c. Certified in compliance with ASSE 1015, AWWA C510, CSA, UL, FM and foundation for cross connection control and hydraulic research at the University of Southern California.
3. 2-1/2” through 10” (64 mm through 250 mm):
  - a. Construction:
    - 1.) Double check valve assembly: Consists of 2 independently acting check valves, 2 resilient seated outside stem and yoke (OS&Y) shutoff valves, and 4 test cocks.
    - 2.) Main body: No threads tapped directly into body, uni-body, and ductile iron-type construction with fused epoxy coating.

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- b. No special tools shall be required for maintenance.
- c. Certified in compliance with ASSE 1015, AWWA C510, CSA B64.5, UL, FM, and Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California.

2.12 WATER METERS

- A. Accurate reading flows from 2-100 gpm at 75 psi.
- B. Coordinate selection with AHJ.

2.13 OIL INTERCEPTORS

- A. Designation on Drawings: OS.

1. Description:

- a. 1/4" (6 mm) epoxy-coated, double-walled, welded steel separator with inlet, outlet, vent, visible double-wall outside trap seal, nonremovable separator screen with removable filter screen.
- b. Separator: Completely unrestricted/unconfined accessible.

2. Accessories:

- a. Cover: 3/8" (10 mm) diamond plate, heavy traffic type for flush with floor installation.
- b. Sediment basket.
- c. Integral extension as scheduled.

END 22 30 00

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Gas-fired water heaters.

1.2 INFORMATIONAL SUBMITTALS

A. Product Data:

- 1. Include appropriate identification, model number, dimensions, materials of construction, connection locations and sizes, options, and wiring diagrams.
- 2. Manufacturer's installation instructions and maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Comply with applicable requirements of state and local plumbing codes, and any other governmental agency under whose jurisdiction Work is being performed.
- B. Pressure vessels shall carry ASME stamp where required by Code.
- C. Natural gas and electric controls shall be UL-approved.
- D. Natural gas heaters shall be approved by AGA.
- E. Throughout project, use products of same manufacturer to greatest extent possible.

2. PRODUCTS

2.1 GAS-FIRED WATER HEATERS

A. Condensing, direct vent:

- 1. Description: Vertical, condensing, direct-vent natural gas water heater with standard legs.
- 2. Tank. Glass-lined steel with foam insulation and steel jacket with backed enamel finish.
- 3. Water heater shall meet requirements of ASHRAE 90.1.



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**Section 22 33 00 – Domestic Water Heaters**

4. Burner: Direct-vent condensing-type with power burner factory mounted and wired.
5. Provide electronic intermittent ignition and integrated control system to maintain water heater at set point.
6. Provide shutoff valve and dielectric union on cold water inlet and hot water outlet of heater.
7. Power: 120 volts, 60 Hz, single-phase.
8. Accessories:
  - a. Hose bibb connection.
  - b. ASME-rated temperature and pressure relief valve.
  - c. ASME-rated vacuum breaker.
  - d. Anode rods for corrosion protection.
  - e. Gas pressure regulator capable of reducing gas pressure from service pressure to water heater requirements.
9. Flue and Venting: Provide flue and venting in accordance with manufacturer's requirements.

END 22 33 00

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Water closets, urinals, and associated flush valves.
- b. Lavatories, sinks and associated faucets and aerators.
- c. Showers and shower faucets.
- d. Emergency eyewash and showers.
- e. Water coolers.
- f. Accessories.

1.2 INFORMATIONAL SUBMITTALS

A. Product Data:

- 1. Include appropriate identification, model number, dimensions, materials of construction, flow, connection locations and sizes, options, and wiring diagrams.
- 2. Manufacturer's installation instructions.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance manuals.

1.4 QUALITY ASSURANCE

A. Regulatory requirements:

- 1. Work shall comply with applicable state and local plumbing codes including but not limited to NSF 61 requirements for Faucets and fixtures fittings that supply drinking water for human ingestion.
- 2. Plumbing fittings shall include necessary devices to conserve water in accordance with requirements of International Energy Conservation Code
- 3. Water flow and consumption rates for plumbing fixtures: Comply with requirements in Public Law 102-486, Energy Policy Act.

- B. Fixtures, trim, and accessories shall be product of one manufacturer to greatest extent practicable.

## 2. PRODUCTS

### 2.1 DESIGN REQUIREMENTS

- A. Fixtures shall be new, free from flaws and blemishes with finished surfaces clear, smooth, and bright.
- B. Provide matching plumbing fittings. Visible parts of fixture brass and accessories shall be heavily chrome-plated.
- C. Provide suitable carriers as necessary.
- D. Provide wall stops at plumbing fixtures.

### 2.2 WATER CLOSETS

- A. Description: Wall-mounted, top spud, vitreous china, siphon-jet, elongated.
- B. Accessories:
  - 1. Flush valve.
  - 2. Seat: Heavy-duty plastic with self-sustaining check hinge and open front.

### 2.3 URINALS

- A. Description: Wall-mounted, vitreous china, siphon jet.
  - 1. Accessories:
    - a. Flush valve.

### 2.4 LAVATORIES

- A. Description: Wall-hung, 20" x 18" (500 mm x 450 mm), vitreous china with soap dispenser and overflow.
- B. Accessories:
  - 1. Angle valves close to or at wall with stop cocks and wall flanges.
  - 2. Adjustable, cast brass, 1-1/4" (30 mm) waste "P"-trap with cleanout.

3. Faucet.
4. Drain and tailpiece.

## 2.5 SINKS

- A. Description: 19" x 19" (475 mm x 475 mm), self-rimming, 18-gage stainless steel bar sink. Provide sound deadening material.
- B. Accessories:
  1. Angle valves close to or at wall with stop cocks and wall flanges.
  2. Adjustable, cast brass, 1-1/2" (38 mm) waste "P"-trap with cleanout.
  3. Faucet.
  4. Drain and tailpiece.

## 2.6 SERVICE SINKS

- A. Designation on Drawings: JSS.
- B. Description: Acid-resisting, enameled cast iron service sink with blank back, stainless steel rim guard, and wall hanger supports.
- C. Accessories:
  1. Faucet.
  2. Trap: Adjustable for 2" (50 mm) connection with cleanout plug strainer.

## 2.7 SHOWERS

- A. Designation: SH.
  1. Type: Field-constructed.
- B. Designation: SH.
  1. Type: Field-constructed, ADA-compliant, transfer.
  2. Provide grab bars, transfer seat

## 2.8 EMERGENCY EYE WASH AND SHOWER

- A. Designation on Drawings: EEWS.

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B. Description: Free-standing combination eyewash and shower.

C. Accessories:

1. Privacy curtain.
2. Scald protection valve.
3. Flow switch and alarm.
4. Thermostatic mixing valve.

2.9 ELECTRIC WATER COOLER

A. Designation on Drawings: EWC

B. Description: ADA-compliant, self-contained, refrigerated, double-basin type with self-closing controls on front and both sides.

END 22 40 00

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 05 93 – Testing Adjusting and Balancing for HVAC**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Procedures, general.
- b. Final reports.
- c. Contractor responsibilities.
- d. Preparation.
- e. Schedule of systems requiring testing, adjusting, and balancing services.

1.2 INFORMATIONAL SUBMITTALS

- A. Prior to start of Work, submit name of organization proposed to perform services. Designate managerial responsibilities for coordination of entire testing, adjusting, and balancing.
- B. Submit documentation to confirm organization qualifications.
- C. Submit 3 preliminary specimen copies of each of report forms proposed for use.
- D. Fifteen days prior to Substantial Completion, submit 3 copies of final reports. Submit reports of testing, adjusting, and balancing which is postponed due to seasonal, climatic, occupancy, or other reasons beyond Contractor's control, promptly after execution of those services.
- E. Schedule of start-up to Engineer.
- F. Contractor shall prepare instrument calibration reports in duplicate for each instrument and control loop. Include instrument calibration data and status of equipment. Note any deficiencies yet to be corrected on instruments that are suitable for operation (e.g.: broken lenses, faulty local indicators on transmitters that can still perform correct output transmission) Contractor shall correct these deficiencies at earliest possible date. Copies shall be submitted for Resident Project Representative's review. Each calibration report shall be signed by Contractor's representative witnessing test.

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**Section 23 05 93 – Testing Adjusting and Balancing for HVAC**

1. Electrical systems test reports: Typewritten, listing equipment used, person or persons performing tests, date tested, circuits tested, and results of tests.
2. Environmental test reports:
  - a. Preliminary:
    - 1.) Submit 3 copies of documentation to confirm compliance with quality assurance provisions:
      - a.) Organization supervisor and personnel training and qualifications.
      - b.) Specimen copy of each report form proposed for use.
    - 2.) Second: At least 15 days prior to starting field work, submit 3 copies of:
      - a.) Set of report forms filled out as to design flow values and installed equipment pressure drops, and required cfm for air terminals.
      - b.) Complete list of instruments proposed to be used, organized in appropriate categories, with data sheets for each. Show discrepancies noted between data shown and Contract Documents, additional, or more accurate, instruments required, and requests for re-calibration of specific instruments.
    - 3.) Third: At least 15 days prior to Contractor's request for final inspection, submit three copies of final reports, on applicable reporting forms, for review.
      - a.) Schedule testing and balancing of parts of systems which is delayed due to seasonal, climatic, occupancy, or other conditions beyond control of Contractor, as early as proper conditions will allow, after consultation with Engineer.
      - b.) Submit report of delayed testing promptly after execution of those services.
  - b. Form of final reports:
    - 1.) Each individual final reporting form must bear signature of person who recorded data and that of testing, adjusting, and balancing supervisor of reporting organization.
    - 2.) When more than 1 certified organization performs testing, adjusting, and balancing services, firm having managerial responsibility shall make submittals.

**DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING**  
**Section 23 05 93 – Testing Adjusting and Balancing for HVAC**

- 3.) Identify instruments of types that were used, and last date of calibration of each.
  - 4.) Record and submit all data measured including air flow, liquid flows, pressure drops, motor loads and all other data requested in this Section.
- G. At completion of Work, Contractor shall submit to User certification that equipment has been commissioned and is in operating condition in accordance with Contract Documents.
- H. Final reports:
1. Organization having managerial responsibility shall make reports.
  2. Each form: Bear signature of recorder, and that of supervisor of reporting organization.
  3. Identify each instrument used and latest date of calibration of each.

**1.3 QUALITY ASSURANCE**

- A. Comply with procedural standards of certifying association under whose standards service will be performed.
- B. Accurately record data for each step.
- C. Comply with applicable procedures and standards of certification sponsoring association; either:
1. "National Standards for Field Measurements and Instrumentation, Total Systems Balance, Air Distribution-Hydronics Systems," by AABC, International Standards for Environmental Systems Balance" by TABB, or "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems," by NEBB.
  2. Perform services under direction of supervisor who is designated and qualified under certification requirements of sponsoring association.
  3. Calibration and maintenance of instruments shall be in accordance with requirements of standards, and calibration histories for each instrument shall be available for examination.
  4. Accuracy of measurements shall comply with requirements of standards.
- D. Comply fully with procedural standards of certifying association under whose standards service will be performed.



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1. Execute each step of prescribed testing, adjusting, and balancing procedures without omission.
2. Accurately record required data.

1.4 COORDINATION

- A. Coordinate services with Work of various trades to ensure rapid completion of services.
- B. Promptly report to Engineer any deficiencies noted during performance of services.

2. PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. Prepare each system for testing and balancing.
- B. Cooperate with testing organization, provide access to equipment and systems. Operate systems at designated times, and under conditions required for proper testing, adjusting, and balancing.
- C. Perform specified services with Contractor's qualified personnel, or employ and pay for qualified organization to perform specified services.
- D. Perform testing of control station equipment, balancing of distribution system, and adjustment of terminal devices for HVAC systems of Project.
- E. Perform testing of hydronic systems, adjust and record liquid flow at each piece of equipment.
- F. Provide instruments required for testing, adjusting, and balancing operations.
  1. Make instruments available to Engineer to facilitate spot checks during testing.
  2. Retain possession of instruments; remove from Site at completion of services.
- G. Furnish material, tools, and labor required to perform start-up of each respective item of equipment, instrument and system:
- H. Provide information and assistance required, cooperate with test, adjust, and balance services.

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- I. Comply strictly with specified manufacturer's procedures in starting up specified systems.

2.2 MATERIALS

- A. Provide and maintain tools and test equipment in first-class condition and quantities sufficient to assure successful performance and completion of required Work.
- B. Furnish and use materials in accordance with these Specifications. Materials shall be of first-class quality, free from defects or imperfections, of recent manufacture, unused and of classification and grade specified.
- C. Test equipment shall have recent calibration checks by equipment manufacturer or authorized facility to assure accuracy of commissioning process.
- D. Piping system joint leak testing compound.
- E. Anti-rust compound for packing gland threads and valve stems.

END 23 05 93

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**Section 23 09 13 – Instrumentation and Control Devices for HVAC**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. HVAC instrumentation for use with control system.

1.2 INFORMATIONAL SUBMITTALS

A. Data Sheets for control components.

B. Complete instruction manual covering function and operation of control components.

C. Bill of Materials.

1.3 QUALITY ASSURANCE

A. Manufacturer shall guarantee control device installed under this Specification to be free from defects in workmanship and material under normal use for a period of one year from date of acceptance of building by User.

B. Replace defective material or workmanship within guarantee period, immediately, without cost to User.

C. Control devices shall be by same manufacturer insofar as practicable. Control devices shall be provided by control system manufacturer unless noted otherwise.

1.4 WARRANTY

A. HVAC systems and products shall be provided with a minimum two-year warranty.

2. PRODUCTS

2.1 THERMOSTATS AND TEMPERATURE SENSORS

A. Electronic immersion and duct temperature sensor:

- 1. Length: Minimum 8' (2.4 m). Provide 1' (300 mm) of sensor for each sq. ft. (sq m) of duct cross section.

- 2. Element: Nickel averaging type.

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3. Accuracy: ( $\pm 1^{\circ}\text{C}$ ).
4. Provide mounting plate, enclosure with cover, conduit connector and wire nuts.

**B. Electronic space, single-temperature thermostat:**

1. Element: Single, bimetal.
2. Direct or reverse acting, as required for application.
3. Fully proportional with adjustable throttling range and sensitivity.
4. Satin chrome metal, locking type cover with concealed set point and visible thermometer. Suitable for institutional use.

**C. Freeze thermostat:**

1. 2-position, electric-type, normally closed.
2. Manual reset.
3. 20' (6 m) sensing element shall cause circuit to open when any 1' (300 mm) section falls below temperature set point.
4. Provide minimum of one 20' (6 m) element for every 15 sq. ft. (1.4 sq m) of coil face area.

**D. Electronic space temperature sensor with set point adjustment:**

1. Single- or dual-scaled set point adjustment as required for application.
2. Sensor: Nickel or platinum 1000-ohm resistance type.
3. Accuracy: ( $\pm 1^{\circ}\text{C}$ ) ( $\pm 1^{\circ}\text{C}$ ).
4. Override button: Integral momentary pushbutton.
5. Locking cover with concealed set point and thermometer, suitable for institutional use.

**2.2 HUMIDITY SENSORS**

**A. Type: Electronic, duct:**

1. Element: Polymer.

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2. Sensing tube shall have sufficient length to measure average duct humidity.
3. Temperature compensated.
4. Operational range: 10% to 100%.
5. Accuracy:  $\pm 3\%$  RH for 5 to 95% RH and  $\pm 5\%$  for 0 to 5% and 95 to 100% RH.

B. Type: Electronic, room.

1. Element: All polymer.
2. Temperature compensated.
3. Operational range: 0% to 10% RH.
4. Accuracy:  $\pm 3\%$  RH for 5 to 95% RH and  $\pm 5\%$  for 0 to 5% and 95 to 100% RH.

2.3 SENSORS

A. Type: Temperature.

1. Type: 1000-ohm resistance.
2. Element: Nickel, platinum, or silicon.
3. Accuracy: ( $\pm 1^{\circ}\text{C}$ ).

B. Type: Dew point.

1. Accuracy:  $\pm 1.5^{\circ}\text{F}$ .
2. Dew point range:  $-50^{\circ}\text{F}$  to  $140^{\circ}\text{F}$  ( $10^{\circ}\text{C}$  to  $60^{\circ}\text{C}$ ).
3. Relative humidity range: 12-100%.
4. Pressure range: 0-125 psia.

C. Provide dew point sensor kit.

2.4 DUCT PRESSURE TRANSMITTER

A. Type: Electronic:

1. Power: 24 volts dc.

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2. Output: 4 to 20 mA.
3. Operational pressure range suitable for application.
4. Temperature limits: 0°F to 175°F (-18°C to 79°C).
5. Accuracy:  $\pm 1\%$  full span including nonlinear hysteresis, and nonrepeatability.

**2.5 LOW DIFFERENTIAL PRESSURE TRANSMITTER AND GAGE**

- A. Diameter: 4" (100 mm).
- B. Pressure range: 0 to 2" (0 to 50 mm) or 0 to 6" (0 to 150 mm), as appropriate for installation.
- C. Power: 24 volts dc.
- D. Output: 4 to 20 mA.
- E. Accuracy:  $\pm 2\%$  full span output.

**2.6 DUCT VELOCITY SENSOR/CONTROLLER**

- A. Type: Electronic.

**2.7 CONTROL DAMPERS**

- A. Materials of construction: 13-gage galvanized sheet steel frame formed into channels and spot welded.
- B. Bearings: Oil-impregnated sintered bronze.
- C. Seals: Synthetic elastomer seals on blade edge and ends
- D. Temperature limits: -20°F to 200°F (-29°C to 93°C).
- E. Leakage: 0.5% at 4" w.g. static pressure and 2,000 ft/min (610 m/min) velocity.
- F. Action: Opposed or parallel
- G. 16-gage (1.5 mm) galvanized steel blades, not over 8" (200 mm) in width.

**2.8 DAMPER ACTUATORS**

- A. Type: Electronic.

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1. Power: 24 volts ac or volts dc, to suit application.
2. Size adequate to provide smooth modulating action or 2-position action, as required.
3. Input: 0 - 10 volts dc or 4-20 mA, as required.
4. Output feedback.
5. Enclosure: NEMA 3R.
6. Spring return: As required.

**2.9 CONTROL VALVES**

**A. Type: 2-way (water service).**

1. Equal percentage throttling plugs.
2. Construction:
  - a. 2" (50 mm) and smaller: ASTM B61 bronze body, screwed ends.
  - b. 2-1/2" (64 mm) and larger: ASTM A126 cast iron body, bronze trim.
3. Pressure class: 150 psig.
4. Packless type with bellows seal.
5. Provide positive positioners.

**B. Type: Modulating steam valve.**

1. Normally closed.
2. Equal percentage throttling plug.
3. Brass seat, stainless steel stems.
4. Replaceable composition disc.
5. Construction:
  - a. 2" (50 mm) and smaller: ASTM B61 bronze body, screwed ends

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b. 2-1/2" (64 mm) and larger: ASTM A126 cast iron body, bronze trim.

6. Pressure class: 150 psig.

7. Provide positive positioners where needed.

**2.10 CONTROL VALVE ACTUATORS**

A. Type: Low-voltage, electronic.

1. Power: 24 volts ac or volts dc, to suit application.

2. Size: Adequate to provide smooth modulating action or 2-position action, as required.

3. Input: 0 to 10 volts dc or 4 to 20 mA, as required.

4. Output feedback.

5. Spring return: As required.

**2.11 AIR FLOW RATE MEASUREMENT STATIONS**

A. Construction: 16-gage (1.5 mm) galvanized steel, epoxy-coated in fume exhaust applications. Copper air straighteners, sensor, and manifolds.

B. Dimensions: Equal to duct dimensions where mounted.

C. Furnish with pressure to electric transducer for static and total pressure measurement.

**2.12 AQUASTATS**

A. Type: Line-voltage.

B. Single-pole, single-throw switching.

C. Rating: Adequate for applied load, minimum 10.0 amperes at 120 volts.

D. Dial range: 100°F to 240°F (38°C to 116°C) or 60°F to 130°F (16°C to 54°C), depending on application.

**2.13 GAGES**



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A. Type: Indication receiver.

1. Diameter: 3" (75 mm).
2. Mounting: Panel flush-mounted.
3. Pressure range: 0 to 20 psig.
4. Scale: °F, inches w. g., % RH with ranges appropriate to application.

B. Type: Low differential pressure.

1. Diameter: 4" (100 mm).
2. Mounting: Flush.
3. Pressure range: 0 to 2" (0 to 50 mm), 0 to 8" (0 to 200 mm) as appropriate for installation.

**2.14 THERMOMETERS**

A. Type: Dial.

1. Diameter: 4-1/2" (115 mm).
2. Mounting: Direct swivel type.
3. Scale: -20°F to 110°F (-29°C to 43°C), 0°F to 260°F (-18°C to 127°C).
4. Graduations: 2°F.
5. Element: Liquid-filled, copper, bulb or averaging type, suitable for installation.

**2.15 CONTROL STEP-DOWN TRANSFORMER**

A. Primary voltage: 120 volts, 60 Hz, single-phase.

B. Secondary voltage: 24 volts ac.

C. Size: As required to power control devices.

**2.16 TRANSDUCERS**

A. Type: Current.

1. Output: 4-20 mA or 0 to 10 volts dc.

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2. Accuracy:  $\pm 1\%$ .
3. Select transducer for normal measured amperage to be near 50% of full scale range.
4. Provide transducer for monitoring amperage of motors.

END 23 09 13

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**SECTION 23 09 33 – Instrumentation and Control**  
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1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design-Build Contractor.
- B. Alternate Bids: Not applicable.

1.2 SUMMARY

- A. Furnish and install a complete PLC based control system as shown on the drawings and as specified herein, including but not limited to the following:
  - 1. Complete Burner Management System (BMS) for each of Steam Generators.
  - 2. Complete Combustion Control System (CCS) for each of Steam Generators.
  - 3. Interface with campus Supervisory Monitoring System.
  - 4. Associated solid state PLC based controls and software.
- B. Install products and materials as shown on the drawings and as specified herein, including but not limited to the following:
  - 1. Boiler Control System
    - a. Each Boiler Control System shall be factory equipped with a pre-configured Programmable Controller and a 7 or optional 10 inch color touch screen Human Machine Interface (HMI).
  - 2. Master Panel
  - 3. Deaerator Control
    - a. Each system shall be factory equipped with a pre-configured programmable Controller and Human Machine Interface.
    - b. System shall provide control logic for the following:
      - 1) 1-4 feed pumps and 1-3 transfer pumps (6 pumps maximum)
      - 2) Make up water level control for DA tank or DA and Surge
      - 3) Low Water, Hi Water, and Aux Low Water alarms
      - 4) Chemical feed control

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4. The enclosure shall be NEMA-12 and shall contain internal lighting and power receptacles for maintenance activities. All panels shall be pre-wired and tested, and shall include testing protocol, test results, wiring diagrams, and general-arrangement drawings.
5. Control Systems shall be engineered, manufactured and tested in a UL-Listed Panel Shop and shall meet or exceed the requirements of NFPA-85. Provide normal and UPS power supplies, all power and control wiring, relays, contacts, switches, and other electrical specialties.
6. Instrumentation components.
7. Provide network bus and tie-ins to the plant DCS.

1.3 DEFINITIONS

- A. DCS: Distributed Control System
- B. DDC: Direct digital control.
- C. EMV: Electrically Motorized Valve
- D. HMI: Human-Machine Interface
- E. I/O: Input/output.
- F. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- G. PC: Personal computer.
- H. PID: Proportional plus integral plus derivative.
- I. PLC: Programmable Logic Controller
- J. RTD: Resistance temperature detector.

1.4 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
  1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducer

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ers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
  3. 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.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
  2. List connected data points, including connected control unit and input device.
  3. Indicate system graphics indicating monitored systems, data connected and calculated point addresses, and operator notations. Provide demonstration discs containing graphics.
  4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, and interconnections.
  5. Indicate description and sequence of operation of operating, user, and application software.
  6. Ensure terminology used in submittals conforms to ASME MC85.1 and NEMA EMC1.
  7. Bill of materials of equipment indicating quantity, manufacturer, and model number.
  8. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
  9. Wiring Diagrams: Power, signal, and control wiring.
  10. Details of control panel faces, including controls, instruments, and labeling.
  11. Schedule of dampers and actuators including size, leakage, and flow characteristics.

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12. Schedule of valves and actuators including flow characteristics.
13. System Hardware:
  - a. Wiring diagrams for control units with termination numbers.
  - b. Schematic diagrams and floor plans for field sensors and control hardware.
  - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
14. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
15. Controlled Systems:
  - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
  - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
  - c. Written description of sequence of operation including schematic diagram.
  - d. Points list.
- C. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
- D. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

1.5 INFORMATIONAL SUBMITTALS

- A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- B. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks.
- C. Qualification Data: For Installer and manufacturer.
- D. Software Upgrade Kit: For User to use in modifying software to suit future systems revisions or monitoring and control revisions.

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E. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For Steam Generator control field devices and instrumentation to include normal and emergency operation and maintenance manuals. Operation and Maintenance Data shall include but not be limited to the following:

1. Maintenance instructions and lists of spare parts for each type of control device used on the project.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration procedures and tolerances.
5. Calibration records and list of set points.

B. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On electronic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. 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.

C. Comply with ASHRAE 135 for DDC system components.

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1.8 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

- A. Field Measurements - Before proceeding with the fabrication of the work, the Contractor shall verify all dimensions and take such measurements as are required for proper fabrication and erection of the work.
- B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- C. Coordinate equipment with Division 26 "Variable Frequency Drives" to achieve compatibility with variable frequency drives and annunciation devices.

2. PRODUCTS

2.1 BOILER CONTROL SYSTEM MAJOR SYSTEM COMPONENTS

- A. Major system components shall include:
  - 1. Rockwell/Allen Bradley Compact Logix Programmable Control Processor.
  - 2. 7 Inch Panel View Plus Color Touch Screen HMI.
  - 3. Local Modbus network for communications with Parallel Positioning Actuators, and Burner Management Control
  - 4. Various Controller Input/Output Modules.
  - 5. One Burner Management Controller and Wiring Sub-Base.
  - 6. One Flame Scanner: Infrared, Ultra-Violet, or UV Self-Check.
  - 7. One Flame Amplifier, to correspond with the selected Flame Scanner.
  - 8. Various Temperature and Pressure Sensors.
  - 9. Alarm Bell
- B. Major functions that the Boiler Control System shall provide:



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1. Automatic sequencing of the boiler through standby, pre-purge, pilot flame establishing period, main flame establishing period, run and post purge.
2. Flame proving and lockout on flame failure during pilot flame proving, main flame proving, or run.
3. Low fire damper/valve position for flame ignition trials.
4. Parallel Positioning Combustion Control for Air and maximum 3 Fuels
5. Optional Variable Speed Drive on Combustion Air Fan Blower Motor
6. Optional O2 Trim (Air Trim)
7. Optional Integrated Draft Control (requires external damper, low draft switch and draft transmitter. BOILER damper assembly includes these items as a standard)
8. Utilize solid state controls and sensors to provide various control functions, such as:
  - a. Parallel Positioning Full Modulation
  - b. Modulating Control algorithm shall be Proportional-Integral-Derivative (PID) type.
  - c. Thermal Shock Protection with water temperature monitoring and set point.
  - d. Various High and Low limit alarms and shutdowns.
9. Touch Screen graphical operator interface and monitoring.
  - a. Minimum 7 Inch Panel View Plus Color HMI.
  - b. Manual control of the boiler-firing rate utilizing control screens on the HMI to increment and decrement the firing rate.
  - c. Interface to commission boilers combustion and other system set points
  - d. On screen real-time display of all connected process parameters.
  - e. On screen commissioning of boiler set points and configurable alarms
  - f. On screen display of system alarms and faults.

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- g. On screen water level indication
  - 10. HMI screens published via integrated web server in HMI
  - 11. Ethernet communications to Variable Speed Drive (if used)
  - 12. E-mail of boiler alarms.
  - 13. Building/Plant Automation System interface (May require protocol translator based on actual communication protocol interface required)
  - 14. High Stack Flue Gas Temperature Monitoring, Cut-Off and Alarm
  - 15. Tamper resistant control logic and password protection.
  - 16. Dual Set Point (Night/Day Set Back) Capabilities.
  - 17. Combustion Air Temperature (Optional).
  - 18. Boiler Shell Water Temperature (Steam Boilers).
  - 19. Boiler Drum Water Level Indication
  - 20. Outdoor Reset for Hot Water Boilers (Optional).
  - 21. Return Hot Water Temperature (optional and only if outdoor reset is not used)
  - 22. Remote Modulation (Not available if two boiler Lead/Lag is used)
  - 23. Remote Firing Rate Set Point control (optional and only if Remote Modulation is not used. Not available if two boiler lead/lag is used)
  - 24. Assured Low Fire Cut-Off (ALFCO). (Used to remote stop/start the burner)
  - 25. 2 Boiler Lead/Lag (Optional – Common Header Transmitter required)
  - 26. Hot Stand By
  - 27. PLC based expanded diagnostics with 3 Auxiliary Discrete (Digital) in puts (Only 2 available if draft control is used)
  - 28. Optional Single Point (jack shaft) Control
  - 29. Alarm Silencer via touch screen HMI
- C. The Boiler Control System shall provide the following safety provisions for:

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1. Integrated Burner Management
  - a. Examine all load terminals to assure it is capable of recognizing the true status of the external controls, limits and interlocks. If any input fails this test, the burner management system should lockout on safety shutdown.
  - b. Closed-loop logic test verifies integrity of safety critical loads (ignition, pilot, and main fuel valves) and must be able to lockout on safety shutdown if any safety critical load is identified as proper or improper.
  - c. Pre-ignition interlocks (fuel valve proof of closure, etc.) and flames signal checked during Standby and Pre-Purge.
  - d. Dynamic checking of the flame signal amplifier. The control flame signal amplifier must be able to recognize a no flame signal during this dynamic amplifier check.
  - e. Safe start check and expand check to include monitoring flame signal during standby.
  - f. High and Low fire relays checked for proper sequencing.
  - g. Tamper-proof Purge Timing and safety logic.
2. Integrated Boiler Operating Controls and Security features
  - a. Operating and Modulating Control.
  - b. Password protection of Programmable Controller logic.
  - c. Password protection of Parallel Positioning Set Up and Commissioning screens
  - d. Password protection of Critical Set Point Screens
3. The Boiler Control System shall provide annunciation and diagnostics:
  - a. Active Alarm Annunciation
  - b. Provide historical alarm information for on screen display
  - c. Indication of failures at start up or during normal operation.
  - d. Capability of alarm history of date, time, cycle of occurrence and date and time of acknowledgement up to the most recent 100 faults.
  - e. Detects and isolates an alarm, and reports internal circuit faults.

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- f. Primary and Secondary Low Water Shutdown and Alarms.
- 4. The Boiler Control System shall be able to operate in these environmental conditions.
  - a. Supply Voltage: 120vac (+10%/-15%) 50 or 60 Hz.
  - b. Maximum total connected load:2000 VA.
  - c. Operating temperature limits: 32 to 130 F
  - d. 85% RH continuous, non-condensing, humidity.
  - e. 0.5G continuous vibration.
- 5. All Boiler Control System wiring shall be in accordance with the National Electrical Codes and local electrical codes.
- 6. System shall meet current NFP85 requirements
- 7. Boiler Control System component functions shall be as follows:
  - a. Burner Management Controller: Provides boiler sequencing logic to meet FM/IRI/UL approval body requirements.
  - b. Touch Screen Graphical Interface (7 or optional 10 Inch Color): Provides user interface to the control system, boiler overview screen with connected boiler parameter readouts, alarm screens, optional water level indication , and system firing rate screen.
  - c. Local Modbus Communication Network for communication with Parallel Positioning Actuators and Burner Management System.
  - d. Various Programmable Controller Input/Output modules: Provides interface for discrete powered and/or isolated relay signals, as well as for analog signals, to and from external devices.
  - e. Stack Temperature Sensor: Measures and transmits a signal to the Programmable Controller in relation to boiler exit flue gas temperature for indication. Also used for high stack temperature alarm and shut-down.
  - f. Steam Pressure Transmitter for Steam Boilers: Provides an analog signal to the Programmable Controller for indication of boiler steam pressure. Utilized for on/off and modulating control of the burner.
  - g. Water Temperature Transmitter for Hot Water Boilers: Provides an analog signal to the Programmable Controller for indication of boiler

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water temperature. Utilized for thermal shock protection, on/off, and modulating control of the burner.

- h. Water (shell) Temperature Sensor on Steam Boilers: Measures and transmits a signal to the Programmable Controller in relation to boiler water temperature. Used for indication and thermal shock protection.

8. Optional Equipment/Features

- a. 10 Inch Panel View Plus Color HMI Touch Screen.
- b. Two Boiler Lead/Lag (Requires common header transmitter)
- c. Master Panel Control Lead/Lag Control for 3-8 Multiple Boiler Systems
- d. Combustion Air Temperature Sensor: Measures and transmits a signal to the Programmable Controller in relation to the combustion inlet temperature for indication.
- e. Level Master and On Screen Level Indication
- f. Remote Firing Rate (modulation) via hardwired 4-20 input (not available if 2 Boiler Lead/Lag is used) or via customers communication protocol interface
- g. Remote Firing Rate Set Point via hardwired 4-20 input (If Remote Firing Rate is not used, not available if 2 boiler Lead/Lag is used) or via customers communication protocol interface. (Remote set point is not recommended on low emission boilers)
- h. Remote Stop/Start via hardwired digital input (not available if 2 Boiler Lead/Lag is used) or via customers communication protocol interface
- i. Outdoor Temperature Reset (Hot Water)
- j. Hot Water Return Temperature (Hot Water Boilers and if Outdoor Temperature is not used)
- k. E-Mailing of Alarms Capabilities.
- l. Building/Plant Automation System interface (May require protocol translator based on actual communication protocol interface required)
- m. Remote Monitoring and Data Acquisition System (SCADA)
- n. External Control Interlock (Example: Fresh Air Damper)

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- o. Economizer Flue Gas Inlet/Outlet Temperature
- p. Stack Draft Control (requires external damper, low draft switch and draft transmitter. BOILER damper assembly includes these items as a standard)
- q. Steam Flow measurement input. (Requires Flow Meter) If input is not used it is defaulted to a 4-20 ma user defined input (monitoring only).
- r. Feedwater Flow measurement input. (Requires Flow Meter) If input is not used it is defaulted to a 4-20 ma user defined input (monitoring only).
- s. Fuel One Flow measurement input. (Requires Flow Meter) If input is not used it is defaulted to a 4-20 ma user defined input (monitoring only).
- t. Fuel Two Flow measurement input. (Requires Flow Meter) If input is not used it is defaulted to a 4-20 ma user defined input (monitoring only).
- u. Economizer Feedwater Inlet Temperature Input. (Requires Sensor) If input is not used it is defaulted to a 4-20 ma user defined input (monitoring only).
- v. Economizer Feedwater Outlet Temperature Input. (Requires Sensor) If input is not used it is defaulted to a 4-20 ma user defined input (monitoring only).
- w. Economizer by-pass damper control

## 2.2 MASTER PANEL

### A. General

1. Lead/Lag Start with either Lead/Lag or Unison Modulation.
2. Boilers' Start and Stop
  - a. Steam pressure, or hot water temperature on hot water systems, is compared with the setpoint and controller's processor executes PID algorithm. Lead boiler is commanded to come on-line first. Lag boiler #1 is commanded to come online when a firing rate signal for the lead boiler reaches lag boiler start point. Lag boiler #1 is commanded to stop when a firing rate signal for the lead boiler reaches lag boiler stop point.

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- b. Lag boiler #2 is commanded to come on-line when a firing rate signal for the lag boiler #1 reaches lag boiler #2 start point. Lag boiler #2 is commanded to stop when a firing rate signal for the lag boiler #1 reaches lag boiler #2 stop point.
  - c. Subsequent boilers operate in a similar fashion.
- 3. Lead/Lag Modulation
  - a. Lag boiler #1 starts modulation after lead boiler reaches maximum firing rate (or firing rate selected by the operator).
  - b. Lag boiler #2 starts modulation after lag boiler #1 reaches maximum firing rate (or firing rate selected by the operator).
  - c. Subsequent boilers operate in a similar fashion.
- 4. Unison Modulation - Firing rates for all boilers are equal.
- 5. Hot Standby - System shall have a provision for keeping lag boilers in hot standby. Standby routine shall be based on a water temperature signal.
- 6. Firing Sequence Selection - Sequence in which boilers come on-line shall be selected via HMI. Adequate check shall be provided to disallow improper sequence selection.
- 7. Automatic Rotation of the Boilers - System shall be provided with a sequence to automatically rotate sequence in which the boilers are fired. Rotation shall be based on the elapsed time.

**B. HMI (Human Machine Interface)**

- 1. Master panel shall include HMI for display and selection of the following parameters:
- 2. Display
  - a. Available boilers
  - b. Number of boilers required
  - c. Selected sequence of firing
  - d. Control output to each boiler
  - e. Header steam pressure or water temperature on hot water systems
  - f. Setpoint

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g. Elapsed time from last rotation

3. Selection

a. Number of boilers

b. Sequence of firing

c. Automatic or manual rotation

d. Individual boiler start and stop points with timers

e. Setpoint

f. Proportional, integral and derivative gains for control algorithm

C. Application And System Requirements

1. This option is applicable to full modulation burners utilizing the HAWK advanced boiler control system and modulating controls.
2. Logic for Lead/Lag control shall reside in the Master Control Panel. Communication between the Master Panel and the individual Boiler Control Panels shall be via Ethernet communication or hard wiring.

2.3 DEAERATOR CONTROL

A. Standard System And Options

1. Hardware Platform - Standard System

- a. Compact Logix L24ER Processor
- b. Embedded 24VDC, 16 Channel Discrete Input Module
- c. Embedded 24VDC, 16 Channel Discrete Output Module
- d. Embedded 4 Channel Analog Input Module
- e. Embedded 2 Channel Analog Output Module
- f. Discrete 24VDC, 16 Channel Input Module
- g. Analog Input Module 4 Channel
- h. Analog Input Module 8 Channel
- i. Analog Output Module 2 Channel



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- j. Analog Output Module 4 Channel
- k. Analog Output Module 8 Channel
- l. Right Termination End Cap
- m. HMI Display, 7” Color Touch Screen - Standard
- n. HMI Display, 10” Color Touch Screen - Optional
- 2. Optional Components
  - a. Veris Current Switch - sized for pump
  - b. Electric actuators for pump water recirculation bypass - sized for system
  - c. PowerFlex 400, 70, 700 or 753 Variable Speed Drive
- B. Sensors And Transmitters
  - 1. Tank level indication
    - a. Standard
      - 1.) DA tank - GEMS Mini Sure Site with transmitter
      - 2.) Surge tank - GEMS Mini Sure Site with transmitter
    - b. Optional
      - 1.) DA tank - Differential pressure level transmitter
      - 2.) Surge tank - Differential pressure level transmitter
  - 2. Tank Pressure and Temperature
  - 3. Pump flow proving sensors
    - a. Pressure switch mounted after each pump or differential pressure switch across pump or Veris current switch on the high voltage pump motor leads.
  - 4. E&H flow transmitters - sized per application
- C. Valves

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1. Make-up water valves - all sized per application – 3 Makeup Valves Maximum
  - a. DA tank make-up valve - Siemens SK electronic actuator with optional 3 valve bypass and strainer
  - b. DA tank emergency or raw water make-up valve - Siemens SK electronic actuator with optional 3 valve bypass and strainer
  - c. Surge tank make-up valve - Siemens SK electronic actuator with optional 3 valve bypass and strainer

D. Pumps

1. Feed water pumps - Grundfos
2. Transfer pumps - Grundfos

E. Software Development Platform

1. RSLogix 5000 (controller logic programming)
2. Factory Talk View ME (HMI programming)
3. Factory Talk View SE (control room display and data acquisition)
4. RSLinx OEM version (OPC server - Building Automation System)

F. Major Functions That The System Shall Provide:

1. Feed water pump control
  - a. System will be able to support up to 5 pumps on Single Tank application and up to 4 pumps on Dual Tank application (6 pumps maximum), selected using the HMI (no PC or additional software required). Upon selection, graphics and control logic will be activated automatically.
  - b. Pumps may be part of a common header or may feed individual boilers. If part of a common header pumps may be configured to operate in a lead/lag sequence based on system demand. If one pump per boiler hard piped, NO VFD option is available and no lead lag or alternation.
  - c. Order of pump alternation can be automatically rotated to share running time and wear equally between pumps.
  - e. For a common boiler feedwater pump discharge system, PLC monitors 4-20 mA pressure/flow signal from boiler feedwater header to deter-

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mine when to command pumps to start/stop. In a VFD system the 4-20 mA pressure/flow signal will determine VFD output.

- f. If the pumps are feeding individual boilers, pumps will be turned on/off based on individual discrete signals from each boiler.
- g. PLC/VFDs can only control pumps that are in AUTO mode. Pumps in manual will run continuously. The hard wired Aux Low Water pump cutoff will prevent pumps from running in any mode if water level drops below set point.

2. Transfer pump control

- a. System will be able to support up to 3 pumps (6 pumps maximum BFP + TP on Dual Tank Application) for transferring water from the Surge tank to the DA. Pumps are selected using the HMI; no PC or additional software required. Upon selection, graphics and control logic will be activated automatically.
- b. Pumps may be configured to operate in a lead/lag sequence based on system demand. In addition, order of pump alternation can be automatically rotated to share running time and wear equally between pumps.

3. DA make-up water level control

- a. The lead pump runs continuously. If DA tank level falls below set point, make up valve is already fully open, and condensate tank discharge pressure falls below set point, the PLC will command the lag pump to start.
- b. When surge tank discharge pressure falls below set point, the PLC will sound an alarm. Operator must respond to the alarm condition and reset the alarm.
- c. When level control is in manual mode, the make up valve can be opened or closed from the HMI screen, or optionally by a manual potentiometer. Either method will allow the operator to manually adjust the valve between fully open and fully closed to control the incoming flow of make up water.
- d. An optional Surge tank MUV biasing mode is available. A bias may be enabled (user defined) to force the primary MUV feeding the DA tank to close as level falls in the surge tank. The bias factor applied to the primary MUV position increases as the level in the surge tank gets lower. This prevents the surge tank from pumping down to low water cutout so it can continue to run while condensate is returned to it. The secondary valve would in this case be plumbed to the DA from a sepa-

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rate source and add water to the DA to be heated, deaerated and sent to the boilers instead of adding cold water to the surge tank.

4. Surge tank make up water level control
  - a. The PLC receives a 4-20 mA signal indicating surge tank water level. Signal is compared to the operator input set point and valve modulates accordingly to control the incoming flow of make-up water.
  - b. When the valve is in manual mode the HMI or optional manual potentiometers will allow the operator to manually adjust the valve between fully open and fully closed.
5. Pump Lead/Lag and Alternating Control
  - a. Selection of pumps and rotation schedule are configurable from the HMI. PLC will monitor all pumps and determine availability; pumps may be taken out of rotation for maintenance.
  - b. When system is in auto rotation, if a pump is not available the PLC will alternate to the next available one. If no pumps are available an alarm will sound, requiring manual reset. PLC will maintain equal run time between all pumps.
  - c. If Lead/Lag option is selected, pump start/stop set points are set from the HMI. Start point is based on percentage of set point achieved by previous pump in sequence. PLC internal timers will maintain minimum load fluctuations.
  - d. If Lead/Lag and VFD options are selected, VFD% to start/stop lag pump is set from the HMI. When lag function is activated, VFDs function in unison modulation until the speed reaches VFD stop point; then lag pump shuts off.
  - e. When pump alternation is selected, alternation schedule is configured from the HMI. When current pump run time is met, next pump will start and come up to speed; previous pump will then stop.
6. Chemical Feed Control
  - a. One set of dry contacts wired to terminal blocks will be provided to change state when any boiler feed pump is running, enabling customer chemical feed pump.

G. Additional System Functions:

1. A pressure sensor mounted in steam space monitors Deaerator pressure.

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2. A set of contacts on each pump's overload relay provides indication of pump failure. If VFDs or soft starters are used, a fault contact is monitored by the PLC to indicate pump failure.
3. A set of contacts on each pump starter indicates pump running. If VFDs or soft starters are used, a contact is monitored by the PLC to indicate run status.
4. A selector switch is mounted at each pump starter to allow Hand-Off-Auto switching. 'Hand' ignores all external signals except Aux Low Water Cut off, 'Off' ignores all signals and prevents pump from running, 'Auto' allows pump to run based on commands from the PLC.

H. Alarm Features

1. DA Tank water level alarms
  - a. Low Water — If water level as indicated by the tank level device falls to a pre- set point, the PLC will sound an alarm, display a message on the HMI, log a message to the alarm history file, and turn on the appropriate stack light.
  - b. Low Low Water — If water level falls further to the pre-set Low Low Water point, the PLC will sound an alarm, display a message on the HMI, log a message to the alarm history file, and turn on the appropriate stack light.
  - c. Hi Water — If water level as indicated by the tank level device rises to a pre-set point, the PLC will sound an alarm, display a message on the HMI, log a message to the alarm history file, and turn on the appropriate stack light.
  - d. Aux Low Water — If water level falls to the pre-set Aux Low Water point, the hard wired Aux Low Water device will open, signalling the PLC and shutting down all pumps for that tank. The PLC will sound an alarm, display a message on the HMI, log a message to the alarm history file, and turn on the appropriate stack light.
2. Surge Tank water level alarms (same as above)

I. Communication Options

1. Ethernet connectivity
  - a. PLC features an OPC compliant Ethernet/IP port for connection to a Building/Plant Automation System or Local Area Network.

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- b. Remote monitoring/data logging available using Factory Talk View SE software.
- c. Connection to Master Panel.
- d. Compliance with IEEE 802.3 Physical and Data Link, TCP/IP protocol, and
- e. Control and Information Protocol (CIP) standards.

2. Other communication options

- a. Communication to most major building management system interfaces such as Johnson Controls Metasys, ASHRAE Bacnet, LonWorks, and Siemens will be available via a Cleaver-Brooks Protonode. Check with Cleaver-Brooks for specific information.
- b. Data can be transferred by Ethernet through a Master Panel to a customer BAS. If a Master Panel is unavailable, the Protonode can be configured to communicate directly between the ADAC and the customer BAS.

3. EXECUTION

3.1 EXAMINATION

- A. Verify that power supply is available to control units and operator workstation.
- B. Verify that duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

- A. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, and wiring is installed prior to installation proceeding.
- B. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- C. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.
- D. Install labels and nameplates to identify control components according to Div. 23 Section "Identification for HVAC Piping and Equipment."

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- E. Install Steam and condensate instrument wells, valves, and other accessories according to Div. 23 Section "Steam and Condensate Piping Specialties."
- F. Install electronic and fiber-optic cables according to Div. 26 Section "Communications Horizontal Cabling."

**3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION**

- A. Install raceways, boxes, and cabinets according to Div. 26 Section "Raceways and Boxes for Electrical Systems."
- B. Install building wire and cable according to Div. 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Div. 26 Section "Communications Horizontal Cabling."
  - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
  - 2. Install exposed cable in raceway.
  - 3. Install concealed cable in raceway.
  - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
  - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
  - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

**3.4 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment in-

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stallation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.



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10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:
  - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
  - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
  - c. Verify that spare I/O capacity has been provided.
  - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
  - a. Check analog inputs at 0, 50, and 100 percent of span.
  - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
  - c. Check digital inputs using jumper wire.
  - d. Check digital outputs using ohmmeter to test for contact making or breaking.
  - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

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5. Flow:
    - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    - b. Manually operate flow switches to verify that they make or break contact.
  6. Pressure:
    - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
  7. Temperature:
    - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    - b. Calibrate temperature switches to make or break contacts.
  8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
  9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
  10. Provide diagnostic and test instruments for calibration and adjustment of system.
  11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

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3.6 COMMISSIONING

- A. Start and commission systems - Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation and turn over to the User.
- B. Provide service engineer to instruct and train the Commissioner's representative(s) in operation and maintenance of systems and equipment at no cost to the User, as scheduled by the Commissioner.
- C. Provide basic operator training for the User's personnel on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time.
- D. Demonstrate a complete functioning and operating system to the User.

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1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build Contractor.

1. Natural gas service to building.

B. Alternate Bids: Not applicable.

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Manual gas shutoff valves.
5. Motorized gas valves.
6. Earthquake valves.
7. Pressure regulators.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

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1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

- A. Steel Support 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.
- 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.

2. PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
  - 1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
  - 2. Service Regulators: 100 psig (690 kPa) minimum unless otherwise indicated.
- B. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.2 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
  - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
  - 2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.

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3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Retain first subparagraph below for underground steel piping. Cathodic protection may be required in addition to protective coating. Coordinate with requirements in Section 134700 "Cathodic Protection."
5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
  - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

**B. PE Pipe: ASTM D2513, SDR 11.**

1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
  - a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.
  - b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
  - c. Aboveground Portion: PE transition fitting.
  - d. Outlet shall be threaded or suitable for welded connection.
  - e. Tracer wire connection.
  - f. Ultraviolet shield.
  - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
4. Transition Service-Line Risers: Factory fabricated and leak tested.
  - a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
  - b. Outlet shall be threaded or suitable for welded connection.

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- c. Bridging sleeve over mechanical coupling.
- d. Factory-connected anode.
- e. Tracer wire connection.
- f. Ultraviolet shield.
- g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

**2.3 PIPING SPECIALTIES**

**A. Y-Pattern Strainers:**

- 1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
- 2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller.
- 3. Strainer Screen: 40 -mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
- 4. CWP Rating: 125 psig (862 kPa).

**B. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.**

**2.4 JOINING MATERIALS**

**A. Joint Compound and Tape: Suitable for natural gas.**

**B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.**

**C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.**

**2.5 MANUAL GAS SHUTOFF VALVES**

**A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.**

**B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.**

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1. CWP Rating: 125 psig (862 kPa) .
  2. Threaded Ends: Comply with ASME B1.20.1.
  3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
  6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.
- C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B584.
  2. Ball: Chrome-plated brass.
  3. Stem: Bronze; blowout proof.
  4. Seats: Reinforced TFE; blowout proof.
  5. Packing: Separate packnut with adjustable-stem packing threaded ends.
  6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  7. CWP Rating: 600 psig (4140 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B584.
  2. Ball: Chrome-plated bronze.
  3. Stem: Bronze; blowout proof.
  4. Seats: Reinforced TFE; blowout proof.



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5. Packing: Threaded-body packnut design with adjustable-stem packing.
  6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  7. CWP Rating: 600 psig (4140 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B584.
  2. Ball: Chrome-plated bronze.
  3. Stem: Bronze; blowout proof.
  4. Seats: Reinforced TFE.
  5. Packing: Threaded-body packnut design with adjustable-stem packing.
  6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  7. CWP Rating: 600 psig (4140 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B584.
  2. Plug: Bronze.
  3. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

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4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125 psig (862 kPa).
6. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

1. Body: Cast iron, complying with ASTM A126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural gas.
5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig (862 kPa).
8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

H. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Body: Cast iron, complying with ASTM A126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural gas.
5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

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6. Operator: Square head or lug type with tamperproof feature where indicated.
  7. Pressure Class: 125 psig (862 kPa).
  - . Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- I. PE Ball Valves: Comply with ASME B16.40.
1. Body: PE.
  2. Ball: PE.
  3. Stem: Acetal.
  4. Seats and Seals: Nitrile.
  5. Ends: Plain or fusible to match piping.
  6. CWP Rating: 80 psig (552 kPa) .
  7. Operating Temperature: Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
  8. Operator: Nut or flat head for key operation.
  9. Include plastic valve extension.
  10. Include tamperproof locking feature for valves where indicated on Drawings.
- J. Valve Boxes:
1. Cast-iron, two-section box.
  2. Top section with cover with "GAS" lettering.
  3. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
  4. Adjustable cast-iron extensions of length required for depth of bury.
  5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

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2.6     **MOTORIZED GAS VALVES**

A. Electrically Operated Valves: Comply with UL 429.

1. Pilot operated.
2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
6. NEMA ICS 6, Type 4, coil enclosure.
7. Normally closed.
8. Visual position indicator.

2.7     **EARTHQUAKE VALVES**

A. Earthquake Valves, Maximum Operating Pressure of 60 psig (414 kPa):  
Comply with ASCE 25.

1. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
2. Maximum Operating Pressure: 0.5 psig (3.45 kPa) 7 psig (48 kPa) 60 psig (414 kPa).
3. Cast-aluminum body with stainless-steel internal parts.
4. Nitrile-rubber, reset-stem o-ring seal.
5. Valve position, open or closed, indicator.
6. Composition valve seat with clapper held by spring or magnet locking mechanism.
7. Level indicator.
8. End Connections: Threaded for valves NPS 2 (DN 50) and smaller.

2.8     **PRESSURE REGULATORS**

A. General Requirements:

1. Single stage and suitable for natural gas.

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2. Steel jacket and corrosion-resistant components.
  3. Elevation compensator.
  4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller.
- B. Line Pressure Regulators: Comply with ANSI Z21.80.
1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
  2. Springs: Zinc-plated steel; interchangeable.
  3. Diaphragm Plate: Zinc-plated steel.
  4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
  5. Orifice: Aluminum; interchangeable.
  6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
  7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
  8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff. Overpressure protection device is optional feature. See Evaluations.
  9. Overpressure Protection Device: Factory mounted on pressure regulator.
  10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
  11. Maximum Inlet Pressure: 100 psig (690 kPa) .

2.9 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

3. EXECUTION

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3.1 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
  - 1. If natural-gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D2774.
- D. Steel Piping with Protective Coating:
  - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
  - 3. Replace pipe having damaged PE coating with new pipe.
- E. Install fittings for changes in direction and branch connections.
- F. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

3.2 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

3.3 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

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C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. 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.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- C. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameter, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

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- D. Install hangers for corrugated stainless-steel tubing, with maximum horizontal spacing and minimum rod diameter, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping within 12 inches (300 mm) of each fitting.
- F. Support vertical runs of steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Support vertical runs of corrugated stainless-steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

**3.5 CONNECTIONS**

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- I. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

**3.6 LABELING AND IDENTIFYING**

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

**3.7 FIELD QUALITY CONTROL**

- A. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.



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- B. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

**3.8 OUTDOOR PIPING SCHEDULE**

- A. Underground natural-gas piping shall be one of the following:
  - 1. PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.
  - 2. Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping shall be one of the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

**3.9 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE**

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground: PE or Cast-iron plug valves.

**3.10 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE**

- A. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full -port, bronze ball valves with bronze trim.
  - 3. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 (DN 65) and larger at service meter shall be one of the following:
  - 1. Two-piece, full -port, bronze ball valves with bronze trim.
  - 2. Bronze plug valve.

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3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:
1. One-piece, bronze ball valve with bronze trim.
  2. Two-piece, full regular-port, bronze ball valves with bronze trim.
  3. Bronze plug valve.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 (DN 65) and larger shall be one of the following:
1. Two-piece, full -port, bronze ball valves with bronze trim.
  2. Bronze plug valve.
  3. Cast-iron, nonlubricated plug valve.

END 23 11 23

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 13 23 – Aboveground Fuel Storage Tanks**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Protected, double-wall steel tanks for fuel oil storage.
- b. Complete with:
  - 1.) Leak detection
  - 2.) Monitoring column
  - 3.) Associated piping connections.
- c. Day Tank with rupture basin
- d. Fuel heater

1.2 INFORMATIONAL SUBMITTALS

A. Manufacturer's tank installation instructions.

B. Product data sheets and descriptive material for major components to be provided

- 1. Tank coatings
- 2. Pumps, valves and fittings
- 3. Piping, venting equipment, leak detection equipment, and overflow protection equipment.
- 4. Other system accessories as required.

1.3 QUALITY ASSURANCE

A. UL labels for petroleum products shall be affixed to each tank.

B. Comply with applicable local and national codes.

2. PRODUCTS

2.1 PROTECTED, DOUBLE-WALL STEEL TANK

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- A. Service: No.2 fuel oil (diesel) storage.
- B. Factory-assembled unit that includes a primary storage tank and integral factory-fabricated secondary containment. Entire tank assembly shall conform to UL 2085. Tank assembly shall bear UL2085 label as a protected tank.
- C. Tank assembly: NFPA 30. Design and manufacture for horizontal cylindrical installation.
- D. As a minimum, coat steel outer wall of tank in accordance with SSPC-SP-6 blast, zinc epoxy primer at 2-3 mils dft, and urethane at 4-6 mils dft.
- E. Primary storage tank: Factory welded, steel conforming to UL 142.
- F. Fire protection material:
  - 1. Lightweight concrete or thermal insulation shall surround primary tank. Tank design shall provide minimum 2-hour fire rating in accordance with UFC appendix Standard A-II-F and UL 2085.
  - 2. Material shall allow liquid leaking from primary tank to penetrate material and communicate with leak detection tube according to UL 2085.
  - 3. Concrete: Monolithic pour, poured at factory.
  - 4. Insulated tanks insulation: Thickness as required to meet UL 2085; install at factory.
- G. Secondary containment:
  - 1. Factory-fabricated, steel type fully enclosing primary storage tank.
  - 2. Containment reservoir shall conform to UL 142.
  - 3. Interstitial space between primary tank and containment reservoir shall be pressure testable and verifiable.
  - 4. Support primary tank within containment reservoir with steel tank saddles, or other similar support, fabricated and installed by tank manufacturer.
- H. Mount tank assembly on manufacturer's standard UL listed support skid that elevates tank assembly above underlying concrete slab minimum of 12" (400 mm).

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I. Tank assembly shall have lifting lugs that allow tank relocation.

J. At a minimum, provide following ports:

1. Fill.
2. Normal vent.
3. Emergency vent.
4. Dispensing pump.
5. Vapor recovery port.
6. Product return port.
7. Level sensing port.

K. Accessories:

1. Ladder and platform assembly.
2. Leak detection system.
3. Insulation fasteners.

**2.2 DAY TANK WITH RUPTURE BASIN**

- A. Factory-assembled unit that includes a storage tank and integral factory-fabricated secondary containment. Entire tank assembly shall include a rupture basin and conform to UL 142. Tank assembly shall bear UL142 label.
- B. Tank assembly: NFPA 30. Design and manufacture for use as a generator day tank.
- C. Provide as a package with all required instrumentation and pumping equipment including Return Pump, Fill Control, and Level Switches mounted to tank. Local control panel with output to main fuel tank pumps and Powerhouse main control system.

**2.3 FUEL HEATER**

- A. Provide provisions for fuel system operation in cold weather including heat tracing and insulation of piping and/or a fuel heater.

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**Section 23 13 23 – Aboveground Fuel Storage Tanks**

2.4 FUEL PUMP SYSTEM

- A. Skid mounted duplex pump sets in a lead lag configuration. Shop fabricated system with strainer, valves, pressure gauges, reliefs, and instrumentation. Designed for outdoor installation.
- B. Internal rotary gear pump. See Section 23 21 23. Materials and design compatible with the fuel installation.
- C. Provide a local control system that will operating in automatic mode. Pumps operate in lead lag configuration. The controls system will monitor the main tanks and generator day tank levels, pump operation, and output to the powerhouse control system.
- D. Sizing: 1500 GPH or as required by the boilers and generators.

END 23 13 23

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 13 23.13 – Shop Fabricated Metal Tanks**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Design, fabrication, testing, inspection, transportation, and installation for tanks.

1.2 INFORMATION SUBMITTALS

A. Quality assurance data:

1. Stamped ASME Section VIII vessels.

- a. Inspection certificates for vessel from ASME authorized inspector.
- b. Copy of U-1 Form for vessel.
- c. National Board identification number.
- d. Copy of ASME nameplate for vessel. Nameplates shall include code required markings, name of User, and User's equipment identification number.
- e. Copy of certified mill report giving chemical compositions and physical properties of materials used for fabrication.

2. Certified copies of hydrostatic tests.

3. Materials of construction and pressure limits.

B. Manufacturer's instructions:

1. Tank installation instructions.

2. Tank and auxiliaries operation and maintenance instructions

1.3 ACTION SUBMITTALS

A. Shop Drawings:

1. Manufacturer.

2. Dimensional outline.

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3. Nozzle schedule including allowable forces and moments.
4. Materials of construction including plate thickness.
5. Equipment weight empty and filled.
6. Support requirements with anchor locations.
7. ASME code.
8. Tag number.

**1.4 QUALITY ASSURANCE**

- A. Design, material, fabrication, and testing shall be in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, latest edition and revisions.
- B. User reserves right to inspect tank(s) at any time during fabrication and testing.

**2. PRODUCTS**

**2.1 DESIGN REQUIREMENTS**

- A. Tank(s) shall be of welded construction and shall be complete, operable, and include accessories, specialties, fastenings, platforms, auxiliary steel, supports, etc.
- B. Provide tank(s), nozzles, flanges, insulation clips, supports, relief valves, connections, and other accessories. Exact orientations and locations to be determined after award of Contract. Tank design, material, fabrication, and testing shall be in accordance with ASME Section VIII where indicated.
- D. Provide access ladders, walkways, and platforms.
- E. Design tank(s) furnished with partition plates so partition and tank are capable of withstanding forces which result when one section of tank is full while other is empty.
- F. Nozzles shall be in accordance with code and as specified in following table. For pipe sizes not listed, use next larger pipe size.

Pipe Size (NPS)	Axial Force (lbf)	Resultant Force (lbf)	Resultant Moment (ft-lbf)
2"	400	580	920



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3"	600	860	1,900
4"	800	1,140	2,660
6"	1,400	2,020	4,620
8"	1,100	3,120	7,000
10"	3,000	4,400	10,000
12"	3,600	5,200	12,200
14"	4,000	5,800	12,600
16"	4,600	6,600	14,400

**G. Horizontal vessel support:**

1. Steel saddles continuously welded to vessel shell.
2. Saddle bolt holes shall be slotted at one end of vessel to provide for thermal expansion.
3. Design to prevent vessel deformation under all load conditions.
4. When reinforcing pad is required at junction of saddle and vessel, continuously weld to shell. Round corners of pad to 1" (25 mm) minimum radius.

**H. Provide tanks with lifting lugs.**

**2.2 FABRICATION**

- A. Welds: Ground smooth and flush.
- B. Flange bolt hole pattern: Straddle tank centerline.
- C. Do not locate manways and nozzles on longitudinal or axial weld seams and, insofar as practicable, avoid girth or hoop seams.
- D. Reinforcement pads and telltale holes for tank openings shall be in accordance with ASME Boiler and Pressure Vessel Code Section VIII Division 1.
- E. Attach nozzle and manway necks by welding completely through total thickness of tank, including reinforcement.
- F. Nozzle projections: Minimum of 8" (200 mm) from tank surface to face of flange.

**2.3 NAMEPLATES**

- A. Permanently attached nameplates which are observable while tank is in operation. Include following information:

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**Section 23 13 23.13 – Shop Fabricated Metal Tanks**

1. Tank name.
2. Tag number.
3. Manufacturer's name.
4. Year of manufacture.
5. Nominal capacity.
6. Design pressure and design temperature.
7. Tank weight empty and full.

END 23 13 23.13

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 21 23 – Hydronic Pumps**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Plumbing and HVAC system pumps, except where provided as integral part of manufactured piece of equipment, including:

1.) End suction.

2.) In-line circulator.

1.2 INFORMATIONAL SUBMITTALS

A. Shop Drawings including:

- 1. Pump curves.
- 2. Materials of construction.
- 3. Schedule of pumps.
- 4. Performance characteristics.
- 5. Data concerning physical dimensions.
- 6. Motor drive assemblies.
- 7. Bearings.
- 8. Seals.
- 9. Impellers capacities.
- 10. Weights.
- 11. Ratings.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance manuals

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**Section 23 21 23 – Hydronic Pumps**

1.4 WARRANTY

- A. HVAC systems and products shall be provided with a minimum two-year warranty.

2. PRODUCTS

2.1 DESIGN REQUIREMENTS

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1,750 rpm unless otherwise noted.
- D. Pumps shall be capable of operating continuously over full operating range without overheating, cavitating, excessive noise or vibration, surging or instability when operating in single or in parallel with other pumps.
- E. Pump connections:
  - 1. 3/4" to 2" (19 mm to 50 mm): Threaded or flanged.
  - 2. 2-1/2" (64 mm) or larger: Flanged.

2.2 END SUCTION CENTRIFUGAL PUMPS

- A. Type: Centrifugal, end-suction, base-mounted, single-stage.
- B. Material:
  - 1. Cast iron
  - 2. Bronze-fitted
  - 3. Ductile iron, bronze-fitted
- C. Bearings:
  - 1. 1/2 hp to 15 hp: Ball bearing, permanently grease-lubricated or sleeve bearing oil-lubricated. 15 hp to 500 hp: Ball bearing, grease-lubricated.
  - 2. Oil seal and integral dirt and water seal at each end of oil reservoir.
- D. Motor: Inverter-duty as specified in electrical requirements.

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**Section 23 21 23 – Hydronic Pumps**

- E. Drive: Flexible coupling with coupling guard.
- F. Seals: Mechanical or packing gland type.
- G. Provide galvanized drain pan with 3/4" (19 mm) drain piped full size to nearest floor drain with Schedule 40 galvanized pipe.
- H. Suction diffuser:
  - 1. Provide at each end suction pump.
  - 2. Provide support foot.
  - 3. Length of straightening vanes shall be a minimum of 2 times the diameter of system pump suction connection.

**2.3 IN-LINE CIRCULATION CENTRIFUGAL PUMP**

- A. Type: In-line circulating.
- B. Materials:
  - 1. Cast iron
  - 2. Bronze-fitted
  - 3. All-bronze
  - 4. Shaft, all pumps: Alloy steel with integral thrust collar and 2 oil-lubricated bronze sleeve bearings.
- C. Seals: standard, mechanical type.
- D. Bearings: Permanently sealed bearings, or oil-lubricated roller or ball bearings with oil reservoirs. Provide oil seal and integral dirt and water seal at each end of reservoir.
- E. Motor: Inverter-duty as specified in electrical requirements.

**2.4 POSITIVE DISPLACEMENT PUMPS**

- A. Type: Single-stage, rotary gear.
- B. Materials:
  - 1. Casing: Cast Iron foot or flange mounting.
  - 2. Shaft: Hardened steel.

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- 3. Sleeves: Stainless steel.
- 4. Pumping gears: Cast Iron or steel.
- C. Bearings: Self-lubricating bronze or grease-lubricated ball.
- D. Drive: Direct-coupled.
- E. Seals: Mechanical
- F. Provide integral bypass type adjustable relief valve.

END 23 21 23

DIVISION 23 – HEATING VENTILATION AND AIR CONDITIONING  
**SECTION 23 22 13.13 – Underground Steam and Condensate Piping**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design-Build Contractor.
- B. Alternate Bids: Not applicable.

1.2 SUMMARY

- A. Section Includes:
  - 1. Steel pipe and fittings.
  - 2. Pre-engineered conduit piping system.
  - 3. Loose-fill insulation.

1.3 DEFINITIONS

- A. HP Systems: High-pressure piping operating at more than 15 psig (104 kPa) as defined by ASME B31.1.
- B. Invert: Vertical distance from Project datum reference point to bottom of interior pipe surface.
- C. LP Systems: Low-pressure piping operating at 15 psig (104 kPa) or less as defined by ASME B31.1.

1.4 ACTION SUBMITTALS

- A. Product Data: For preengineered conduit piping system components.
- B. Shop Drawings: For underground steam and condensate distribution piping. Signed and sealed by a qualified professional engineer.
  - 1. Include calculations showing requirements for expansion compensation for underground piping.
  - 2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.
  - 3. Show pipe sizes, locations, inverts, and pitch. Show piping in trench and piping in conduit, with details showing clearances between piping.

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4. Show insulation thickness.

- C. Delegated Design Submittal: For underground steam and condensate piping systems indicated to comply with performance requirements and design criteria, including analysis data and design drawings signed and sealed by the professional engineer responsible for their preparation.
1. Include design calculations and details for selecting thermal expansion and thrust restraints.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from steam distribution piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet (1:500) and at vertical scale of not less than 1 inch equals 5 feet (1:50).
1. Show locations and inverts of utility system manholes and piping. Show types, sizes, materials, and inverts of other utilities crossing steam distribution piping.
2. Show depth of cover from top of steam distribution system piping to finished grade.
- C. Qualification Data: For Installer.
- D. Welding certificates.
- E. Material Test Reports: For conduit piping, by a qualified testing agency.
- F. Source quality-control reports.
- G. Field quality-control reports.

**1.6 QUALITY ASSURANCE**

- A. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX.
1. Retain ASME B31.1 option in first subparagraph below for piping in a steam power plant. Retain ASME B31.9 option for piping in HVAC and process steam applications.
2. Comply with provisions in ASME B31.9.



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3. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- B. ASME Compliance: Comply with ASME B31.9 for materials, products, and installation.
- C. ASME Compliance: Provide safety valves and pressure vessels bearing appropriate ASME labels.

**1.7 FIELD CONDITIONS**

- A. Interruption of Existing Utilities: Do not interrupt utilities serving occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary utility services in accordance with requirements indicated:
  1. Notify Construction Manager no fewer than two days in advance of proposed interruption of utility.
  2. Do not proceed with interruption of utility without Construction Manager's written permission.

**2. PRODUCTS**

**2.1 PERFORMANCE REQUIREMENTS**

- A. Provide components and installation capable of producing steam and condensate piping systems with the following minimum working-pressure ratings:
  1. HP Steam Piping: 175 psig (kPa).
  2. LP Steam Piping: 25 psig (kPa).
  3. Condensate Piping: 165 psig (kPa) at 400 deg F.
- B. Delegated Design: Engage a qualified professional engineer to design underground steam and condensate piping systems, including restraints and anchors.

**2.2 STEEL PIPE AND FITTINGS**

- A. Steel Pipe: ASTM A53/A53M, black steel, plain ends, welded and seamless, Grade B, black with plain ends; wall thickness as indicated in "Piping Application" Article.
- B. Cast-Iron, Threaded Fittings: ASME B16.4, standard pattern, with threads in accordance with ASME B1.20.1; Classes 125, 150, and 300 as indicated in "Piping Application" Article.

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- C. Malleable-Iron, Threaded Fittings: ASME B16.3, ASME B1.20.1; Classes 150 and 300 as indicated in "Piping Application" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Application" Article.
- E. 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.
- F. Steel Welding Fittings: ASME B16.9 and ASTM A234/A234M, seamless or welded.
  - 1. 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. Nipples: ASTM A733, standard weight, seamless, carbon-steel pipe complying with ASTM A53/A53M.
- H. 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- (3.2-mm-) maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised face, Class 250, cast-iron and steel flanges.
- I. Flange Bolts and Nuts: ASME B18.2.1 carbon steel, unless otherwise indicated.

**2.3 PREENGINEERED CONDUIT PIPING SYSTEM**

- A. Description: Factory-fabricated and -assembled, airtight and watertight, drainable, pressure-tested piping with conduit, inner pipe supports, and insulated carrier piping. Fabricate so insulation can be dried in place by forcing dry air through conduit.

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**SECTION 23 22 13.13 – Underground Steam and Condensate Piping**

1. Source Limitations: Obtain piping system from single source from single manufacturer.
- B. Carrier Pipe: Material as indicated in "Piping Application" Article. See Part 3 articles in this Section for required carrier pipe.
- C. Carrier Pipe Insulation:
  1. Mineral-Wool Pipe Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type II, 1200 deg F (649 deg C), Grade A.
    - a. Bands: ASTM A666, Type 304, stainless steel, 3/4 inch (19 mm) wide, 0.020 inch (0.5 mm) thick.
  2. Calcium Silicate Pipe Insulation: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a nonasbestos fibrous reinforcement. Comply with ASTM C533, Type I.
    - a. Bands: ASTM A666, Type 304, stainless steel, 3/4 inch (19 mm) wide, 0.020 inch (0.5 mm) thick.
  3. Polyisocyanurate Foam Pipe Insulation: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
    - a. Comply with ASTM C591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
    - b. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches (38 mm), as tested in accordance with ASTM E84.
    - c. Fabricate shapes in accordance with ASTM C450 and ASTM C585.
  4. Polyurethane Foam Pipe Insulation: Unfaced, preformed, rigid cellular polyurethane material intended for use as thermal insulation.
    - a. Comply with ASTM C591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
    - b. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches (38 mm), as tested in accordance with ASTM E84.
    - c. Fabricate shapes in accordance with ASTM C450 and ASTM C585.

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**D. Minimum Clearance:**

1. Between Carrier Pipe Insulation and Conduit: 1 inch (25 mm).
2. Between Insulation of Multiple Carrier Pipes: 3/16 inch (4.75 mm).
3. Between Bottom of Carrier Pipe Insulation and Conduit: 1 inch (25 mm).

**E. Conduit: Spiral wound, steel.**

1. Finish: With two coats of fusion-bonded epoxy, minimum 20 mils (0.50 mm) thick.
2. Cover: With polyurethane foam insulation with an HDPE jacket; thickness indicated in "Piping Application" Article.
3. Piping Supports within Conduit: Corrugated galvanized steel with a maximum spacing of 10 feet (3 m).
4. Fittings: Factory-fabricated and -insulated elbows and tees. Elbows may be bent pipe equal to carrier pipe. Tees shall be factory fabricated and insulated, and shall be compatible with carrier pipe.
5. Expansion Offsets and Loops: Provide directional changes to permit piping expansion without exceeding allowable pipe stress.
6. Accessories include the following:
  - a. Water Shed: Terminal end protector for carrier pipes entering building through floor, 3 inches (75 mm) deep and 2 inches (50 mm) larger than conduit; terminate conduit 20 inches (500 mm) above the floor level.
  - b. Guides and Anchors: Steel plate welded to carrier pipes and to conduit, complete with vent and drainage openings inside conduit.
  - c. End Seals: Steel plate welded to carrier pipes and to conduit, complete with drain and vent openings on vertical centerline.
  - d. Gland Seals: Packed stuffing box and gland follower mounted on steel plate, welded to end of conduit, permitting axial movement of carrier piping, with drain and vent connections on vertical centerline.
  - e. Joint Kit: Half-shell, pourable or split insulation and shrink-wrap sleeve.

**F. Manholes: Black steel with lifting eyes.**

1. Finish: Spray-applied urethane, minimum 30 mils (0.75 mm) thick.

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2. Access: 30-inch- (750-mm-) diameter waterproof cover with gasket, ladder, and two 6-inch (150-mm) vents, one high and one low, extending above grade with rain caps.
  3. Conduit Stub-Outs and Seals: Welded steel with drain and vent openings.
  4. Sump: 12 inches (300 mm) in diameter; 12 inches (300 mm) deep.
  5. Flotation Anchor: Oversized bottom keyed into concrete base.
- G. Source Quality Control: Factory test conduit to 15 psig (105 kPa) for a minimum of two minutes with no change in pressure. Factory test carrier pipe to 150 percent of operating pressure of system. Furnish test certificates.

3. EXECUTION

3.1 PIPING APPLICATION

A. HP Steam Piping:

1. NPS 2 (DN 50) and Smaller: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
3. NPS 14 through NPS 18 (DN 350 through DN 450): Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
4. NPS 20 (DN 500) and Larger: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
5. Conduit Piping: Standard weight steel carrier pipe, with mineral-wool carrier-pipe insulation and with coated and insulated conduit.
  - a. Piping Insulation Thickness: 2 inches (50 mm).
  - b. Conduit Insulation Thickness: 2 inches (50 mm).

B. Condensate Piping:

1. NPS 2 (DN 50) and smaller shall be either of the following:
  - a. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

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2. NPS 2-1/2 (DN 65) and larger shall be either of the following:
  - a. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
3. Conduit Piping: Standard weight, steel pipe and fittings with mineral-wool carrier-pipe insulation and with coated and insulated conduit.
  - a. Piping Insulation Thickness: 2 inches (50 mm).
  - b. Conduit Insulation Thickness: 2 inches (50 mm).

**3.2 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Show piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Remove standing water in the bottom of trench.
- C. Bed the pipe on a minimum 6-inch (150-mm) layer of pipe system manufacturer's recommended granular fill material with a minimum 6-inch (150-mm) clearance between pipes.
- D. Do not backfill piping trench or insulate piping until field quality-control testing has been completed and results approved.
- E. Install piping at uniform grade of 0.2 percent downward in direction of flow or as indicated.
  1. Maintain continuous bedding under piping. Do not leave gaps in pipe bedding, allowing pipe to sag between contact points with the bedding.
- F. Install condensate piping at uniform grade of 0.4 percent downward in direction of flow.
  1. Maintain continuous bedding under piping. Do not leave gaps in pipe bedding, allowing pipe to sag between contact points with the bedding.
- G. In conduit pipes, install drain valves at low points and manual air vents at high points.
- H. Install components with pressure rating equal to or greater than system operating pressure.
- I. Install piping in straight lines. Do not bend pipe.

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- J. Install fittings for changes in direction and branch connections.
- K. After field quality-control testing is complete, backfill with 6 inches (150 mm) of clean, granular material in accordance with piping system manufacturer's written instructions. If mechanical compaction is required, manually backfill to 12 inches (300 mm) before using mechanical-compaction equipment.

**3.3 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
  - 5. Prepare steam and condensate piping for testing in accordance with ASME B31.9 and ASME B31.1 and as follows:
    - a. Leave joints, including welds, uninsulated and exposed for examination during test.
    - b. Isolate equipment and instrumentation. Do not subject equipment and instrumentation to test pressure.
    - c. Install relief valve set to relieve at pressure no more than one-third higher than test pressure.
    - d. Fill system with ambient temperature water. Where there is risk of freezing, perform testing with air or liquid that will not freeze or cause damage to piping system materials.
    - e. For hydrostatic testing, install vents at high points to release trapped air while filling system. Remove test liquid through drip legs installed at accessible low points.
  - 6. Test steam and condensate piping as follows:
    - a. Subject steam and condensate piping to hydrostatic test pressure that is not less than 1.5 times system design pressure. Disconnect connections to equipment and instrumentation during hydrostatic test.
    - b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
    - c. Do not pressurize carrier pipe with air.

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- d. Maintain test pressure for four hours with no loss of pressure.
- 7. Test conduit as follows:
  - a. Seal vents and drains and subject conduit to 15 psig (105 kPa) compressed air for four hours with no loss of pressure. Repair leaks and re-test.
- D. Piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. When successful testing is complete, flush carrier piping to remove dirt or debris remaining after construction. Drain piping after flushing is complete.
- G. Fill underground piping system with permanent system liquid prior to system testing and balancing.

END 23 22 13.13



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**Section 23 22 16 – Steam and Condensate Piping Specialties for  
Facility Services Systems**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Steam traps.
- b. Vacuum breakers.

1.2 ACTION SUBMITTALS

A. Shop Drawings. Data shall include:

- 1. Manufacturer
- 2. Model
- 3. Application
- 4. Materials of construction
- 5. Dimensional Drawings
- 6. Pressure rating (pressure and vacuum)
- 7. Temperature rating

2. PRODUCTS

2.1 STEAM TRAPS

A. Type: Float and thermostatic (F&T).

- 1. Fully-modulating type with semi-steel body and cover, suitable for continuous operation.
- 2. Stainless steel float, air vent, head, seat, and valve mechanism.
- 3. Provide to drain from unit heaters, converters, heating coils, steam separators, flash tanks, steam jacketed equipment, and direct steam injected equipment.

B. Type: Inverted bucket (IB).

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**Section 23 22 16 – Steam and Condensate Piping Specialties for  
Facility Services Systems**

1. Inverted-bucket type with semi-steel body and cover, suitable for intermittent operation.
2. Stainless steel bucket, seat, head, operating mechanism, and strainer.
3. Provide to drain condensate from steam main headers and branch lines.

2.2 VACUUM BREAKERS

- A. Body: Stainless steel or ASTM B62, brass, 300 psig (20.68 bar) working pressure at 365°F (185°C).
- B. Ball: Stainless steel.
- C. Valve seat: Stainless steel or rubber O-ring, suitable for high-temperature service.

END 23 22 16

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 22 23 – Steam Condensate Pumps**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Steam condensate system pumps, except where provided as integral part of manufactured piece of equipment, including:

1.) Condensate.

2.) Vacuum heating.

1.2 ACTION SUBMITTALS

A. Shop Drawings including:

- 1. Pump curves.
- 2. Materials of construction.
- 3. Schedule of pumps.
- 4. Performance characteristics.
- 5. Data concerning physical dimensions.
- 6. Motor drive assemblies.
- 7. Bearings.
- 8. Seals.
- 9. Impellers capacities.
- 10. Weights.
- 11. Ratings.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance manuals

2. PRODUCTS

2.1 DESIGN REQUIREMENTS

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**Section 23 22 23 – Steam Condensate Pumps**

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1,750 rpm, unless otherwise noted.
- D. Pumps shall be capable of operating continuously over full operating range without overheating cavitating, excessive noise or vibration, surging or instability when operating in single or in parallel with other pumps.
- E. Pumps shall be suitable for handling fluids at 230°F.

**2.2 CONDENSATE PUMP UNITS**

- A. Service: Steam condensate.
- B. Type: Simplex or duplex as indicated in pump schedule, base-mounted with centrifugal type pumps, receiver and factory installed and wired operating controls.
- C. Pumps: Centrifugal, close-coupled, mechanical seals.
- D. Motor: ODP.
- E. Controls: Unit-mounted, float-operated magnetic starters with overload and low-voltage protection and alternator for duplex units. Both pumps shall operate if one has insufficient capacity.
- F. Receivers.
- G. Pumps:
  - 1. Single-stage or 2-stage, centrifugal, design, permanently aligned and flange-mounted for vertical operation.
  - 2. Each pump shall be bronze fitted with enclosed bronze centrifugal impeller, axial flow, bronze straightening vanes, renewable bronze case ring and stainless steel shaft.
  - 3. Mechanical seals suitable for 250°F (121°C) operation. Each pump closed-coupled to vertical, dripproof motor, delivering full capacity at boiling temperature, or at 2' (600 mm) NPSH.
- H. Provide units with float-operated magnetic starters with overload and undervoltage protection.
- I. Control panel.

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**Section 23 22 23 – Steam Condensate Pumps**

2.3 VACUUM CONDENSATE PUMPS

- A. Packaged construction type, with components and accessories mounted and wired; ready for external piping.
- B. Components: Receiver; water pump(s); separately mounted and independently controlled air pump(s); 1 inlet strainer; float and vacuum controls; electrical controls; accessories.
- C. Receiver tank:
  - 1. Vertical cast-iron with working capacity as scheduled; inlet centerline maximum 15" (380 mm) above floor; consisting of condensate receiver and independent hurling water separation chamber.
  - 2. Accessories: Deaerating cascade baffle; water level gage; vacuum gage; dial thermometer; lifting eye bolts; and reverse-acting temperature limit switch.
  - 3. Inlet strainer with self-cleaning bronze screen and dirt pocket, vertically removable for cleaning.
- D. Air pump:
  - 1. One multi-jet vacuum producer and 1 centrifugal pump and motor assembly mounted on common cast-iron separation chamber.
  - 2. Capable of delivering scheduled capacity saturated air at 5-1/2" (140 mm) Hg vacuum and 160°F (71°C); rated-and tested in-accordance with ASHRAE 47.
  - 3. Hurling or sealing water for air pump, recirculated from independent reservoir and not mixed with condensate.
  - 4. Separation chamber equipped with water level gage, dial thermometer, suction swing check valve, air vent and overflow connections, and automatic hurling water level controls.
  - 5. Pumps: Flange-mounted centrifugal type designed for vertical operation; bronze fitted with bronze impeller, renewable bronze case ring, stainless steel shaft, and mechanical shaft seal.
- E. Controls.

END 23 22 23

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 25 19 – Water Treatment Equipment**

1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design-Build Contractor.
- B. Duplex reverse osmosis (RO) water treatment system including zeolite softener systems complete with necessary accessories and appurtenances.
- C. Chemical feed system including tanks and pumps.
- D. Packaged condensate recovery surge/storage vessel and transfer pumps.
- E. As minimum, skid-mounted zeolite softener system shall consist of following:
  - 1. Two zeolite softeners with ion exchange media.
  - 2. Regeneration equipment including brine storage / measuring tank (brine maker) and pumps, and salt bulk bag storage rack.
  - 3. Interconnecting piping and valves between skids.
  - 4. Motor starters and protective relays, as required.
  - 5. Analog signal wiring from analog field instruments to terminal strip in control panel.
  - 6. Control panel for single-point electrical disconnecting means power connection, mounting power supplies, motor starters, protective relays, transformers, and miscellaneous hardware, as required.
  - 7. PLC controller with HMI for local control of Zeolite softener skid.
  - 8. Field instrumentation, control devices, control tubing and wiring.
- F. As minimum, skid-mounted RO water treatment system shall consist of the following:
  - 1. One operating and one backup RO system with pressure vessels and RO membranes.
  - 2. Chemical feed systems.
  - 3. High-pressure feed pumps.
  - 4. Feedwater pre-treatment equipment.

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**Section 23 25 19 – Water Treatment Equipment**

5. RO storage tank.
6. Interconnecting piping and valves between skids.
7. Motor starters and protective relays, as required.
8. Analog signal wiring from analog field instruments to terminal strip in control panel.
9. Control panel for single-point electrical disconnecting means, mounting power supplies, motor starters, protective relays, transformers, and miscellaneous hardware, as required.
10. PLC controller with HMI for local control of RO water treatment skid.
11. Field instrumentation, control devices, control tubing and wiring.

**1.2 SYSTEM DESCRIPTION**

**A. Existing conditions:**

1. Source of raw water: City of Elgin, Illinois municipal system.
2. Raw water analysis to be used for design shall be obtained from City of Elgin, Illinois and submitted to water treatment manufacturer.
3. Raw water supply pressure: 55-85 psig. 60-65 psig average.

**B. Project requirements:**

1. Materials or features not described: Manufacturer's standard for equipment and suitable for specified service conditions.
2. Provide any additional pretreatment as required to meet feedwater requirements for double-pass RO system.
3. Duty:
  - a. Zeolite softeners shall remove particulate material, and ionizable soluble materials including calcium, magnesium, copper, and iron from campus potable water.
  - b. Reverse osmosis system shall further remove impurities or polish filtered water.
4. Service run termination:
  - a. Zeolite softeners: As required.

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**Section 23 25 19 – Water Treatment Equipment**

- b. RO system: As required.
- 5. Provide necessary control panels for mounting of programmable logic controller and single-point electrical power connection, single-point communication connection, analog and control signal termination strip and mounting all necessary power supplies, motor starters, protective relays, transformers, and any other necessary hardware for complete and operable system.
- 6. One operating and one back-up RO unit is required.
- 7. Final product (permeate) water flow rate from RO unit: minimum 15 gpm per RO unit or as required for makeup by the steam production equipment. Any pretreatment shall have effluent capacity to meet feedwater requirements of each RO unit.
- 8. Each skid shall include:
  - a. Single-point inlet water connection.
  - b. Single-point outlet water connection.
  - c. Single-point electrical disconnecting means.
  - d. Single-point service air connection, as required.
  - e. Instrument termination panel.

1.3 SUBMITTALS

- A. Computations setting forth gross and net capacity of each system.
- B. Regeneration schedules showing flows, regenerant use and time interval of each step.
- C. System piping and instrumentation schematics showing all valves and instruments.
- D. Outline drawings showing equipment arrangement.
- E. Installation drawings for equipment furnished.
- F. Location of all field connections for continuation by installer.
- G. Complete wiring, schematic and logic drawings.
- H. Details of instrument and control devices furnished including outline and installation drawings and catalog data.



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**Section 23 25 19 – Water Treatment Equipment**

- I. Operation and maintenance manuals. Provide, at minimum:
  - 1. General description and technical data.
  - 2. Receiving, storage, installation, and testing instructions.
  - 3. Operating and maintenance procedures.
  - 4. Complete set of final drawings.
  - 5. Complete documentation of inspections and tests performed, including any logs, curves, and certificates. Documentation shall note any replacement of equipment or components that failed during testing.
  - 6. Spare parts lists.
  - 7. Installation field reports.
  - 8. Data sheets updated to reflect field installation conditions.

1.4 QUALITY ASSURANCE

- A. Provide warranty for RO unit and its components to be free from fault or defect in design, workmanship and materials. Warranty shall be for a minimum of 12-months from date of placement in service.
- B. Any defects or improper workmanship shall be repaired or replaced without charge, F.O.B. the installation site, within the warranty period.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Equipment assembly: Mounting and assembly of equipment shall be on skids or racks with face piping and valves in place as much as possible within shipping limits. Equipment assemblies shall be arranged to fit in space available as shown on Drawings.

2. PRODUCTS

2.1 APPROVED MANUFACTURER

- A. Bridging documents are based on systems manufactured by Marlo.

2.2 ZEOLITE SOFTENERS

- A. Number required: minimum 2.
- B. Design pressure: 125 psig.

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**Section 23 25 19 – Water Treatment Equipment**

- C. Flow rate: As required.
- D. Size: TBD.
- E. Exchange media:
  - 1. High capacity sulfonated polystyrene media.
- F. Regenerants:
  - 1. Concentrated sodium chloride brine (NaCl) to be diluted as required in regeneration process.
- G. Regeneration equipment:
  - 1. Brine storage and salt handling tank:
    - a. Approximate size: 50” by 60”
    - b. Capacity: Sufficient size to hold 1 bulk bag (approximately 2000lbs of salt).
  - 2. Bulk Salt Storage:
    - a. Provide bulk bag storage rack for a minimum of 6 months of salt supply.
  - 3. Brine pumps:
    - a. Number required: 1 or as required.
    - b. Type: Horizontal, centrifugal, direct-driven with vertical split case, end suction, top discharge, back pull out design. Pumps shall be chemical process type constructed to ANSI B73.1.
    - c. Capacity and discharge head: As Required.
    - d. Pumped liquid: Saturated brine.

**2.3 REVERSE OSMOSIS EQUIPMENT**

- A. Type: Duplex RO System (1 Operating / 1 Back Up)
- B. RO membranes:
  - 1. Material: Polyamide (PA), spiral wound thin film composite (TFC).
  - 2. Diameter: 8”.
  - 3. Element length: 40”.

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4. Element area: As required.
5. Manufacturer: Dow or GE.
- C. Flux rate, Pass 1 maximum: 15 gfd.
- D. Pressure vessels (membrane housings):
  1. Material of construction: FRP.
  2. Diameter: 8”.
  3. Type: Side entry.
  4. Design: In accordance with ASME Code for Pressure Vessels Section X.
  5. Feed/concentrate side ports: Stainless steel with grooved ends to accommodate flexible grooved couplings.
  6. Manufacturer: Code Line.
- E. Mounting: RO unit shall be on steel frame skids permitting shipment and setting in place with minimum disassembly. Install pressure vessels and associated equipment on common frame.
- F. Accessories:
  1. High-pressure pumps:
    - a. Quantity: 1 per unit, plus 1 spare on hand.
    - b. Design conditions: Capacity and discharge head as required
    - c. Type: Multistage, centrifugal.
    - d. Material of construction: Type 316L stainless steel, or better.
    - e. Manufacturer: Grundfos pumps.
  2. Sample valves: Locate on central panel draining to common basin.
  3. CIP valves.
  4. Individual pneumatically operated valves to control operating and cleaning cycles.
  5. Instrumentation: As required.

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2.4 ADDITIONAL PRETREATMENT EQUIPMENT

A. RO cartridge pre-filters:

1. Filter housings: Type 316L stainless steel.
2. Cartridge filter elements: polypropylene, micron rating sufficient to reduce Silt Density Index to RO membrane manufacturer's requirements.

2.5 CHEMICAL FEED SYSTEM

A. Chemical feed systems: Provide chemical additive system as required by the water treatment, condensate, deaerator, boilers, and steam systems. Additives may include anti-scalant/dispersant, microbiocide, sodium bisulfite, oxygen scavenger, scale inhibitor, and pH control.

1. Mounting: On stand-alone steel frame skids permitting shipment and setting in place with minimum disassembly. Chemical feed skid shall not be attached to any other water treatment equipment.
2. Tanks:
  - a. Chemicals will be supplied in totes or drums.
  - b. Secondary spill containment
  - c. Capacity: Sufficient for 3 days of continuous system operation, or 50 gallons, whichever is greater minimum.
  - d. Low Tank Level Sensor and Alarm
3. Pumps:
  - a. Type: Diaphragm metering.
  - b. Discharge pressure: As required.
  - c. Accessories:
    - 1.) 4-function valve for anti-siphon, pressure relief, priming, and back pressure control.
    - 2.) "Digi-pulse" flow monitor for sensing of low or no flow conditions.
    - 3.) Control: Microprocessor-based, adjustable stroke length and stroke speed. Automatically adjusted rates based on operating data or instrument measurement (pH, ORP, others).

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**Section 23 25 19 – Water Treatment Equipment**

4. Include as an Alternate - 1 year service agreement for supply of chemical feed additives and water testing service.

2.6 REVERSE OSMOSIS WATER STORAGE

- A. Provide storage vessel for the RO Filtered water. Minimum volume: 12hrs of storage
- B. Provide repressurization pumps.

2.7 CONDENSATE WATER STORAGE

- A. Provide packaged condensate recovery surge/storage vessel and transfer pumps including storage tank, motors, and accessories.
- B. Sizing: Minimum volume for 1 hour of storage
- C. Materials: Compatible with hot condensate (212°F) and RO water that has not been to the deaerator.
- D. Provide instrumentation, connections, and accessories as required.
- E. Provide condensate transfer pumps with local control system or control system combined with the deaerator.

3. EXECUTION

3.1 MANUFACTURER'S FIELD SERVICES

- A. Inspect equipment during installation and after it is installed to assure that all details of installation are correct and that equipment is prepared for operation in accordance with manufacturer's instructions and recommendation.
- B. Supervise ion exchange resin loading, if required.
- C. Check connections to equipment and adjust, or supervise adjustment of, control and indicating devices after equipment has been installed and connected.
- D. Fully instruct User's operating personnel in operation and maintenance of equipment.
- E. Supervise preliminary operation of equipment and make necessary adjustments.
- F. Perform initial resin conditioning, if required.

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- G. Conduct service runs to assure satisfactory operation of equipment and controls.
- H. Perform tests to demonstrate production of guaranteed quality water.

END 23 25 19

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DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 31 00 – HVAC Ducts and Casings**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

a. Metal ducts.

b. Duct lining.

1.2 PERFORMANCE REQUIREMENTS

A. Guarantee ductwork to be free of vibration, chatter, objectionable pulsation, and excessive leakage under all conditions of operation.

1.3 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Duct fittings, including particulars such as gage sizes, welds, and configurations.

B. Samples: Duct fittings.

1.4 QUALITY ASSURANCE

A. Use material, weight, thickness, gage, construction, and installation methods as outlined in following SMACNA publications:

1. SMACNA Duct Construction Standards Metal & Flexible, Third Edition.

2. SMACNA Fibrous Glass Duct Construction Standards, Seventh Edition.

B. Construct and install ductwork in accordance with provisions of International Mechanical Code.

C. Perform leakage test as outlined in SMACNA HVAC Air Duct Leakage Manual Second Edition 2012.

D. Verify field measurements prior to fabrication.

2. PRODUCTS

2.1 MATERIALS

A. Galvanized sheet steel:



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1. Cold-rolled, soft sheet steel capable of double seaming without fracture.
2. Zinc coating: G90 in accordance with ASTM A653 and ASTM A90.

B. Sealant:

1. Water-based, water-resistant.
2. Fire-resistive.
3. Compatible with mating materials.
4. Elastomeric mastic
5. Maintain manufacturer's recommended temperatures during and after installation.

2.2 MANUFACTURED DUCTWORK

A. Type: Double-wall.

B. Construction: Spiral lockseam.

C. Outer shell: ASTM A653 galvanized sheet steel.

D. Inner lining: Perforated ASTM A653 galvanized sheet steel, 22% open area.

E. Insulation: 1" (25 mm) thick glass fiber insulation. Insulation shall meet requirements of glass fiber duct lining specified in this section.

F. Fittings:

1. Machine-formed, 1.5 centerline radius or sectional.
2. Spot or tack welded and sealed.
3. For tees and reducing tees: "LO-LOSS" type.

G. Internal bracing: Not acceptable.

H. Provide shipping braces or rigid duct connectors to retain proper shape during shipping. If shipping braces are used, remove before installation of duct.

END 23 31 00

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 33 00 – Air Duct Accessories**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Access doors.
- b. Fire dampers.
- c. Smoke dampers.
- d. Combination fire/smoke dampers.
- e. Balancing dampers.
- f. Backdraft dampers.
- g. Flexible connections.
- h. Flexible duct.
- i. Prefabricated roof curbs.
- j. Prefabricated roof rails.

1.2 INFORMATIONAL SUBMITTALS

- A. Shop Drawings: Data concerning dimensions, capacities, ratings and appropriate identification.
- B. Product Data: Manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.

1.3 QUALITY ASSURANCE

- A. Manufacturer's qualifications: Manufacturers must have at least 5 years experience manufacturing duct accessories, of required types and sizes and whose products have been satisfactory used in similar service.
- B. Regulatory requirements:
  - 1. Fire dampers and Combination Fire/Smoke Dampers: UL-listed and constructed in accordance with UL 555.

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**Section 23 33 00 – Air Duct Accessories**

2. Combination Fire/Smoke Dampers and Smoke Dampers: UL listed and constructed in accordance with UL 555S
3. Fusible links: UL-listed and constructed in accordance with UL 33.
4. Access doors: UL-listed.
5. Use material, weight, thickness, gage, construction, and installation method as outlined in:
6. SMACNA Duct Construction Standards - Metal & Flexible, Third Edition.
7. NFPA 90A - Standard for Air Conditioning and Ventilating Systems.
8. NFPA 90B - Standard for Installation of Warm Air Heating and Air Conditioning Systems.
9. UL 214 - Test for Flame-Propagation of Fabrics and Films.

2. PRODUCTS

2.1 ACCESS DOORS

- A. Fabricate rigid and close fitting doors of materials identical to duct with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum 1" (25 mm) thick insulation with sheet metal cover.
- B. Hinges and locks.
- C. Units shall be suitable for duct pressure class in which it is to be installed.

2.2 DYNAMIC FIRE DAMPERS

- A. Rating:
  1. Fire UL 555 rated for horizontal or vertical installation.
  2. Rating: Provide 1-1/2 hour or 3 hour rating as required by building code.
  3. Dynamic: 2,000 fpm at 4" w.g (10.2 m/s at 1kPa).

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B. Construction:

1. Housing: Galvanized steel for galvanized steel ducts, stainless steel for stainless and aluminum ducts.
2. Blade: Folding curtain type 100% out of airstream (Type B) material to match housing.

C. Fusible link: 165°F (74°C).

D. Fire dampers shall be rated to close with airflow in either direction.

E. Provide bracing, sleeves, and other accessories required by damper manufacturer to meet rated installation requirements.

2.3 COMBINATION FIRE/SMOKE DAMPERS

A. Ratings:

1. Fire: 1-1/2 hour; UL 555 listed, unless noted otherwise.
2. Smoke: Leakage Class II; UL 555S listed. Maximum of 20 cfm per sq. ft. at 4" w. g. (10.2 m/s at 1kPa) and 250°F.
3. Dynamic: 2,000 fpm at 4" w. g. (10.2 m/s at 1kPa).

B. Construction:

1. Housing: Galvanized steel or stainless steel to match duct construction use stainless steel for aluminum ducts, minimum 16 gage (1.5 mm).
2. Blade: Double skin, airfoil type; maximum blade width shall be 6" (150 mm) wide. Galvanized or stainless steel to match duct construction use stainless steel for aluminum ducts.
3. Jamb seal: Stainless steel.
4. Blade seal type: Silicone.

C. Electric fusible link: 165°F (74°C).

D. Actuators.

E. Damper, actuator, and electric "Fuse" link shall be factory installed and wired. Assembled unit shall have single-point power connection and single point fire alarm system monitoring connection. Complete assembly shall be UL 555 and UL 555S listed for use as a fire/smoke damper.

2.4 MANUAL BALANCING DAMPERS

A. Rectangular dampers

1. Single blade dampers:

- a. Suitable for ducts 12” (300 mm) in height and less and 36” (900 mm) in width and less.
- b. Construction:
  - 1.) Frames: Galvanized steel minimum 20-gage (0.9 mm) channel, or minimum 0.081” (2.1 mm) aluminum channel.
  - 2.) Blades: Single thickness, galvanized steel minimum 22-gage (0.8 mm) for 18” (450 mm) wide and less and 20-gage (0.9 mm) over 18” (450 mm) or aluminum minimum thickness of 0.080” (2.032 mm). Blades shall be stiffened as necessary.
  - 3.) Axles: Minimum 3/8” (10 mm) diameter galvanized steel for ducts 18” (450 mm) wide and less, minimum 1/2” (13 mm) diameter galvanized steel for ducts and over 18” (450 mm). Use stainless steel for stainless or aluminum ducts.
  - 4.) Bearings. Oil-impregnated bronze bearings or molded synthetic.

2. Multi-blade dampers: Suitable for all ducts.

- a. Frames: galvanized steel minimum 16-gage (1.5 mm), or minimum thickness of 0.081” (2.1 mm) aluminum channel.
- b. Blades: opposed type, 6” (150 mm) maximum width, galvanized steel minimum 16-gage (1.5 mm), or extruded aluminum minimum thickness of 0.125” (3 mm).
- c. Axles: Minimum 1/2” (13 mm) diameter galvanized or extruded.
- d. Bearings. Oil-impregnated bronze bearings or molded synthetic.
- e. Linkage: Galvanized steel located outside of air stream. For multi-section dampers, provide jackshaft for operation from one side.

B. Round dampers:

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1. Single blade dampers.
2. Construction:
  - a. Frame: Galvanized steel minimum 20-gage (0.9 mm).
  - b. Blades: Single thickness galvanized steel minimum 20-gage (0.9 mm).
  - c. Axles: Minimum 3/8" diameter or square galvanized steel bar.
  - d. Bearings: Oil impregnated bronze bearings or molded synthetic.
- C. Provide with locking hand quadrant with damper position indicator. Where duct is externally insulated provide 2" (50 mm) minimum standoff bracket.
- D. Construct dampers over 48" (1.2 m) in width in multiple sections with mullions.
- E. Provide end bearings or other seals on dampers located in 3" (750 Pa) pressure class or higher ducts.

**2.5 BACKDRAFT DAMPERS**

- A. Type: Rectangular; multi-blade, counterbalanced type; suitable for flange and gasket connection to ductwork.
- B. Construction:
  1. Frames: Minimum 20-gage (0.9 mm) galvanized steel, or 0.081" (2.1 mm) thick extruded aluminum channel.
  2. Blades: 28-gage (0.4 mm) galvanized steel or 0.070" (1.8mm) thick extruded aluminum
  3. Axles: Minimum 3/16" (5 mm) diameter steel axle and blade bracket assembly, or 1/2" (13 mm) diameter, synthetic, full length.
  4. Bearing: Oil impregnated bronze bearings or nylon.
  5. Seals: Vinyl gasket or polyurethane foam blade edge seals.
- C. Performance: Rate dampers in accordance with AMCA Standard 500

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**Section 23 33 00 – Air Duct Accessories**

2.6 FLEXIBLE CONNECTIONS

- A. Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment
- B. Material: Fire-retardant, waterproof, airtight, and comply with UL 214, NFPA 90A, and NFPA 701; 30 oz/sq yd, closely woven glass fabric, double coated with neoprene.
- C. Flexible connection fabric shall be approximately 2" (50 mm) wide tightly crimped into metal edging strip and attach to ducting and equipment by screws or bolts at 6" (150 mm) intervals.

2.7 FLEXIBLE DUCT

- A. Description: UL 181 Class I flexible duct complying with NFPA 90A and 90B
- B. Construction:
  - 1. Inner liner: Chlorinated polyethylene factory clinched in cold-rolled galvanized steel spiral, or with spiral wire permanently bonded to fabric,
  - 2. Insulation: Fiberglass insulation thickness for R-value indicated.
  - 3. Outer jacket: Flame-resistant polyethylene vapor barrier.
- C. Performance:
  - 1. R-value: 4.2 minimum.
  - 2. Maximum operating pressure: 6" w.g. (1.5 kPa).
  - 3. Operating temperature: -20°F to 220°F (-29°C to 104°C).
  - 4. Maximum flame smoke rating: Maximum of 25/50.

2.8 PREFABRICATED ROOF CURBS

- A. Construction:

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**Section 23 33 00 – Air Duct Accessories**

1. 18-gage (1.2 mm), galvanized steel, 55% aluminum-zinc coated sheet, all-welded. Suitable for roof type and suitable for roof slope to provide level equipment mounting surface.
2. Corners: Mitered and continuously welded.
3. Insulation: 1-1/2" (38 mm) thick neoprene coated, 1-1/2 lb/cu ft (24 kg/cu m) density, rigid fiberglass.
4. Wood nail strip: 2 x 2 treated with high quality wood preservative.

B. Accessories:

1. Plywood deck with curb cover for future curbs as shown.
2. Provide vents for hoods serving kitchen equipment.

C. Height: 16" (400 mm) minimum.

2.9 PREFABRICATED ROOF RAILS

A. Construction:

1. 18-gage (1.2 mm) galvanized steel, welded. Suitable for roof type and suitable for roof slope to provide level equipment or pipe mounting surface.
2. Corners: Mitered and continuously welded.
3. Insulation: 1-1/2" (38 mm) thick neoprene coated, 1-1/2 lb/cu ft (24 kg/cu m) density, rigid fiberglass.
4. Wood nail strip: 2 x 2 treated with high-quality wood preservative.

B. Height of rail above top surface of deck: 1'-4" (400 mm).

C. Provide auxiliary framing members for rails to transfer equipment load to adjacent roof framing members.

END 23 33 00



DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 34 00 – HVAC Fans**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Propeller wall fans.
- b. Powered roof fans.
- c. Centrifugal cabinet fans

1.2 INFORMATIONAL SUBMITTALS

A. Product Data:

- 1. Catalog data showing selection and options.
- 2. Manufacturer's Installation Instructions.

B. Shop Drawings:

- 1. Dimension drawings.
- 2. Fan curves.
- 3. Sound ratings.
- 4. Material of construction.
- 5. Weights.
- 6. Vibration isolation.
- 7. Motor data as specified.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Insofar as practicable, provide fans of same manufacturer throughout.
- B. Test fans as complete units in accordance with applicable test code of AMCA. Fans shall be certified by AMCA.

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**Section 23 34 00 – HVAC Fans**

- C. Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.
- D. Fabrication and installation shall be in accordance with SMACNA and manufacturer's recommendations.
- E. Industrial Ventilation, 25th Edition, American Conference of Governmental Industrial Hygienists.

1.5 WARRANTY

- A. HVAC systems and products shall be provided with a minimum two-year warranty.

2. PRODUCTS

2.1 DESIGN REQUIREMENTS

- A. Provide fans with variable pitch V-belt drives for 15 hp and smaller and fixed drives for 20 hp and larger. Provide variable pitch drive for purposes of initial system balancing on 20 hp and larger fans. Provide fixed pitch drives for final system balancing. V-belt drives shall be designed for 150% of motor rating.
- B. Fans shall be statically and dynamically balanced and shall operate without objectionable noise or vibration. Variable speed fans shall be statically and dynamically balanced for entire range of speed operation.
- C. Where fan drives are exposed, provide guards in accordance with applicable code requirements. Provision shall be made so tachometer may be used to verify fan speed without removing guard assembly.

2.2 PROPELLER WALL EXHAUST AND SUPPLY FANS

A. Construction:

- 1. Housing: Welded and/or bolted steel.
- 2. Propeller: Steel.

B. Bearings:

- 1. Regreasable with fittings extending outside of casing for ease of service.
- 2. Heavy-duty, self-aligning, pillow block, ball bearing type.
- 3. L50 rated at not less than 200,000 hours.

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**Section 23 34 00 – HVAC Fans**

C. Accessories:

1. Unit-mounted disconnect switch. Wall collar.
2. OSHA wire guard with hinge and locking hasp.
3. Weather hood.
4. Damper.
5. Filter section

2.3 POWERED ROOF EXHAUST FANS:

A. Construction:

1. Housing: Heavy-gage spun aluminum.
2. Wheel: Centrifugal, backward inclined aluminum.

B. Bearings:

1. Regreasable with fittings extending outside of casing for ease of service.
2. Heavy-duty, self-aligning, pillow block, ball-bearing type.
3. L50 rated at not less than 200,000 hours.

C. Accessories:

1. Unit-mounted disconnect switch.
2. Roof Curb shall adjust for roof or structure slope. Top of curb shall be level.
3. Factory-fabricated roof curb.
4. Hinged base.
5. Gravity damper.
6. Motor-operated damper.
7. Bird screen.
8. Lifting lugs.
9. Drive assembly vibration isolators.

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**Section 23 34 00 – HVAC Fans**

10. Fan speed controller for direct drive units.

2.4 CENTRIFUGAL CABINET FANS

A. Construction:

1. Housing: Galvanized steel.
2. Wheel: Galvanized steel forward curved, non-overloading.

B. Drive: Direct-drive.

C. Accessories:

1. Unit-mounted disconnect switch.
2. Backdraft damper.
3. Vibration isolators.
4. Oven baked white enamel steel grille for ceiling fans.
5. Fan speed controller.
6. Time delay switch.
7. Wall cap.

END 23 34 00

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 35 00 – Special Exhaust Systems**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Paint shop fume hood.
- b. Tech shop dust collection system.

1.2 INFORMATIONAL SUBMITTALS

- A. Shop Drawings including data pertaining to manufacturer, model, type, materials of construction, pressure drops and capacities of products specified.

1.3 QUALITY ASSURANCE

- A. Work shall be in accordance with International Mechanical Code and International Building Code.

2. PRODUCTS

2.1 PAINT SHOP - DING AND POINT SOURCE FUME EXHAUST SYSTEM

- A. Flexible ductwork shall be confined to exhaust arm assemblies.
- B. Systems shall be complete with:
- C. Electrostatic filters, where indicated.
- D. Ductwork.
- E. Exhaust arm assemblies.
- F. Mylar coated, fiberglass reinforced flexible ductwork.

2.2 CARPENTRY SHOP - LOCAL PICKUP HOODS

- A. Furnish pickup hoods, as required, as detailed and as indicated in Industrial Ventilation, 15th Edition, American Conference of Industrial Hygienists, Edwards Brothers, Inc., Ann Arbor, Michigan.

3. EXECUTION

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**Section 23 35 00 – Special Exhaust Systems**

3.1 MATERIALS HANDLING SYSTEMS

- A. Install material handling system in accordance with manufacturer's recommendations.
- B. Systems shall be complete as required for each system including:
  - 1. Dust collectors.
  - 2. Filters.
  - 3. Ductwork.
  - 4. Fans.
  - 5. Flexible ductwork.
  - 6. Material pickup heads.
  - 7. Blast gates.
  - 8. Floor sweeps.
  - 9. Cone adapter.
- C. Install blast gates in vertical branch ducts near served equipment.
- D. Install galvanized, flexible piping with no excessive lengths. Length shall be minimum necessary.
- E. Install minimum 4" flexible duct connections at fan discharge and dust collector inlet connections.

3.2 FABRICATION

- A. Longitudinal joints of ducts shall be lapped and riveted or spot welded on 3" maximum centers and soldered airtight.
- B. Girth joints shall be made with inner lap in direction of air flow with 1" minimum laps.
- C. Elbows: Centerline radius of 2 pipe diameters.
- D. Hoods must be reinforced and ground free of sharp edges and burrs.
- E. Main transition tapers: 5" taper for each inch, 1" diameter change.
- F. Branch ducts shall enter main ducts at preferred angle of 30°, not to exceed 45°. Branches to enter at top or side of mains only.

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**Section 23 35 00 – Special Exhaust Systems**

- G. Provide dead-end caps 6" from last branch.
- H. Rectangular ducts shall be used only when clearances prevent use of round ducts. Weight of metal shall be equal to round duct construction of diameter of greatest dimension.

END 23 35 00

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 37 00 – Air Outlets and Inlets**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

a. Diffusers, registers, and grilles:

1.) Supply grilles and registers.

2.) Return, exhaust, and transfer grilles and registers.

3.) Industrial supply grilles.

4.) Industrial return and exhaust grilles.

b. HVAC intake and relief hoods:

c. Louvered penthouses.

d. Gravity ventilators.

1.2 INFORMATIONAL SUBMITTALS

A. Product Data:

1. Catalog data showing selection and options.

2. Manufacturer's installation Instructions.

B. Shop Drawings:

1. Dimension drawings.

2. Airflow capacities.

3. Sound ratings.

4. Material of construction.

5. Finishes.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.



DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 37 00 – Air Outlets and Inlets**

1.4 QUALITY ASSURANCE

- A. Wherever possible, provide product of same manufacturer throughout.
- B. Grilles, registers, and diffusers shall be rated in accordance with ANSI/ASHRAE 70 (latest edition) Method of Testing for Rating the Performance of Air Outlets and Inlets.

2. PRODUCTS

2.1 DIFFUSERS, REGISTERS, AND GRILLES

A. Supply grilles and registers:

- 1. Type: Rectangular, double deflection, 1-1/4" margin, and 2/3" or 3/4" blade spacing.
- 2. Construction:
  - a. Materials: Steel or extruded aluminum.
  - b. Individually adjustable horizontal and vertical blades.
  - c. Front blades horizontal, rear blades vertical.
- 3. Frame: Suitable for ceiling, wall, or duct mounting.
- 4. Performance: Maximum NC level shall be 30 and maximum static pressure drop shall be 0.05 in. w.g.

B. Return, exhaust, and transfer grilles and registers:

- 1. Type: Rectangular, horizontal 42° deflection blades, 1-1/4" margin, 2/3" or 3/4" blade spacing.
- 2. Frame: Suitable for mounting in wall, ceiling, or duct.
- 3. Materials of construction: Steel or extruded aluminum.
- 4. Performance: Maximum NC shall be 30, and maximum static pressure drop shall be 0.05" w.g.

C. Industrial supply grilles:

- 1. Type: High-volume, corrosion-resistant with 1-1/4" margins, 1-1/2" blade spacing.
- 2. Frame: Suitable for duct mounting.

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3. Materials of construction: Extruded aluminum.
4. Performance: Maximum NC shall be 30, and maximum static pressure drop shall be 0.05" w.g.

**D. Industrial return and exhaust grilles:**

1. Type: Heavy-duty, 0° deflection, 1/2" blade spacing.
2. Frame: Suitable for duct mounting.
3. Materials of construction: 20-gage steel or heavy duty extruded aluminum.
4. Integral damper.
5. Performance: Maximum NC shall be 30, and maximum static pressure drop shall be 0.05" w.g.

**E. Linear diffusers:**

1. Type: Linear slot-type with fixed pattern deflector and companion boot.
2. Frame: Suitable for mounting on standard tee-bar suspended ceiling system.
3. Materials of construction: 24-gage zinc-coated steel boot insulated with 1/2" fiberglass insulation.
4. Performance: Maximum NC shall be 30, and maximum static pressure drop shall be 0.05" w.g.

**F. Linear returns:**

1. Type: Linear slot-type with fixed pattern deflector and companion boot.
2. Frame: Suitable for mounting on standard tee-bar suspended ceiling system.
3. Materials of construction: 24-gage zinc-coated steel.
4. Performance: Maximum NC shall be 30, and maximum static pressure drop shall be 0.05" w.g.

**G. Ceiling diffusers:**

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1. Style: Round or square face ceiling diffuser with panel and round or square neck.
2. Frame: Suitable for mounting in lay-in acoustical tile ceiling (tee-bar, exposed grid).
3. Materials of construction: Steel or aluminum.
4. Performance: Maximum NC shall be 30, and maximum static pressure drop shall be 0.05" w.g.

**2.2 HVAC INTAKE AND RELIEF HOODS**

**A. Louvered penthouses:**

1. Construction:
  - a. Square or rectangular.
  - b. Welded 8 gage support structure.
  - c. Extruded aluminum louvers with mitered corners.
  - d. Welded aluminum base with curb cap.
  - e. Anti-condensate coating.
  - f. Hoods shall be securely attached, hinged for damper access, and shall be stressed or otherwise reinforced for snow and wind loads and sloped for drainage.

**B. Gravity ventilators:**

1. Construction:
  - a. Tiered 16 gage removable spun aluminum hood.
  - b. Rigid aluminum support structure.
  - c. Welded aluminum base and curb cap.
  - d. Spun aluminum baffle with rolled reinforced bead.

END 23 37 00

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**Section 23 52 00 – Heating Boilers and Accessories**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Condensing Boilers.
- b. Condensing Boiler Accessories.

1.2 ACTION SUBMITTALS

A. Shop drawings:

- 1. Fuel train.
- 2. Wiring diagram.

B. Product data:

- 1. Boiler trim and control equipment.
- 2. Burner and control equipment.
- 3. Dimensions.
- 4. Connection points for following:
  - a. Natural gas.
  - b. Combustion air.
  - c. Breeching.
  - d. Electrical.

1.3 INFORMATIONAL SUBMITTALS

- A. Test Reports: Operational test report.
- B. Manufacturer's installation instructions.
- C. Heat exchanger warranty.

1.4 CLOSEOUT SUBMITTALS

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A. Manufacturer's operation and maintenance instructions.

1.5 QUALITY ASSURANCE

A. Boiler shall bear ASME "H" stamp.

B. ASHRAE 90.1 energy efficiency standards.

C. ANSI Z21.13 test standard.

1.6 WARRANTY

A. HVAC systems and products shall be provided with a minimum two-year warranty.

2. PRODUCTS

2.1 DESIGN CRITERIA

A. Design boiler for interior installation.

B. Minimum efficiency on natural gas of 96% at full fire at 100°F return water temperatures.

2.2 CONDENSING BOILERS

A. Provide factory packaged unit complete with jacket, gas manifold, burner, controls, primary heat exchanger, secondary heat exchanger, circulation pump, and other trim required for operation.

B. Casing: Minimum 16-gage steel jacket with powder coated finish. .

C. Primary heat exchanger: Copper tube with integral fins with cast iron headers and stainless steel inner shell

D. Secondary heat exchanger: Type 316L stainless steel for condensing application. Provide provisions for condensate removal.

E. Burner:

1. Gas fired.

2. Sealed combustion chamber.

3. Flame rectification probe.

4. 96% minimum thermal efficiency.

F. Trim:

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1. Water circulation pump.
  2. 30 lb ASME pressure relief valve.
  3. Inlet and outlet temperature gages.
  4. Air pressure switch.
  5. Drain valve.
  6. High temperature limit switch.
  7. Two low water level cutoff switches; one shall be a manual reset.
- G. Control panel shall be unit mounted.
- H. Safety controls:
1. Operating temperature controller for automatic start and stop.
  2. High limit temperature controller with manual reset.
  3. One low water cutoff probe in boiler shell.
  4. Air safety switch to prevent operation unless sufficient combustion air is assured.
  5. Flame detector to prove combustion
- I. Venting:
1. Provide air intake connection with flexible rubber coupling. Do not design connection to boiler combustion air connection to support external mechanical load from combustion air system.
  2. Forced draft combustion boiler shall be UL-approved as a direct vent boiler. Boiler shall require a stack utilizing CAT IV - AL-29-4C or equivalent, and be approved by manufacturer.
  3. Horizontal stack shall pitch back to boilers at least 1/4" (6 mm) per linear exhaust stack feet.
- J. Provide condensate drain connection in exhaust outlet. Provide condensate drain kit to collect and drain flue gas condensate. Condensate piping shall be galvanized steel.

END 23 52 00

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 52 39-19 – Packaged Fire Tube Boilers and Accessories**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build Contractor.

1. Three packaged-type, forced draft, fire-tube boiler with economizer.
2. Manufacturer's field services.

1.2 RELATED REQUIREMENTS

A. Section 23 09 33 - INSTRUMENTATION AND CONTROL FOR STEAM GENERATORS: Boiler Controls System for the new boilers and boiler master panel.

1.3 INFORMATIONAL SUBMITTALS

A. Product Data:

1. Description and make of burner, flame safety control system, and combustion control system.
2. Weight of unit shipped assembled.
3. List of recommended spare parts with prices. Do not include in bid price.
4. Complete electrical data.
5. Operation, service, and parts manual for equipment furnished.
6. Maximum allowable loads (lbs) and moments (ft-lbs) at boiler steam nozzle and thermal growth and direction (in) when operating.

B. Test Reports:

1. Two certified manufacturer's data reports covering shop tests.
2. Performance data of all components.
3. Certified factory test report to verify construction and operation of unit.
4. Authorized boiler inspection reports prior to shipment.

1.4 ACTION SUBMITTALS

A. Shop Drawings:

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1. General description of steam generating unit and auxiliary equipment with complete listing of all components.
2. Certified outline drawing showing generating unit and auxiliary equipment.
3. Certified outline drawings indicating loads, anchor bolt locations and size, external connection details and locations.
4. Certified electrical drawings for controls and external wiring connections.
5. Schematic control and wiring diagrams.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and maintenance manuals for equipment including spare parts lists, bill of materials, operating and maintenance procedures. Include equipment outline drawings and data sheets in manuals.
- B. Complete price list of recommended spare parts for 5 years of operation.

**1.6 QUALITY ASSURANCE**

- A. Design and construct boiler and accessories in accordance with ASME Boiler and Pressure Vessel Code, Section I, Power Boilers, and local laws, regulations, and codes having jurisdiction in area where plant is located.
- B. Boiler controls and safety devices shall be designed and constructed in accordance with NFPA 70 and 85. Electrical equipment shall be in conformity with Underwriters' Laboratories requirements.
- C. Complete packaged boiler shall be approved as a unit by Underwriters' Laboratories and shall bear UL/ULC label.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Goods shall be shipped as packaged units.
- B. Piping connections and other openings shall be plugged or capped to prevent entrance of foreign material.
- C. Thoroughly coat exposed machined surfaces with rust preventative.
- D. Goods shall be properly covered, skidded, and crated to facilitate handling and to withstand normal shipping and handling shocks and vibration.



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1.8 GUARANTEE

- A. Entire boiler/burner package shall be guaranteed and warranted by boiler manufacturer. Warranty shall include all parts for a period of twelve (12) months from date of start-up.
- B. Guarantee boiler capacity as specified in article “Design and Operating Conditions.”

2. PRODUCTS

2.1 MANUFACTURER

- A. Bridging documents are based on a Cleaver-Brooks Model CBEX Dryback Elite-700-500-200ST.

2.2 DESIGN AND OPERATING CONDITIONS

- A. Horsepower: 500 bhp.
- B. Design pressure: 175 psig.
- C. Operating pressure: 140 psig.
- D. Operating temperature: 353°F.
- E. Feedwater operating pressure, inlet economizer: 230 psig.
- F. Feedwater temperature, inlet economizer: 227°F.
- G. Fuel:
  - 1. Design boiler to operate using commercially available natural gas or No. 2 fuel oil. Manufacturer shall provide specific fuel analysis used in determining performance of boiler,
  - 2. Natural gas: Plant pressure is nominal 10 psig.
  - 3. No. 2 fuel oil: Plant pressure is nominal: 30 psig operating, 75 psig maximum.
- H. Emissions:
  - 1. Emissions of nitrogen oxides shall not exceed 30 ppm, dry volume basis and corrected 3% O<sub>2</sub> when firing natural gas.
  - 2. Design boilers to meet applicable emission limits contained in the new facility air permit as described in the Basis of Design Section 9.

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- I. Boiler efficiency (fuel-to-steam) with economizer shall be not less than 84% (HHV) at full load when firing natural gas.
- J. Boiler efficiency (fuel-to-steam) with economizer shall be not less than 87% at full load when firing fuel oil.
- K. Electrical characteristics: 480-volt, 60 Hz, 3-phase. Boiler to contain necessary transformers to provide auxiliary power.
- L. Boilers will be located indoors.
- M. Boiler Stack height will be based on International Mechanical Code, International Fuel Gas Code, and new facility air permit requirement.

**2.3 FIRE TUBE STEAM BOILER**

- A. Packaged, 4-pass steel scotch marine fire-tube boiler for positive pressurized firing with integral forced draft burner. Boiler shall be of dry-back design, with minimum 5 square feet of heating surface per boiler horsepower. Mount boiler on heavy steel frame with integral forced draft burner and burner controls.
- B. Boiler shall be completely preassembled and fire tested at factory. Unit shall be ready for immediate mounting on floor or simple foundation and ready for attachment of feedwater, steam, fuel, electrical, vent, and blowdown connections.
- C. Construct boiler pressure vessel in accordance with ASME Boiler Code and shall receive authorized boiler inspection prior to shipment. A copy of inspection report shall be furnished to User.
- D. Boilers shall be of all-welded construction and shall be designed to minimize stresses due to uneven temperatures of various metal parts during firing.
- E. Front and rear doors shall be davited to allow full access to front and rear tube sheet, respectively. When opened, doors shall expose all tubes, tube sheets and furnace for ease of inspection and maintenance.
- F. Observation ports for inspection of flame conditions shall be provided at rear end of boiler and in burner assembly at front end.
- G. Skid and lifting holes: Boiler shall be welded to heavy-duty skid type base designed so that boiler can be moved using rollers or by lift truck. Lifting holes shall be available to permit raising or lowering boiler by crane.

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**2.4 EMISSION CONTROLS**

- A. Boiler shall be equipped with a low emission (LE) option for guaranteed NO<sub>x</sub> performance at 30 ppm, dry volume basis and corrected to 3% O<sub>2</sub> when firing natural gas.
- B. Emission control system shall not use an external fan, control valve, and piping. Boiler fuel-to-steam efficiency and rated boiler capacity shall be guaranteed while boiler is operating at low NO<sub>x</sub> performance levels.
- C. Burner, boiler, and low NO<sub>x</sub> system shall be manufactured as a package by a single manufacturer. The low emission option shall include factory testing as a package, and shall bear UL packaged label. The boiler nameplate shall include approved UL low NO<sub>x</sub> boiler model designation. No field assembly of burner or low NO<sub>x</sub> equipment shall be required.

**2.5 BOILER ECONOMIZER**

- A. Design and construct economizer in accordance with latest edition of Section 1 of ASME Boiler and Pressure Vessel Code and local laws, regulations, and codes having jurisdiction in area in which plant site is located. Applicable Code pressure vessel stamp with papers to be furnished and included with instruction manuals.
- B. Shop hydrostatic test shall be performed by manufacturer on economizer in accordance with ASME Boiler Code.

**2.6 BOILER TRIM**

- A. Furnish unit with boiler trim in accordance with ASME Code and State of Illinois requirements.
- B. Safety valve: Number and size in accordance with ASME Code.
- C. Provide piping extending to limit of ASME boiler piping (boiler external piping and joint).

**2.7 COMBUSTION CONTROL SYSTEM**

- A. Boiler shall be factory equipped with integrated boiler control system providing technology and functions as indicated Section 23 09 33.
- B. Integrated packaged burner design consisting of natural gas/fuel oil burner and piping train; combustion air windbox with forced draft fan and drive assembly; flame safeguard system; and firing rate control system. Flame safeguard system shall comply with NFPA 85.

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C. Natural gas and fuel oil burner and piping:

1. Burner shall be suitable for burning natural gas and No. 2 fuel oil.
2. Piping trains, burner, and controls shall be UL-listed and FM-approved.
3. Main gas piping train shall be factory piped and contain single process connection, including strainer.
3. Main fuel piping shall consist of manual fuel train isolation valve, pressure regulator, relief valve (if required), low gas pressure switch, primary shutoff valve, secondary shutoff valve, butterfly modulating valve, 2 motorized safety shutoff valves with both having proof of closing interlock, normally open automatic vent valve, pressure gages, test connections, and checking cock.
4. Main fuel piping shutoff valves shall be motorized with proof of closure switch. Provide valved and capped leakage test connection with leakage test valve following both primary and secondary shutoff valves.
5. Provide lubricated cock-type manual isolation valves.
6. Full modulating control of fuel and combustion air.
7. Utilize solid state controls and sensors to provide various control functions.
8. Modulating control algorithm shall be proportional-integral-derivative (PID) type.
9. Pilot fuel piping shall consist of manual isolation valve, one N.O. solenoid vent valve, 4-1/2" pressure gauge on gas supply at ignitor, pressure regulator, relief valve (if required), and two solenoid-type safety shutoff valves.
10. Fuel oil piping train shall be factory piped and contain single process connections for fuel oil supply, fuel oil return, and atomizing air. Main fuel oil piping shall consist of oil temperature switch, oil flow control valve, oil back-pressure regulator, dual safety shutoff valves each with proof of closure (provide means to prevent or relieve excess pressure between these 2 valves), 4-1/2" oil supply pressure gage on oil supply to piping train, fuel oil heater, oil supply pressure switch, oil temperature indicator, automatic gun purge valves and piping, 4-1/2" pressure gage for oil supply at burner, and inlet hand shutoff valve.
11. Provisions for hardwired signals to and from existing boiler master panel:

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- a. Boiler start command.
- b. Firing rate command.
- c. Ready signal
- D. Provide pressure transmitter, manifold for use by local boiler master. Provide plant master signal and transmitter.
- E. Unit shall have combination gas and oil burner.
- F. Additional features:
  - 1. Variable speed outputs to combustion air fan blower motor for improved boiler efficiency and reduced energy costs
  - 2. Parallel positioning fuel/air combustion control system.
  - 3. O<sub>2</sub> trim for constant combustion monitoring and optimum fuel to air adjustment.
- G. Unit shall have efficient gas combustion by entering gas through ports ahead of diffuser providing mixing of gas and air.
- H. Flame retention shall be assured at all firing rates. Unit shall have 10:1 turndown capability on natural gas and 8:1 turndown capability on No. 2 fuel oil. Control system shall have selector switch which permits selection of fixed rate or fully modulating operation. No burner modifications or readjustment shall be required when changing from one fuel to other.
- I. Unit shall have backward-curved, cast aluminum impeller mounted in machined housing which shall provide combustion air for various furnace pressures. Air housing shall be hinged for convenient inspection or service of firing head components.
- J. Provide burner with air inlet silencers.
- K. Provide pressure gauge at burner inlet to boiler.
- L. Maximum sound level of boiler/burner package shall not exceed 90 dBA when measured in accordance with ABMA Sound Test Standards.

**2.8 BOILER MANAGEMENT CONTROL SYSTEM**

- A. Boiler shall be factory equipped with integrated boiler control system providing technology and functions as indicated Section 23 09 33.

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2.8 BOILER ELECTRICAL INTERFACE

- A. Equip boiler with single-point connection; 480 volts, 3-phase, 60 Hz, 150 amperes minimum supply required. Electrical entrance box shall have disconnect capable of being locked in either “On” or “Off” position. Entrance box shall have nameplate complying with NEC Article 670.3.
- B. Common enclosure shall house control panel and entrance panel. Enclosure shall be NEMA 4 rated and shall be mounted at side of boiler in a location convenient to operator. Enclosure shall consist of upper and lower sections divided by a partition with a separate hinged door for each section. Upper section (low voltage) will house boiler controls including flame safeguard (BMS), water level system controller and Boiler Control system. Lower panel section (high voltage) will house entrance panel.
  - 1. Electrical equipment and wiring shall be in conformance to UL requirements and NEC.
  - 2. Furnish boilers with control circuit transformer and fuse protection for control circuit.

2.9 FEEDWATER CONTROL VALVES AND ACCESSORIES

- A. Electric proportioning type, carbon steel, feedwater regulator station with 3-valve bypass arrangement. Size regulator to flow adequate feedwater from deaerator, through flue gas economizer and into boiler with minimum pressure loss.
- B. Water column/low water cutoff and water level control system:
  - 1. Type: Microprocessor-based electronic controller, noncontact, nonwearing, continuously reading absolute level sensor and pressure chamber.
  - 2. Panel-mounted and operate in ambient temperatures from 32°F to 125°F.
  - 3. Pressure chamber: Boiler-mounted and operate to pressures of 250 psig.
  - 4. Level sensor shall operate to pressures of 250 psig and temperatures to 400°F.
  - 5. Construct pressure containing components in accordance with ASME Code.
  - 6. Level and error indicating lights, alphanumeric display for messaging, reset/menu switch and following features:

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- a. Continuous level indication.
- b. Low water cutoff and alarm.
- c. High water alarm.
- d. Low and high water warning.
- e. Full control of modulating feedwater valve.
- f. Continuous monitoring of float operation.
- g. Column blowdown detection and reminder.
- h. Auto or manual reset.
- i. Real time clock.
- j. Alarm annunciation.
- k. Alarm history files with time stamp.
- l. Water column blowdown record.
- m. Auxiliary low water cutoff check.
- n. RS 232 interface.
- o. Maximum contacts rating 15 amperes resistive load.

C. Provide feedwater piping with single pipe connection.

**2.10 BREECHING AND DUCTWORK**

- A. Stacks and breeching shall be positive pressure, air-insulated double wall piping with factory prefabricated sections such that adjacent sections can be butted together and fastened to hold entire assembly together, and maintain proper air space between inner and outer walls.
- B. Stacks and breeching components, support and terminations shall be tested and listed by UL 103, for use with building heating equipment burning gas, liquid or solid fuels as described in NFPA 211.
- C. Stacks and breeching shall have inner walls of minimum 20 gage Type 304 stainless steel for gas and No. 2 oil, or 20-gage Type 316 stainless steel for coal, solid fuels, and No. 4 and No. 6 oil.
- D. Outer jacket:

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1. Minimum 24-gage, Type 304 stainless steel for sizes 6” to 24” I.D.
2. Minimum 20-gage Type 304 stainless steel for sizes 26” to 48” I.D.
- E. Provide minimum 1” air space between inner and outer walls of stacks and breeching. Inner and outer walls shall remain concentric through use of sinusoidal spacers, which are not fixed to either wall. Inner and outer walls shall be separable for ease of replacement in event of damage.
- F. Make connections through use of point-of-use nuts and bolts. Field seal inner pipe joints by use of containment bands and high-temperature sealant (i.e. VS-2000). Outer joints exposed to outside weather conditions shall use VS-600 to seal against precipitation.
- G. Stacks and breeching shall comply with National Safety Standards and all building codes when installed in accordance with manufacturer’s installation instructions. Stacks extending above roof shall terminate a minimum of 3’ above roof or parapet (NFPA 211), or as required by local codes.
- H. Parts exposed to outside atmosphere shall be made of Type 304 or Type 316 stainless steel or shall be coated by installer with one base coat and one finish coat of weather-resistant paint.
- I. System shall maintain airtight integrity at pressures up to 60” wc.
- J. Two 90° opposed environmental test ports with access covers in vertical stack section above roof line.

**2.11 SOURCE QUALITY CONTROL**

- A. Shop-assembled pressure parts of boiler(s) and other accessories shall be hydrostatically tested in manufacturer's shop at a pressure of 1-1/2 times design pressure. Manufacturer's data report to confirm compliance with ASME Code requirements shall be furnished by manufacturer.
- B. Shop test burner assemblies and controls at factory.

**3. EXECUTION**

**3.1 BREECHING AND DUCTWORK**

- A. Install to provide clearances to combustibles as low as 6” depending on pipe diameter with flue gas temperatures not exceeding 1,000°F continuous or 1,400°F continuous.
- B. Inspect ducts to ensure construction debris is removed prior to startup of boilers.



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- C. Expansion joints: Install where necessary to permit unrestricted thermal movement of ductwork and breeching, avoiding transmission of forces to any equipment, structural supports, etc.
- D. Provide flashings at wall or roof penetrations in accordance with manufacturer's recommendations. Make appropriate modifications to accommodate for roof, floor or wall construction.

**3.2 FACTORY TESTS**

- A. Perform and document factory testing to meet ASME Code requirements and their quality control plans.
- B. User shall have option of witnessing shop tests.

**3.3 FIELD PERFORMANCE TESTS**

- A. Supplier shall perform a short form ASME performance acceptance test. User will furnish fuel, treated feedwater, electric power, control air, test instruments, and personnel.
- B. Supplier shall conduct boiler testing on natural gas. Test shall be over full range of boiler in 10% increments of capacity. Boiler test time at each 10% increment shall be 5 minutes minimum.
- C. Upon completion of field performance testing, submit detailed startup and testing report.
- D. If furnished equipment fails to function properly according to guaranteed performance, Contractor shall make necessary corrections, including replacement equipment and field labor, at no cost to User, and after such corrections are completed, demonstrate to User that equipment function properly and guaranteed performance is obtainable.

**3.4 MANUFACTURER'S FIELD SERVICES**

- A. Furnish services of manufacturer's authorized factory service engineer to start-up, adjust, and operate boilers and all other equipment furnished by boiler manufacturer.
- B. Manufacturer's authorized factory service engineer shall provide one additional day to instruct User's personnel in start-up, adjustment, and operation of boilers and all other equipment furnished by boiler manufacturer.
- C. User will furnish all fuel, water, boil-out chemicals, power, and labor required during startup, adjustment, and operation of boilers.

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- D. Provide written record of startup performance including burner setting at high and low fire.

3.5 TRAINING

- A. Engage a factory-authorized service representative to train Using Agency's maintenance personnel to adjust, operate, and maintain equipment.

END 23 52 39.19

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING  
**Section 23 73 00 – Central Station Air Handling Unit**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor to provide roof-mounted, central station air handling units as scheduled on Drawings.
  - a. Units serving conditioned spaces (DX cooling and hot water heat) may be provided as split systems (basis of design) or as packaged rooftop units.
  - b. Unit serving the boiler room shall be roof-mounted with hot water heating coil.

1.2 INFORMATIONAL SUBMITTALS

A. Product Data:

1. Catalog data showing selection and options.
2. Manufacturer's Installation Instructions.
3. Fan curves showing cfm, static pressure and rpm, brake horsepower for operating range of 10% above and below design condition.
4. Manufacturer's operation and maintenance data.

B. Shop Drawings:

1. Dimension drawings.
2. Fan curves.
3. Sound ratings.
4. Material of construction.
5. Weights.
6. Tag numbers.
7. Vibration isolation.
8. Motor data.

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**Section 23 73 00 – Central Station Air Handling Unit**

1.3 QUALITY ASSURANCE

- A. Energy efficiency: Meet or exceed ASHRAE 90.1.
- B. Indoor environmental quality:
  - 1. Ventilation: Meet or exceed ASHRAE 62 and all published addenda.
  - 2. Filtration: Meet or exceed ASHRAE 52.
  - 3. Thermal Comfort: Meet or exceed ASHRAE 55.
  - 4. Maintain positive pressure within the building.
- C. Insofar as practicable, provide air handling units of same manufacturer throughout.
- D. Provide fans bearing AMCA certified rating seal.
- E. Provide filter media with UL Class I or Class II rating, as required by local authorities.
- F. Units shall display ARI certification symbols.
- G. Materials shall meet requirements of NFPA 90A and 90B.
- H. Comply with AMCA standards for testing and rating fans, and testing louvers, dampers, and shutters.
- I. Comply with SMACNA duct construction standards for air handling units.

1.4 WARRANTY

- A. HVAC systems and products shall be provided with a minimum two-year warranty.

2. PRODUCTS

2.1 DESIGN REQUIREMENTS

- A. Air handling unit total static pressure shall include static pressure loss of casing and components furnished within unit.
- B. Motor furnished with fan shall not operate into motor service factor. Drive efficiency shall be considered in motor selection according to manufacturer's published recommendation, or in accordance with AMCA Publication 203, Appendix L.

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C. Fans shall be statically and dynamically balanced and shall operate without objectionable noise or vibration throughout entire range of fan speed.

D. Design air handling unit to meet the requirements of ASHRAE 62.1.

**2.2 EQUIPMENT**

A. Air-cooled condensing units as scheduled on Drawings.

**2.3 FAN**

A. Supply fan: Variable-speed fans shall be balanced through entire speed range.

B. Provide heavy-duty, self-aligning pillow-block type ball bearings, L50 life of 200,000 hours. Extend lubrication fittings to exterior of fan casing for ease of service.

C. Provide fans with variable pitch V-belt drives for 15 hp and smaller and fixed drives for 20 hp and larger. Provide variable pitch drive for purposes of initial system balancing on 20 hp and larger fans. Provide fixed pitch drives for final system balancing. Design V-belt drives for 150% of motor rating

D. Provide fans with belt guard if belt and drive assembly is located outside of casings. Make provisions for use of tachometer to verify fan speed without removing belt guard assembly. Outdoor units shall have fans located within casing. Units with fans located in casing do not require belt guards

E. Provide vibration isolators recommended by air handling unit manufacturer.

F. Provide roll filter section to match unit size.

G. Flat filter boxes:

1. Provided as part of mixing box.

2. Limit filter velocity, based on gross area, to maximum 400 ft/min (122 m/min).

3. Filter: Minimum Efficiency Reporting Value (MERV) 8 tested in accordance with ASHRAE Standard 52.2.

H. Provide 2 spare sets of filters to User for each filter section at final acceptance by User.

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**Section 23 73 00 – Central Station Air Handling Unit**

2.4 MIXING BOX

- A. Combination damper/filter/mixing section furnished as part of air handling unit.
- B. Dampers:
  - 1. Furnish dampers as part of air handling unit.
  - 2. Provide factory-mounted airflow measurement station and dampers in outdoor and/or return-air opening to measure airflow.
- C. Outdoor units: Provide outdoor air hood.

2.5 COILS

- A. Coils mounted in casing shall be accessible for service and shall be removable from either side of unit without dismantling entire unit.
- B. Provide sealing collars to prevent leakage where coil connections penetrate unit casing or end panel.
- C. Outdoor units: Provide external piping cabinet. Cabinet shall have same construction as main unit casing and have removable panels for piping access.

3. EXECUTION

3.1 ROOF CURBS

- A. Galvanized steel roof mounting curb as recommended by manufacturer; with wood nailing strip.

3.2 ACCESSORIES

- A. Refrigerants: As scheduled on Drawing.
- B. Drain pan: Double-sloped; noncorroding.
- C. Dampers and links: Corrosion-resistant.

END 23 73 00

1. GENERAL

1.1 WORK INCLUDES:

A. Base Bid:

1. Design-Build Contractor shall provide:

- a. General electrical requirements for equipment and services including, but not limited to:
  - 1.) Factory wiring.
  - 2.) Low voltage field wiring.
  - 3.) Low voltage splices and terminations.
  - 4.) Low voltage cabinets and electrical enclosures.
  - 5.) Equipment safety grounding.
  - 6.) Low voltage fuses and fuse blocks.
  - 7.) Electrical meters.
  - 8.) Control relays and switches.
  - 9.) Pushbuttons.
  - 10.) Indicating lights.
  - 11.) Alarm and trip contacts.
  - 12.) Low voltage starters.
  - 13.) Low voltage circuit breakers and disconnect switches.
  - 14.) Auxiliary power transformers.
  - 15.) Power factor correction capacitors.
  - 16.) Outlet, pull, and junction boxes.
  - 17.) Plates and covers.
  - 18.) Wiring devices,
  - 19.) Welding receptacles.

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- 20.) Panelboards.
- 21.) Welding.
- 22.) Shop finish.
- 23.) Rust-inhibiting compounds.
- 24.) Galvanizing.
- 25.) Packaging, identification, and tagging.
- 26.) Nameplates.
- 27.) Trip setting coordination.
- 28.) Grounding and bonding.
- 29.) Fireproofing and fire ratings.
- 30.) Testing and demonstration.

**1.2 RELATED WORK**

- A. Section 02 41 00 –Demolition: Demolition of electrical items.

**1.3 INFORMATIONALSUBMITTALS**

- A. Submit with Bid: Description of manufacturer's standard factory test procedure for logic systems.
- B. Product Data:
  - 1. List of proposed material identifying manufacturer, type and model number for equipment to be provided for complete job.
  - 2. Manufacturer's catalog sheets marked to indicate specific type, model or catalog number of equipment to be provided.
  - 3. Equipment drawings, elementary diagrams, schematics, wiring, performance curves, instruction manuals, and all other documentation necessary for complete description of material being supplied and as required to support installation, commissioning and maintenance of equipment. Manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted.
  - 4. Manufacturer's technical descriptions, product data sheets, and applicable manuals for use in protective device system coordination including:



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- a. Fuse manufacturer, type, ratings, and protection curves.
- b. Circuit breaker manufacturer, type, trip setting ranges, and protection curves.
- c. Relay trip device ranges, curves, and setting manuals.
- d. Transformer damage curves.
- e. CT ratios and saturation curves.
- f. VT ratings.
5. List of recommended spare parts required for equipment start-up, commissioning and operation.
6. List of special maintenance tools required for installation and operation of equipment.
7. If necessary, provide additional data to clearly demonstrate that proposed alternate equipment meets or exceeds equipment as specified.
8. When requested by Engineer, submit system information, including but not limited to, utility feeders, existing relays, circuit breakers, fuses, and transformers.

**1.4 CLOSEOUT SUBMITTALS**

**A. Operation and maintenance manuals. Provide at minimum:**

1. Itemized equipment list.
2. General description and technical data.
3. Receiving, storage, installation, and testing instructions.
4. Operating and maintenance procedures.
5. Complete set of final drawings requiring no further action.
6. Complete documentation of inspections and tests performed, including logs, curves, and certificates. Documentation shall note any replacement of equipment or components that failed during testing.
7. Spare parts list.
8. Lubrication recommendations.

9. Warranty information.

**1.5 MAINTENANCE MATERIALS**

- A. Extra materials: Provide touchup paint in same type and color to repair at least 25% of finish-painted equipment surface. Paint shall be sufficient to perform touch-up painting in accordance with shop-applied material instructions for repair painting.
- B. Each piece of equipment shall be furnished with special tools as required for installation, maintenance, and dismantling of equipment.
  - 1. Furnish in quantities as necessary to complete work on schedule.
  - 2. Tools shall be new and shall become property of Owner.
  - 3. Tools and intended use shall be identified in assembly instructions. Tools shall only be used for their intended purpose.

**1.6 QUALITY ASSURANCE**

- A. Manufacturer qualifications:
  - 1. Manufacturer of equipment specified shall be recognized in industry for normally supplying this type of equipment.
  - 2. Manufacturer shall be ISO certified.
  - 3. When requested by Engineer, provide list of similar equipment installations that have employed identical equipment from manufacturer.
- B. Installer qualifications:
  - 1. Installer shall be skilled in trade and shall have thorough knowledge of products and equipment specified.
  - 2. Cutting, drilling, trenching, or channeling necessary to properly install equipment shall be performed by competent skilled crafts people in safe, professional manner.
- C. Regulatory requirements: Perform electrical construction in accordance with NEC, local and state codes as applicable to job site.
- D. Materials and equipment furnished for permanent installation shall be new, unused, and undamaged.
- E. Asbestos not allowed.

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- F. Parts shall be manufactured to American industry standard sizes and gages to facilitate maintenance and interchangeability. Metric sized components not allowed unless specifically requested and approved.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Pack, ship, handle, and store in accordance with manufacturer's requirements.
- B. Ship equipment completely factory assembled unless physical size, arrangement, configuration, or shipping and handling limitations make this impracticable. Shipping splits and required field assembly shall be identified with equipment submittals.
- C. Costs associated with sections, accessories, or appurtenances requiring field assembly shall be Contractor's responsibility.
- D. Separately packaged parts and accessories shall be consolidated and shipped together with equipment. Mark each container clearly to identify contents and as belonging with main equipment.
  - 1. Provide individual weatherproof itemized packing slips attached to outside of each container for contents included. Provide duplicate inside each container.
  - 2. Attach master packing list, covering accessory items for equipment, to main piece of equipment.
  - 3. Mark each container with project identification number for equipment and container number followed by total number of containers.
- E. Equipment shall be suitably protected during shipment, handling, and storage. Damage incurred during shipment shall be repaired at no cost to Owner.
- F. Protect coated surfaces against impact, abrasion, and discoloration.
- G. Electrical equipment and insulation systems shall be protected against ingress of moisture. Use space heaters if necessary to protect against moisture.
- H. Exposed threads shall be greased and protected.
- I. Pipe, tube, and conduit connections shall be closed with rough usage plugs. Seal and tape open ends of piping, tubing, and conduit.
- J. Equipment openings shall have covers, and taped to seal equipment.
- K. Store materials in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

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1.8 SCHEDULING

- A. Coordinate with Owner early and late shipping and delivery schedules for items requiring storage and handling at Site.

1.9 WARRANTY

- A. Electrical equipment shall be provided with manufacturer's standard warranty, but not less than 1 year.

2. PRODUCTS

2.1 DESIGN CRITERIA

- A. Service conditions: Provide equipment and material suitable for intended service and installation at location indicated.
- B. Low-voltage auxiliary and control power.
1. Electrical power for ac control and instrumentation equipment:
    - a. Provide devices necessary for proper operation and protection of equipment during electrical power supply and ambient temperature fluctuations specified.
    - b. Design for continuous operation at any voltage from 85% to 110% of nominal voltage. Dropout voltage shall be 60% of nominal for relays and 75% for contactors and starters.
  2. Electrical power for dc devices:
    - a. Design for continuous operation on ungrounded station battery system, capable of maintaining operation at any voltage from 80% to 112% of nominal voltage.
    - b. Electrical devices served shall not impose ground connection on supply.
- C. Auxiliary power: Design auxiliary equipment for low voltage service, with electrical power designed to operate from one of nominal electrical power sources as follows and as indicated on Drawings:

Volts	Phase	Frequency
480Y/277	3 or 1	60
208Y/120	3 or 1	60
120/240	1	60
125	1	dc

## 2.2 FACTORY WIRING

- A. Select cable for electrical and environmental conditions of installation, and suitable for unusual service conditions where encountered.
  - 1. Proper temperature application cable shall be used throughout, but shall be not less than 90°C rated.
  - 2. Conductors routed over hinges shall use extra-flexible stranding.
  - 3. Cable insulation shall be rated for maximum service voltage used, but not less than 600 volts.
  - 4. Splices not allowed.
- B. Panel, control cabinet, switchboard, motor control center, and switchgear wiring shall use flame retardant cross-linked polyethylene (XLP) or flame retardant ethylene-propylene rubber (EPR) insulation that meet or exceed requirements of UL 44 for Types SIS, and XHHW.
  - 1. Minimum size: No. 14 AWG (1.5 mm<sup>2</sup>).
  - 2. Conductors: Annealed bare copper with fine stranding passing IEEE 1202 and UL VW-1 flame test.
- C. Instrumentation, thermocouple, and thermocouple extension wire shall use twisted shielded pairs/triads having flame retardant cross-linked polyethylene (XLPE) insulation, and chlorinated polyethylene (CPE) jacket.
  - 1. Minimum size: No. 16 AWG (1.0 mm<sup>2</sup>).
  - 2. Conductor type:
    - a. Instrument: Annealed copper Class B stranding.
    - b. Thermocouple: Solid alloy, ANSI MC 96.1.
  - 3. Provide each pair/triad with shield.
  - 4. Shielding shall consist of aluminum-polyester tape and flexible strand tin-coated No.18 AWG (0.75 mm<sup>2</sup>) copper drain wire.
  - 5. Drain wire for each instrument cable shall be insulated with spaghetti sleeve. One end of shield wire shall be terminated on grounded terminal.
  - 6. Cables shall pass IEEE 1202 and ICEA 70,000 Btu/hr vertical tray flame test, and each conductor shall pass UL VW-1 flame test.

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D. Terminations:

1. Conductor terminal connectors shall be insulated, ring tongue, compression type connectors properly sized for conductor and terminal.
  - a. Connectors shall be constructed of copper and shall be tin-plated.
  - b. Interior surface of connector wire barrel shall be serrated; exterior surface of connector wire barrel shall be furnished with crimp guides.
2. Uninsulated terminal connectors shall be used for conductors terminated on devices equipped with individual fitted covers, such as, but not limited to, control switches and lockout relays.
3. Connections requiring disconnect plug and receptacle type devices shall be provided with factory-terminated conductors on each plug and receptacle.
  - a. Plugs and receptacles shall be factory wired into junction boxes containing terminal blocks for external connections.
  - b. Conductors on disconnect portion of plug-receptacle assemblies shall be in common jacket.
4. Prior to shipment of equipment, remove temporary wiring installed in factory for equipment testing.
5. Current transformers shall terminate on shorting type terminal blocks. Ship with shorting jumpers installed.

E. Identification and labeling:

1. Provide conductor identification sleeve on each end of each internal conductor. Mark each sleeve with opposite end destination identification with nonsmudging, permanent black ink. Sleeves shall be UV-resistant self-adhesive type or PVC, not less than 1/2" long.
2. Permanently label each terminal block, terminal, conductor, relay, breaker, fuse block, and other auxiliary devices to coincide with identification indicated on manufacturer's drawings.

2.3 FIELD WIRING

- A. Nationally or internationally recognized cable manufacturer shall produce cable provided.
1. Metal-clad cable, NEC Type MC, may not be substituted in place of cable and conduit unless specified otherwise, or unless approved in writing.

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2. Comply with code and Project requirements directly associated with use of each cable type.
- B. Cables specified are for voltages 600 volts and below.
- C. Wiring shall be annealed, bare copper with not less than 98% conductivity, unless specified otherwise.
- D. General-purpose building conductor used on interior lighting circuits and general-purpose branch circuits routed entirely in conduit shall be single conductor.
  1. Voltage rating: 600-volt.
  2. Conductor: Class B, solid or stranded, annealed, uncoated copper, minimum size No. 12 AWG (4.0mm<sup>2</sup>).
  3. Insulation: Polyvinyl chloride (PVC) complying with NEC for type THHN or THWN.
  4. Jacket: Overall clear nylon jacket applied over conductor insulation, UL-listed as gasoline and oil resistant.
  5. Cables shall pass IEEE 383 70,000 Btu/hr, UL Standard 83 for Type THHN or THWN wire.
  6. Color coding:

Provide conductor sizes No. 8 AWG and smaller in following colors:

- a. Source voltage of 208Y/120 volts:
  - 1.) Phase A: Black.
  - 2.) Phase B: Red.
  - 3.) Phase C: Blue.
  - 4.) Neutral: White.
- b. Source voltage of 120/240 volts:
  - 1.) Phase A: Black.
  - 2.) Phase B: Red.
  - 3.) Neutral: White.

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- c. Source voltage of 480Y/277 volts:
  - 1.) Phase A: Brown.
  - 2.) Phase B: Orange.
  - 3.) Phase C: Yellow.
  - 4.) Neutral: Gray.
- d. Sizes No. 6 AWG and larger shall be black and color-coded with field-applied tape.
- 7. Installations in dry or damp locations shall utilize THHN and installations in wet locations shall utilize THWN.
- E. Single-conductor, low-voltage power cable for motors, feeders, branch circuits, and dc circuits routed in conduit, duct bank, or cable tray:
  - 1. Voltage rating: 600-volt.
  - 2. Conductor: Annealed, bare copper, Class B, stranded, minimum size No. 12 AWG (4.0mm<sup>2</sup>).
  - 3. Insulation: Cross-linked polyethylene (XLPE), complying with NEC Type XHHW-2. Insulation shall be sunlight resistant and cable tray (CT) rated.
  - 4. Jacket: None.
  - 5. Color coding: Black.
  - 6. Wire shall be identified by surface marking indicating manufacturer, conductor size, conductor material, voltage rating, UL symbol, and listed type.
  - 7. Cables shall pass IEEE 383 70,000 Btu/hr, ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and UL 1581, VW-1 vertical flame test.
  - 8. Temperature rating: 90° C for normal operation in wet or dry locations.
- F. Multiconductor, low-voltage power cables for motors, feeders, and branch circuits routed in cable tray, conduit or duct bank:
  - 1. Voltage rating: 600-volt.
  - 2. Conductors: Annealed, bare copper, Class B, stranded, minimum size No. 12 AWG (4.0mm<sup>2</sup>).



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3. Insulation: Cross-linked polyethylene (XLPE) complying with NEC Type XHHW-2.
  4. Jacket: Flame-retardant, heat, moisture, and sunlight-resistant; polyvinyl chloride (PVC).
  5. Color coding: Insulated phase conductors shall be black and shall have printed numbers in accordance with ICEA Method 4. Each cable shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, metal, voltage rating, and UL listing as suitable for cable tray use.
  6. Phase conductors shall be cabled together with Class B stranded, bare copper grounding conductor and fillers. Ground wire size shall comply with requirements of UL 1277.
  7. Cover cable assembly with helically applied polyester binder tape with minimum 10% overlap.
  8. Cables shall pass IEEE 383 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame test.
  9. Temperature rating: 90° C for normal operation in wet or dry locations.
- G. Multiconductor, low-voltage power cables for motors fed from adjustable speed drives, any installation.
1. Voltage rating: 600-volt.
  2. Conductors: Annealed, bare copper, Class B, stranded, minimum size No. 12 AWG (4.0mm<sup>2</sup>)
  3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) complying with physical and electrical requirements for NEC Type XHHW-2.
  4. Jacket: Flame-retardant, polyvinyl chloride (PVC).
  5. Armor/shield: Continuously welded and corrugated high conductivity aluminum.
  6. Ground conductors: 3 segmented Class B strand, annealed copper conductors sized to meet requirements of UL 1569.
  7. Marking: Insulated phase conductors shall be black and shall have printed numbers in accordance with ICEA Method 4. Each cable shall be

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identified by means of surface ink printing indicating manufacturer, number of conductors, size, metal, voltage rating, and UL listing.

8. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL-approved and marked with FT-4 designation.
  9. Rated for Class 1, Div 1 hazardous locations.
  10. Temperature rating: 90°C maximum continuous operating temperature in wet or dry locations.
- H. Multiconductor cable for control, interlocks, current transformers (CTs), voltage transformers (VTs), routed in cable tray and conduit:
1. Voltage rating: 600-volt.
  2. Conductors: Annealed, bare copper, Class B, stranded, CT minimum size No. 10 AWG (6.0mm<sup>2</sup>), VT minimum size No. 12 AWG (4.0mm<sup>2</sup>).
  3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) or complying with NEC Type XHHW-2.
  4. Jacket: Flame-retardant, heat, moisture, and sunlight-resistant; polyvinyl chloride (PVC).
  5. Conductors shall be cabled together with nonhygroscopic fillers.
  6. Cover cable assembly with helically applied binding tape with minimum 10% overlap.
  7. Color coding: Insulated conductors shall have colored insulation meeting ICEA Method 1, Table E-2 color code (K2 color code).
  8. Each cable shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, voltage rating, and UL listing as rated for cable tray.
  9. Cables shall pass IEEE 383 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests.
  10. Temperature rating: 90° C for normal operation in wet or dry locations.
- I. Instrumentation cable installed indoor or outdoor routed in cable tray, conduit, and ducts:
1. Voltage rating: 300-volt.

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2. Conductors: Annealed, bare copper, Class B, stranded, minimum size No. 16 AWG (1.0 mm<sup>2</sup>).
3. Insulation: Flame-retardant polyvinyl chloride (PVC).
4. Jacket: Flame-retardant, heat, moisture, and sunlight resistant; polyvinyl chloride (PVC).
5. Pairs/triads: Each twisted with lay not exceeding 2" (50 mm).
6. Color code: Insulated conductors shall have colored insulation meeting ICEA Method 1, Table E-2 color code (K2 color code): Pairs black/red; Triads black/red/blue.
8. Assembly:
  - a. Each pair or triad shall be cabled together with aluminum/polyester tape shield helically wrapped with minimum lap of 15% of tape width and isolation tape. Entire cable assembly shall have overall aluminum/polyester tape shield helically wrapped.
  - b. Flexible strand tin-coated No.18 AWG (0.75 mm<sup>2</sup>) copper drain wire shall be helically wound between twisted conductors and tape shield.
9. Each instrumentation cable shall be identified by means of surface ink printing indicating manufacturer, conductor size, and quantity, UL listing.
10. Cables shall pass UL 1581, 70,000 Btu/hr flame test.
- J. Provide high-temperature wire around process equipment operating at temperatures exceeding standard cable ratings.
  1. Voltage rating: 600-volt.
  2. Temperature rating: Up to 1000°C.
  3. Conductor: Stranded, "A" nickel.
  4. Insulation: Layers of ceramic fiber braids.
  5. Jacket: Overall metallic sheath.
- K. Category 6 communication cable circuited in tray, conduit or used for field wiring internal to cabinets.
  1. Conductor: Solid, bare copper minimum No. 23 AWG.
  2. Insulation: Fluorinated ethylene propylene (FEP) insulated singles.

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3. Insulated conductors: Unshielded, twisted 4 pairs enclosed with a spline fluorinated ethylene propylene filler material.
  4. Cable assembly shall be covered with clear “Flamearrest” jacket, sequentially marked at 2’ (600 mm) intervals. Ripcord shall be integrally installed to allow easy removal of jacket material.
  5. Each communication cable shall be identified by means of surface ink printing indicating manufacturer, model, or catalog number. Cable shall meet TIA/EIA Draft 9A CAT6.
  6. Cables shall be capable of passing UL flame test Type CMP.
  7. Manufacturer: Belden “DataTwist” 7852A.
- L. Twin-axial communication cable installed indoors in cable tray and conduit:
1. Voltage rating: 600-volt.
  2. Conductor: One pair, bare copper, No. 18 AWG with 7 x 26 stranding.
  3. Insulation: Flame-retardant polyolefin.
  4. Assembly: Aluminum foil-polyester tape shield with No. 20 AWG, 7 x 28 stranded tinned copper drain wire with 100% shield coverage, and tinned copper braid shield with minimum 55% coverage. Overall cable assembly shall be Type “PLTC.”
  5. Jacket: Polyvinyl chloride (PVC).
  6. Cable shall be UL-listed 1581 for flame resistance.
  7. Temperature rating: 75°C in dry maximum operating temperatures in dry locations.
  8. Manufacturer: Belden, “DataTray” 600-volt, industrial twin-axial cable, Catalog Number 3072F.
- M. Fiber cable systems: Reference specification section 40 95 33-23-13.
- N. Uninsulated and Insulated grounding conductors:
1. Voltage rating: 600V, green XHHW-2, when insulated.
  2. Conductors: Class B, stranded, bare copper.

**2.4 SPLICES AND TERMINATIONS**

- A. Splices, except as in lighting and general purpose power circuits specified below, not allowed unless specifically indicated on Drawings or required for connection to equipment.
- B. Temperature rating of splices and terminations: No less than 75°C.
- C. Splices allowed in lighting and general-purpose power circuits.
  - 1. Provide wire and cable connectors of high-conductivity, corrosion-resistant material with contact area equal to at least current carrying capacity of wire or cable.
  - 2. General lighting and general-purpose building power circuits:
    - a. Twist-type, insulated spring connectors for splices on solid or stranded conductors smaller than No. 6 AWG.
    - b. Use indent, hex screw, or bolt clamp-type connectors, with or without tongue for splices on solid or stranded conductors No. 6 AWG and larger.
    - c. Apply insulating 600-volt tape.
- D. Insulating tapes and compounds for terminations and splices: UL-listed for intended use, location, and voltage by manufacturer.
- E. Termination of conductors to equipment with bolted connections:
  - 1. Use compression type lugs:
  - 2. Compression lugs for cables 250 kcmil and larger shall have at least 2 clamping elements of compression indents, and provision for at least 2 bolts for joining to apparatus terminals.
  - 3. Crimping hand tools used for securing conductors in compression type connectors or terminal lugs shall be made for purpose and conductor sizes involved.
  - 4. Crimping tools shall be ratchet-type preventing tool from opening until crimp action is completed.
  - 5. Tools shall be product approved by connector manufacturer.

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F. Terminals:

1. Conductors No. 10 AWG and smaller: Marathon 1500 Series.
2. Conductors larger than No. 4/0 AWG: Terminate to tinned copper bus bar drilled and tapped with standard NEMA sized and spaced holes.

G. Coordinate sizes and types of conductor terminals for 600-volt power cable terminations in equipment with furnished conductor and terminal connector data.

H. Provide 600-volt rated terminal blocks for instrumentation and control conductors for connection to circuits external to specified equipment, and for internal circuits crossing shipping splits.

1. Use crimp-on terminals matching termination point terminations in manufacturer-furnished panels. Splices not allowed.
2. Terminal blocks for thermocouple extension wire: Buchanan “Medium Duty” with thermocouple contacts or Marathon 200 Series with Omega Engineering, Inc. Type TL terminal lugs.
3. Furnish with white marking strips.
4. Where permitted by safety codes and standards, provide without covers. Neither step-type terminal blocks nor angle mounting of terminal blocks allowed.
5. Fuses may be mounted on terminal blocks.
6. Maximum 2 conductors in accordance with termination point.

I. Terminal blocks for external connections shall leave from centrally mounted location, not from individual devices in enclosure.

1. Group-in instrument and control compartment for easy accessibility.
2. Provide sufficient space on each side of each terminal block to allow orderly arrangement of leads to be terminated on block.
3. Locate auxiliary equipment in compartments, enclosures, or junction boxes so service personnel will have direct access without interference from structural members and instruments without removal of barriers, cover plates, or wiring.
4. Do not mount terminal blocks in compartments containing cables or buses operating at voltages above 600 volts.
5. Size for wire sizes of incoming conductors as necessary.

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- J. Install shorting-type terminal blocks nearest current transformer in accessible location for each set of CTs supplied with equipment furnished, no other shorting-type terminal blocks allowed, unless specified otherwise.
- K. Install din-rail mounted miniature circuit breakers (MCB) for protection of VT circuits on line and load side. Breakers shall have alarm contacts wired to terminal blocks.
- L. Terminate each conductor in multiconductor control cable or as shown on Drawings. Provide 10% spare terminals for circuit modifications.
- M. Each control switch and lockout relay shall have minimum of 4 spare normally open and 4 spare normally closed contacts wired out to terminal blocks.
- N. Circuit identification number listed on either circuit schedule or panel schedule shall be used to identify circuit, positioned as near as possible to end of each conductor on multiple single wire circuits and on cable jacket for multiconductor cables.
- O. Cable designations shall be visible after installation without requiring physical movement of cable.

**2.5 ELECTRICAL ENCLOSURES**

- A. Size junction boxes, pull boxes, and enclosures in accordance with requirements of NEC.
- B. Junction boxes and pull boxes 4” (100 mm) trade size or smaller in any dimension shall be galvanized malleable iron, or cast ferrous metal NEMA rated for installed location. Do not use concentric knockouts.
- C. Junction boxes, pull boxes, and electrical enclosures larger than 4” (100 mm) trade size in any dimension shall be as follows, unless required otherwise.
  - 1. NEMA rating for electrical enclosures installed in nonhazardous locations:
    - a. Indoor:
      - 1.) Dry environmentally controlled area: NEMA 12.
      - 2.) Noncorrosive wet or hose-down area: NEMA 4.
      - 3.) Corrosive wet or hose-down area: NEMA 4X

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b. Outdoor:

- 1.) Corrosive area: NEMA 4X.
  - 2.) Noncorrosive area hose-down or spray area: NEMA 4.
  - 3.) Noncorrosive area nonhose-down area NEMA 3R.
2. Construct noncast-metal electrical enclosures from reinforced steel plate capable of supporting devices mounted on or within enclosure without deflection. Steel plate thickness shall conform to UL requirements.
  3. Enclosures shall be of adequate strength to support mounted components during shipment and installation.
  4. Conduit entrances: Field drilled.
  5. Electrical enclosures located in outdoor, wet, or hose down areas shall be provided with space heaters. Provide space heaters completely wired within enclosure. Provide following:
    - a. Space heater.
    - b. Adjustable thermostat with set point temperature indicator.
    - c. One miniature circuit breaker protective device.
    - d. Space heaters, thermostat, and protection shall not interfere with cable into or out of enclosure, or with maintenance or replacement of devices within enclosure.
    - e. Use of space heaters shall not change or discolor any painted surface.
    - f. Space heater capacity shall maintain enclosure internal temperature above dew point under specified service conditions.
    - g. Space heaters: Rate for 240 volts ac minimum, and size for operation on applied voltage of 120 volts ac.

D. Outdoor electrical enclosures with ventilating openings:

1. Louver on outdoor electrical equipment and protect in accordance with NEMA type.
2. Equip openings on outdoor electrical equipment with fine mesh filters and stainless steel bug screens.



## 2.6 OUTLET BOXES

- A. Outlet boxes for concealed wiring systems: Sheet metal, galvanized or cadmium plated.
- B. Minimum 4" (100 mm) square, 1-1/2" (38 mm) deep, sized to accommodate devices and number of conductors in accordance with NEC. Equip with plaster ring or cover as necessary for flush finish.
- C. Exposed conduit systems shall have surface-mounted boxes unless specified otherwise. Boxes for exposed wiring in nonhazardous, noncorrosive, and nonweatherproof locations shall be malleable iron, cadmium finish or cast aluminum alloy, minimum 4" (100 mm) square, 1-1/2" (38 mm) deep.
- D. Enclosures shall be as required for areas in which they are installed and as specified.
  - 1. Boxes: Install flush in masonry construction and design for intended use.
  - 2. Recessed boxes:
    - a. Where fixture is mounted, boxes shall be minimum 4" (100 mm) and octagonal in shape or 4" (100 mm) square by 1-1/2" (38 mm) deep with round plaster ring.
    - b. Where used as junction box, boxes shall be minimum 4" (100 mm) square by 2-1/8" (53 mm) deep.
  - 3. Outlet boxes for wall concealed telephone and signaling systems: 4" (100 mm) square by 1-1/2" (38 mm) deep, minimum. Furnish with plaster ring and cover plate.
  - 4. Floor boxes for floor outlets:
    - a. Cast-metal with threaded conduit entrances, brass flange ring and brass duplex flap cover plate.
    - b. Watertight with leveling and adjustment screws for adjusting cover plate to finished floor.
    - c. Minimum 4" (100 mm) diameter and 3-1/2" (88 mm) deep with approved gasket or seal between adjusting ring and box.
  - 5. Floor outlets for combination signaling, data, and power outlets: Construct of steel base, PVC housing, and steel bracket to allow feed

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through wiring and activation load-bearing support. Box construction shall meet UL 514A requirements.

- a. Entire housing shall be removable for unrestricted access.
- b. Once assembled, PVC housing shall be capable of carrying 6,000 lb (2722 kg) load.
- c. Coordinate outlet requirements with communication system requirements.

- 6. Floor boxes in 2-hour rated floors shall be secured in cored hole and shall be UL classified and listed for 2-hour rated floors.

**2.7 PULL AND JUNCTION BOXES**

- A. Furnish junction boxes and pull boxes were shown on Drawings, and where necessary to facilitate pulling wires and cables without damage.
- B. Above ground boxes shall be formed from sheet steel, with corners folded in and securely welded with inward flange on each of 4 edges.
- C. Drill box for mounting and attachment of cover; galvanize after fabrication.
- D. Cover: Construct of one-piece galvanized steel and provide with stainless steel round head machine screws.
- E. Box and cover shall be made of code gage steel, or heavier if shown on Drawings.
- F. Size: Minimum 4-1/2" (113 mm) deep and in accordance with NEC. Use next larger standard size when necessary in accordance with manufacturer standard sizes.
- G. Furnish pull and junction boxes without knockouts for field drilling.
- H. Enclosures shall be as required for areas in which installed and in accordance with requirements specified.
- I. Underground boxes: Specifically design and construct for intended installed location, and be either pre-formed concrete or PVC. Covers shall be capable of withstanding, without failure, type of traffic in general area.
- J. If pull and junction boxes are exposed in and around architecturally finished surfaces, paint box to match finish of nearby surfaces, unless indicated otherwise.

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- K. Bolt-on junction box covers 3'-0" (900 mm) square or larger, or heavier than 25 lb. (11 kg) shall have permanent rigid handles. Covers larger than 3'-0" x 4'-0" (900 mm x 1200 mm) shall be split.

**2.8 EQUIPMENT SAFETY GROUNDING**

- A. Install exposed raceway electrically continuous. Conduit and tray shall not be considered to be only ground conductor.
- B. Furnish equipment that is part of integral shipping unit or assembly with bare copper ground conductor extending to central ground connection lug. Lug shall be suitable for field connection to local ground. Electrical equipment shall be considered any device that is energized.
- C. Single-point ground connections required for proper operation of electronic equipment shall be insulated from equipment safety ground. Such connections shall be extended, using insulated cable, to single insulated termination point suitable for field connection to appropriate ground system.
- D. Conduits containing power circuits shall have ground conductor installed inside conduit. Ground conductor shall be bonded to equipment or tray or duct ground at both ends.
- E. Provide ground bushing on each conduit containing power circuit. Connect ground bushings together inside enclosure and to enclosure ground lug or ground bus.
  - 1. Use No. 8 AWG conductor for ground bushings trade size 1-1/2" (38 mm) and smaller.
  - 2. Ground bushings larger than 1-1/2" (38 mm) shall be sized in accordance with requirements of NEC, but in no case shall bushings be smaller than No. 8 AWG.
- F. Ground conductor: Uninsulated, Class B standard, round soft drawn uncoated copper as defined in ICEA S-19-81, unless specified otherwise.
- G. Hardware: Clamps, bolts, washers, nuts, and other hardware used with grounding conductor shall be copper, copper alloy, high copper alloy, or silicon bronze.

**2.9 PIN AND SOCKET CONNECTORS**

- A. Unless shown on Drawings, not allowed.

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**2.10 FUSES AND FUSE BLOCKS**

- A. Modular-type, Class H screw terminal fuse blocks with Bakelite frame and reinforced retaining clips. Blocks shall be similar in construction and by same manufacturer.
- B. Slow blow fuses: Bussmann Type MDL or Gould Shawmut Type GDL with ampere ratings of 1/4, 1/2, 1, or 2.
- C. Fast acting fuses: Bussmann Type NON or Gould Shawmut Type OT with ampere ratings of 1, 3, 6, 10, 15, 20, or 30.
- D. Extremely fast acting fuses: Bussmann Type KAB with ampere ratings of 1, 3, 6, 10, 15, 20, or 30.

**2.11 ELECTRICAL METERS**

- A. Meters for measuring electrical quantities shall be utility grade, multifunction, switchboard-type with accuracy of  $\pm 0.2\%$  or better for volts and amperes, and 0.4% for power functions.
- B. Readouts shall have true RMS capability with at least 1/2" (13 mm) high intensity LED displays and be capable of surge withstand exceeding IEEE C37.90.1.
- C. Instruments checked in field and found to be inaccurate in excess of percent error shall be returned for replacement without cost to Owner.
- D. Design meters for operation through 5-ampere current transformer secondary and 120-volt voltage transformer secondary.
- E. Provide communications capability; coordinate with Owner.

**2.12 CONTROL RELAYS**

- A. General service, industrial grade auxiliary relays rated 600-volt.
- B. Contacts: Reversible from N.O. to N.C. in field.
- C. Timing relays for critical service: Agastat Series 7000.

**2.13 CONTROL SWITCHES**

- A. Multistage, rotary-type rated 120 volts ac or 125 volts dc, 3 amperes, as required.
- B. Handles: Black, fixed, modern, pistol grip type. Provide engraved black plastic escutcheon plates with targets.

C. Provide with colored LED lamps and nameplates as required.

**2.14 PUSHBUTTONS**

A. Standard pushbuttons: Heavy, industrial-type rated 120 volts ac or 125 volts dc, 3 amperes, as required.

B. Provide with colored LED lamps and nameplates as required.

**2.15 INDICATING LIGHTS**

A. Status indicating lights: High-intensity, cluster, LED-type for panel mounting.

B. Coordinate indicating light colors with indicated conditions as follows. Indicating lights shall be energized when condition exists and shall be de-energized when condition does not exist:

1. Red: Equipment energized: such as motor running, valve open, or breaker closed.
2. Green: Equipment de-energized: such as motor stopped, valve closed, or breaker open.
3. Amber: Equipment abnormality: such as motor trip, breaker trip, or relay trip.
4. White: Monitoring of control power or trip coil: such as lockout relay trip coil monitor or breaker trip coil monitor. Light is on during normal circuit operation and off during loss of power or loss of coil.
5. Blue: Loss of control power.

**2.16 ALARM AND TRIP CONTACTS**

A. Alarm contacts for remote annunciation: Suitable for operation at 120 volts ac and 125 volts dc. Contacts shall be rated at least 0.5-ampere make and break, minimum.

B. Alarm contacts: Normally closed contacts that open to alarm condition.

C. Trip contacts for remote trip: Suitable for operation at 125 volts dc and rated 5 amperes make or break, minimum.

**2.17 SEPARATELY MOUNTED COMBINATION MOTOR STARTERS**

A. Enclosed, 3-phase, full-voltage, nonreversing, unless indicated otherwise.

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- B. Complete combination starter shall have minimum interrupting rating of 65 kA or greater if specified elsewhere or indicated on Drawings.
- C. Starter enclosures shall have enclosure NEMA rating specified herein.
- D. Provide combination starter with microprocessor-based contactor and integral electronic overload protection; minimum size shall be NEMA 1.
- E. Each phase shall have microprocessor-monitored current sensor for motor running overload, phase loss and phase unbalance protection.
  - 1. Provide Class II ground fault protection; set to 20% of maximum continuous ampere rating and have delay of 20 seconds and run delay of 1 second to prevent nuisance trip on start.
  - 2. Single-speed starters shall be furnished with 3 current sensors. 2-speed starters shall be furnished with 6 current sensors.
- F. Starters shall be furnished with motor circuit protectors (MCP) rated 600-volt.
  - 1. Each breaker shall be manually operated with quick-make, quick-break, trip-free toggle mechanism.
  - 2. Starters shall have external manual breaker-operating handle with provisions for up to 3 padlocks.
  - 3. Access door shall be interlocked with motor circuit protector, so door cannot be opened while breaker is closed except by interlock override.
  - 4. Starter contactor shall mechanically operate auxiliary contacts. Each starter shall include auxiliary contacts required for application, plus 2 spare NO and 1 spare NC contacts.
  - 5. Provide membrane-style pushbutton control module and LED lights, if indicated on schematics, to control starter functions and indication. Pushbuttons and LEDs shall be clearly identified.
  - 6. Verify and match control power transformers, overload protection, and sizes of starters to actual equipment furnished.
  - 7. Size control power transformers (CPT) to supply control circuit and any additional loading simultaneously. Minimum CPT size shall be 100 volts-amperes for Size 1 starters and 150 volts-amperes for Size 2 and larger starters.
  - 8. CPTs shall have primary leads protected, and one secondary lead protected and one secondary lead grounded. Provide DIN rail-mounted, miniature circuit breakers for protection. Fuses not allowed.

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9. Starters for systems with system voltage of 120 volts or less shall not require CPT.
10. Two-speed starters and reversing starters shall be mechanically and electrically interlocked so only one set of contacts can be closed at any one time.

**2.18 LOCAL SEPARATE MANUAL STARTERS**

- A. Separately enclosed manual starters, shall be provided with adjustable, bimetallic, Class 10 ambient-compensated, integral overload relay and fixed magnetic short-circuit trip mechanism designed to trip at 12 times maximum current rating.
- B. Starters shall use high-conductivity copper for current carrying parts.
- C. Size starters for motors served in accordance with NEC and manufacturer's recommendations.
- D. Mount manual starters in enclosures with NEMA rating for area as specified herein.
- E. If applicable, starters shall be UL-listed and CSA-certified for group installations.
- F. Accessories shall be available for auxiliary contacts, trip alarm, under-voltage release, and shunt trip for field installation.
- G. Starters shall be pad-lockable with 3 padlocks in "On" and "Off" position.

**2.19 LOCAL SEPARATE CIRCUIT BREAKERS**

- A. Provide 3-pole, molded-case, separately enclosed circuit breakers of not less than interrupting rating shown on Drawings at rated voltage.
  1. Provide with thermal and instantaneous trip elements.
  2. Breakers shall use high-conductivity copper for current carrying parts. Breaker enclosures shall have NEMA type enclosure as specified.
- B. Each breaker shall be manually operated with quick-make, quick-break, and trip-free toggle mechanism. Thermal elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration.
- C. Circuit breakers shall have "On," "Off," and "Tripped" indication and shall be pad-lockable with 3 padlocks in "On" and "Off" position.

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1. Breakers rated over 70 amperes shall be rated 100% and have adjustable electronic trip units.
2. Breakers shall be capable of adding alarm, lockout, shunt trip, and under-voltage as options.

**2.20 LOCAL SEPARATE DISCONNECT SWITCHES**

- A. Three-pole, nonfusible, heavy-duty, rated 600-volt with continuous current rating as shown on Drawings and as required by load.
  1. Type: Either molded-case or blade.
  2. Switches shall use high-conductivity copper for current carrying parts.
- B. Switches shall be positive, quick-make, and quick-break mechanisms.
  1. Switch assembly plus operating handle shall be integral part of enclosure base.
  2. Each switch shall have handle whose position is easily recognizable and which can be locked in "On" and "Off" position with 3 padlocks. "On" and "Off" positions shall be clearly marked.
- C. Switches shall be UL-listed and horsepower rated. Where applicable, switches shall have defeatable door interlocks that prevent door from being opened while operating handle is in "On" position.

**2.21 AUXILIARY POWER TRANSFORMERS**

- A. Provide separately mounted transformers as shown on Drawings.
- B. Windings: Copper.
- C. Transformers shall be self-air-cooled, dry-type, capable of wall- or floor-mounting, and enclosed for wiring connection by conduit. In areas where dust and dirt may be normally present, use encapsulated-type transformers.
- D. NEMA enclosure type protection shall be as specified herein.
- E. Provide at least 2 full kVA capacity voltage taps above and 2 full kVA capacity taps below nominal rating. Each tap shall be 2.5% step.
- F. Transformer shall be capable of at least 150°C rise above rated site maximum ambient without degrading transformer life.
- G. Transformers shall be capable of continuous operation at rated kVA with normal life expectancy as defined in ANSI C57.



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- H. Sound level shall not exceed NEMA maximum average sound level.
- I. Enclosure: Sheet steel with corrosion-resistant finish and manufacturer's standard color.

**2.22 PLATES AND COVERS**

- A. Provide finish plates and covers of appropriate type and size for wiring and control devices, signal, and communication outlets.
- B. Mark each plate and cover to show circuit and panel designation. Unless indicated to be engraved plate, use self-sticking, clear membrane, UV-resistant labels with typed black letters. Handwritten labels not allowed.
- C. Coordinate color with adjacent surfaces.
- D. Raised cover galvanized steel plates shall be acceptable for use on surface-mounted outlet boxes in unfinished areas where weatherproof plates are not required.
- E. For weatherproof installations, cover plates shall be gasketed and rated for NEMA Type 4 installation.
- F. Device plate mounting hardware shall be countersunk and finished to match plate.

**2.23 WIRING DEVICES**

- A. Where more than one flush device is indicated in same location, mount devices in gangs under common plate.
- B. Switches for control of ac lighting panel load circuits, single-pole, 3-way, and 4-way, shall be premium, heavy-duty specification-grade, and meet FS W-S-896E. Switches shall be rated for use at 120 or 277 volts and 20 amperes minimum.
- C. Device color, if not shown on Drawings, shall be coordinated to match adjacent finishes.
- D. Wall switches requiring pilot light indication shall have red LED pilot light when toggled "On."
- E. Pulse control of lighting contactors shall be 20 amperes, 120/277 volts, momentary, double-throw, and center "Off."
- F. Standard convenience outlets: Premium, heavy-duty, specification-grade, duplex, 3-wire, grounding, 20-ampere, 125-volt for 120-volt circuits, and rated 250-volts for 240 or 208-volt circuits.

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- G. Ground fault circuit interrupter (GFI) receptacles: Duplex, 20-ampere, and 125 volts, feed-through type.
- H. Isolated ground (IG) outlets: Duplex, 3-wire, with isolated grounding terminal, 20-ampere, and 125 volts. Outlets shall be orange in color, unless specified otherwise.

**2.24 WELDING**

- A. If special welding requirements are required for any piece of equipment during installation, requirements shall be stated on manufacturer's shop drawing of affected part.
- B. Furnish detailed welding requirements with equipment shipment.

**2.25 WELDING RECEPTACLES**

- A. Coordinate manufacturer and type with Owner's requirements.
- B. Provide in appropriate amperage as shown on Drawings; 600-volt, 3-phase with grounding conductors connected through fourth pole.
- C. Provide 1 matching plug with appropriate woven grip and plug cap for cable size.
- D. Match receptacles to equipment.

**2.26 PANELBOARDS**

- A. Dead-front, circuit breaker type, rated for voltage, phase, with main lugs or main breaker as indicated on panel schedules.
- B. Enclosure shall be NEMA-rated for installation location and capable of flush or surface mounting.
- C. Enclosure cover and access door shall be hinged with breaker operating handles accessible through latchable and lockable door.
- D. Typed panel directory located inside door shall have panel and circuits function clearly identified. Handwritten panel schedules not allowed.
- E. Provide main and neutral buses insulated from cabinet with separate ground bus. Bus material shall be copper. Ground bus shall be similar to neutral bus in size and number of conductor terminating positions.
  - 1. Bond ground bus to panelboard enclosure by copper ground strap or copper conductor of appropriate size. Bond neutral bus to ground bus in accordance with requirements of NEC.

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2. Grounding bus connection to enclosure by removable screws not allowed.
3. Bus shall be capable of terminating clamp type lugs for neutral cable in each supply conduit, and connections for neutral cable in each load circuit.
4. Neutral bus shall be fully rated, unless specified otherwise.
5. Isolated ground panelboards: As specified above, except isolated ground bus shall be bonded, by insulated ground conductor, back to source of separately derived system. Do not bond isolated ground bus to panelboard enclosure unless this is first point of grounding for separately derived system.

**2.27 CIRCUIT BREAKERS**

- A. Molded-case, thermal-magnetic, bolt-in, individually front replaceable, and shall visibly indicate "On," "Off," and "Tripped" position.
- B. Branch circuit breakers used for lighting circuits shall be switch duty rated, "SWD."
- C. Breakers having multiple poles shall be manufactured as common trip type.
- D. Interrupting rating shall be not less than interrupting rating of panelboards, and not series rated to achieve required short circuit interrupting rating.
- E. Provide handle clips for 10%, or minimum of 2 whichever is greater, for breakers to prevent casual operation. If no breakers are indicated for installation, then provide on breakers labeled as spare.
- F. Breakers, and provisions for future breakers, shall be provided in quantities, poles, and ampere ratings shown on Drawings.
- G. Molded-case circuit breakers used in ac and dc panelboards and ac load centers shall be bolt-on type, G-frame size.

**2.28 FINISHES**

- A. Manufacturer's standard coating systems shall be factory-applied. Coating systems shall provide resistance to corrosion caused by weather and industrial environments.
  1. Surfaces inaccessible after factory or field assembly shall be protected for life of equipment.
  2. Painted surfaces shall be filled to provide smooth, uniform base for painting.

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3. Surfaces requiring field welds shall not be coated within 3” (75 mm) of field weld.
- B. Coating material and application techniques shall conform to regulations of air quality management agency having jurisdiction.
- C. Exterior surfaces of control and electrical equipment, including panels, cabinets, switchgear, transformers, and motors shall be manufacturer’s standard colors unless specified otherwise.
- D. Apply high-temperature coating systems to uninsulated equipment operating at temperatures at or above 200°F (93°C).

**2.29 RUST-INHIBITOR COMPOUNDS**

- A. Uncoated machined and ferrous surfaces subject to corrosion shall be protected with rust-inhibitor compounds.
- B. Rust-inhibitor compounds used to protect surfaces of equipment and piping exposed to feedwater or steam shall be completely water-soluble.
- C. Surfaces to be field welded shall be coated with consumable rust-inhibitor compounds that will not affect quality of weld.
- D. External gasket surfaces, flange faces, couplings, rotating equipment shafts and bearings shall be thoroughly cleaned and coated with rust-inhibitor compounds.

**2.30 GALVANIZING**

- A. Galvanized structural steel members and steel assemblies shall be pickled after fabrication. Remove scale, rust, grease, and other impurities, then hot-dip galvanized in accordance with ASTM.
- B. If galvanized member is to be bolted, structural bolts shall be galvanized in accordance with ASTM.

**2.31 IDENTIFICATION AND TAGGING**

- A. Conduits inside manholes, hand holes, building entrance pull boxes, and junction boxes shall be provided with 19-gage (1 mm) stainless steel identification tags, with 1/2” (13 mm) stamped letters and numbers.
  1. Attach conduit Identification tags with stainless steel banding. Tag position shall be readily visible for inspection.
  2. Tags shall provide, as minimum:

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- a. Circuit origination and destination.
  - b. Voltage.
  - c. Number of conductors in accordance with phase.
  - d. Number of phase conductors.
- B. Cables passing through or terminating in manholes, hand holes, and pull boxes shall have 19-gage (1 mm) stainless steel identification tags with stamped lettering that provides circuit identification information.
- C. Provide power, control, and instrumentation cables with permanent type identification markers with typed cable numbers and from/to information at each point of termination. Cable numbers and from/to information will be provided for circuits not associated with low-voltage panelboards.
- 1. Position cable markers to be readily visible for inspection.
  - 2. Cable numbers shall match those as shown on Drawings.
  - 3. Provide wire tags at each termination point for each conductor. Tags shall be permanent, wrap around, heat-shrinkable type with typewritten information.
- D. Color-code power conductors with electrical tape or provide with colored jacket.
- 1. Source voltage of 208Y/120 volts:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
    - d. Neutral: White.
  - 2. Source voltage of 120/240 volts:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Neutral: White.

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3. Source voltage of 480Y/277 volts:
  - a. Phase A: Brown.
  - b. Phase B: Orange.
  - c. Phase C: Yellow.
  - d. Neutral: Gray.
4. Source voltage of 240/120-volt delta: High-leg systems shall not be used without Engineer approval.
5. Service entrance and equipment ground conductors shall be bare copper or green insulated conductor. Equipment bonding conductors shall be bare copper.
6. Isolated ground conductors shall be insulated; green in color with integral yellow stripe. No substitutions.

E. Signage:

1. Provide proper signage, plaque, directory and warning labels for electrical equipment and raceway in accordance with NEC requirements.
2. One-line diagram: Display unfolded and behind clear plastic so diagram is clearly visible.
3. Mount diagram to permanent structure or wall and located within sight of each feeder, branch-circuit disconnect, each service disconnect, and switchgear. Place permanent legible warning sign in conspicuous location with wording “Danger – High Voltage” required for following areas over 600 volts:
  - a. A “Danger – High Voltage” warning sign lettering shall be a minimum of 1” (25 mm) high and remaining lettering a minimum of 1/4” (6 mm) high.
  - b. Locations:
    - 1.) At entrances to electrical equipment vaults and electrical equipment rooms, areas, or enclosures, and manholes and handholes, unless words are cast into access cover.
    - 2.) At points of access to conductors on high-voltage conduit systems and cable systems.

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- 3.) On cable trays and cable trench containing high-voltage conductors with maximum spacing of warning notices not to exceed 10' (3 m).
- 4.) On metal-clad and metal-enclosed switchgear panels or doors providing access to live parts over 600 volts [a], [Article 225.70].
- 5.) On isolated phase and nonsegregated phase bus duct, at access openings unless Owner has a differing standard.

**2.32 EQUIPMENT NAMEPLATES**

- A. Laminated white-over-black plastic such that face is white with black letters, with 1/8" (3 mm) engraved letters securely fastened with minimum of 2 self-tapping, stainless steel screws.
- B. Motor starters, either separately mounted or contained in motor control centers, shall have nameplates identifying related equipment. Where separate control and indicating lights are used, starters shall have engraved or etched legends ("start", "stop", etc.) as shown on Drawings.
- C. Provide control stations with nameplates identifying related equipment. Control and indicating lights shall have engraved or etched legends as shown on Drawings.
- D. Circuit breakers within main switchboards and distribution switchboards shall be provided with nameplates identifying related equipment being served.
- E. Fused and nonfused switches shall have 2 front cover-mounted nameplates.
  1. Nameplate containing permanent record indicating switch type, manufacturer's name, catalog number, and appropriate rating for equipment served.
  2. Provide additional nameplate to identify associated equipment.
- F. Panelboards shall have front cover-mounted nameplates identifying panelboard, matching information shown on Drawings and associated panel schedule. Nameplate shall have at least 4 lines of text consisting of:
  1. Line 1: Panel equipment identification number.
  2. Line 2: IEEE Voltage Designation.
  3. Line 3: Appropriate description from which power is derived, (i.e. fed from HP1 through XFMR-LP1).
  4. Line 4: Location of power source, (i.e. PP-1, NW wing).

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- G. Lighting and auxiliary power transformers shall have front cover-mounted nameplates identifying transformer, matching information shown on Drawings. Nameplate shall have at least 2 lines of text that consist of:
1. Line 1: Transformer equipment identification number.
  2. Line 2: Location of derived power source (i.e. fed from MDB, Elec Rm Basement).
- H. Nameplates shall meet requirements of NFPA 70E

**2.33 HARDWARE**

- A. Provide hardware including, but not limited to, anchor bolts, nuts, washers, expansion anchors, wire nuts needed for installation.
- B. Hardware smaller than 3/4" (19 mm) shall match NEMA standard size bolt holes on motors and electrical equipment.

**2.34 LOGIC SYSTEMS FACTORY TESTING**

- A. Prior to shipment, test electrical equipment containing solid-state logic systems in accordance with manufacturer's standard tests for minimum of 120 hours under power.
1. Components tested shall include electronic devices; power supplies, input-output devices, operator interface devices, and interconnecting cables provided with system.
  2. System shall be tested as complete assembly. Testing of individual components or modules not allowed as system tests.
- B. System test shall include:
1. Means of confirming logic or mathematical design response of system by simulating changes in system input.
  2. Test shall repeatedly cycle system through operations system will be expected to perform in service with loads on various components equivalent to those which will be experienced in actual service.
  3. Adjustment of power source voltages to high and low limits. Verify correct operation of system at both high and low power source voltage limits.
- C. System shall be tested and verified capable of providing surge withstand capability in accordance with requirements of ANSI C37.90.1.



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- D. Perform tests with solid-state logic system exposed to ambient temperature appropriate to service for which associated electrical equipment is designed.

3. EXECUTION

3.1 EXAMINATION OF SITE

- A. Contractor shall be responsible for familiarity with Project Site conditions. Equipment furnished and installed shall be capable of withstanding most severe conditions that will be encountered.

3.2 PROTECTION OF WORK

- A. Protect installed Work and provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- B. Damage occurring to building or equipment during installation shall be repaired or replaced to conditions existing prior to damage at no additional cost or delay to project or Owner.

3.3 INSTALLATION

- A. Install equipment and materials in accordance with manufacturer's recommendations and Drawings.
- B. Details for equipment and systems installed in accordance with industry standard techniques will not be furnished.
- C. Installation details furnished on Drawings shall be followed unless found to be unsafe, inappropriate for equipment specified, or unachievable due to site conditions.
- D. Install equipment indicated on Drawings as furnished by others, unless noted as installed by others, including but not limited to:
  - 1. Medium-voltage switchgear.
  - 2. Medium-voltage bus duct.
  - 3. Secondary unit substations.
- E. Except as otherwise specified or indicated on Drawings, equipment shall be installed plumb, square, and level.
- F. Sheet metal junction boxes, equipment enclosures, sheet metal raceways, and similar items mounted on earth-bearing walls shall be separated from wall not less than 1/4" (6 mm) by corrosion-resistant spacers.

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G. Substations, switchgear, motor control centers, and similar equipment located outdoors shall be permanently sealed at base. Openings into equipment shall be screened or sealed as to prevent entrance of birds, rodents, and insects the size of wasps and mud daubers.

1. Sealing material at base shall be concrete grout.
2. Small cracks and openings shall be sealed from inside with silicone sealant.
3. Large openings shall use galvanized screen mesh.

**3.4 TRIP SETTING COORDINATION**

A. Motor overload protection shall be selected and set by Contractor based on final motor nameplate information. Size motor circuit protectors to coordinate with motor starting characteristics and overload protection. Submit summary of settings to Owner, list:

1. Equipment project identification number.
2. Nameplate information.
3. Overload device trip range.
4. Overload device setting.
5. Trip device rating.
6. Trip device setting if different from rated value.

B. Set trip devices and verify devices are operating within manufacturer's tolerances. Make changes to settings not complying with requirements furnished by Engineer. Device settings will be furnished for following equipment:

1. Medium-voltage system.
2. Low-voltage switchgear.
3. Diesel Generator.

**3.5 CABLE**

A. Prior to installation of each cable or cable group into assigned raceway, verify that raceway has been correctly sized.

1. Where raceway is not indicated in circuit schedule or on Drawings, size in accordance with requirements of NEC.

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2. If raceway size indicated on Contract Documents is inadequate, notify Engineer.
- B. Replace cables pulled into wrong raceway or cut too short to rack and train.
- C. Do not reinstall cables installed in wrong raceway and removed. Discard cables unless inspected and accepted by Owner's Representative in writing.
- D. Carefully lay or pull circuits in cable tray so neither cables nor tray is damaged.
- E. Protect cables from dirt, water, oil, damaging chemicals, and from physical injury prior to, and during installation.
- F. Cables shall be cut sufficiently long to conform to contour of trays, with particular attention paid to vertical inside bends.
- G. Remove excessive slack so cables lie parallel to sides of trays.
- H. Multiple single-conductor power cables No. 1/0 AWG (50 mm<sup>2</sup>) or larger installed in cable tray that constitute single power circuit shall be grouped together in triplexed or quadriplexed arrangement. Maintain cable spacing to be 2.15 x O.D. of largest conductor in group or adjacent group.
- I. Multiconductor power cables No. 4/0 AWG (120 mm<sup>2</sup>) or larger installed in cable tray shall be installed in single layer with maintained spacing of not less than 1 cable diameter of largest cable.
- J. Fasten cables to cable tray with rated nylon ties to hold cables in place.
- K. Perform fishing and pulling with flexible round metal tape, CO<sub>2</sub> propelled polyethylene cord, nylon rope, or manila rope.
- L. Cable damage caused by improper pulling tension and excessive sidewall pressures shall be considered for any cable pulls that require use of mechanized cable pulling machine, whether installed underground or overhead.
  1. NEC requirements shall be used as guideline. Calculations shall be performed for duct bank runs over 300' (90 m), and for installations in conduit over 100' (30 m).
  2. Monitor pulling tension during installation of cable. Tension shall not exceed maximum recommended by cable manufacturer.
  3. To avoid damage from excessive sidewall pressure at bends, pulling tension shall not exceed cable manufacturer's recommendation.

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4. Pulling mechanisms, manual or power type, shall have rated capacity in tons legibly marked on mechanism.
5. During installation, observer shall constantly watch dynamometer and record maximum tension achieved during pull.
  - a. If excessive strain develops, stop pulling operation at once. Determine difficulty and correct.
  - b. Provide records of dynamometer readings to Engineer.
  - c. Inform Owner prior to cable pulls.
6. Do not use woven wire cable grips. Only use pulling eyes for pulling cables.
7. As soon as cable is pulled into place, remove pulling eyes and reseal cable.
- M. Insert reliable nonfreezing type of swivel or swivel connection between pulling rope and eye to prevent twisting under strain.
- N. Only use lubricants as recommended by cable manufacturer. Water-based lubricants not allowed.
- O. Outside of each cable reel shall be carefully inspected. Remove protruding nails, fastenings, or other objects that might damage cable.
  1. Perform visual inspection for flaws, breaks, or abrasions in cable sheath as cable leaves reel. Pulling speed shall be slow enough to permit inspection.
  2. Damage to sheath or finish of cable shall be sufficient cause for rejecting cable.
  3. Cable damaged during installation shall be replaced at no expense to Owner.
- P. Permanent radius of each bend after cable installation shall be in accordance with manufacturer's recommendations.
- Q. Cable supports and securing devices shall have bearing surfaces located parallel to surfaces of cable sheath. Install to provide adequate support without deformation of cable jackets or insulation.
- R. Provide adequate cable end lengths. Properly install in junction boxes and manholes to avoid longitudinal strains and distorting pressures on cable at conduit bushings and duct end bells.

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- S. Final inspection shall be made after cables are in place. Where supports, bushings, and end bells deform cable jacket, provide additional supports.
- T. Splices, joints, and connections shall be made only in accessible junction boxes in accordance with methods specified and instructions of cable manufacturer. Splices not allowed unless shown on Drawings.
- U. Rough-in wiring terminated in junction boxes shall have at least 8" (200 mm) of free conductor coiled in box for connection to equipment and receptacles.
- V. Circuit information for circuits originating from panelboards is indicated on panel schedules. Other circuits are identified on circuit schedule.
  - 1. Do not combine receptacle loads with lighting loads.
  - 2. Circuits fed from panelboards shall not be combined with circuits from circuit schedule.
- W. Panelboard circuits are indicated as individual runs. Circuits may be combined into common conduits in accordance with rules of NEC. Perform work associated with combining of circuits at no additional cost to Owner.

**3.6 WIRING DEVICES, BOXES, AND FITTINGS**

- A. Install galvanized or cadmium plated, threaded, malleable iron boxes and fittings in:
  - 1. Embedded in concrete walls, ceiling, and floors.
  - 2. Outdoor exposed faces of masonry walls.
  - 3. Locations where weatherproof cover is required by code or this specification.
- B. Install galvanized or cadmium plated sheet steel boxes in:
  - 1. Indoor exposed faces of masonry walls.
  - 2. Interior partition walls.
  - 3. Joist supported ceilings.
- C. Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.
- D. Telephone and communication conduit systems shall have separate junction boxes and pull fittings.

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- E. Install fire system wiring in dedicated conduit system.
- F. Finish openings so standard sized cover plates can be used. Oversized plates not allowed.
- G. Mount wall switches 3'-6" (1050 mm) above finished floor or grade unless specified otherwise. After circuits are energized, test wall switches for proper operation.
- H. Outlets:
  - 1. Standard mounting height: 18" (450 mm) above finished floor, unless specified otherwise.
  - 2. Outlets outdoors, garages, basements, shops, storerooms, and other rooms where equipment may be hosed down: 4'-0" (1200 mm) above finished floor or grade.
  - 3. Surface-mount welding receptacles 4'-0" (1200 mm) above finished floor or grade.
  - 4. After circuits are energized, test each receptacle for correct polarity.
  - 5. Test GFCI receptacles for proper operation.
  - 6. Mount wall thermostats 5'-6" (1650 mm) above finished floor unless noted otherwise. Thermostats mounted shall be suitably insulated from wall temperatures.
- I. Communication outlets:
  - 1. 18" (450 mm) above finished floor unless required otherwise.
  - 2. Outlets outdoors, garages, basements, shops, storerooms, and rooms where equipment may be hosed down: 4'-0" (1200 mm) above floor.
- J. Clock outlets: Locate 7'-0" (2.13 m) above finished floor or grade.

### 3.7 GROUNDING AND BONDING

- A. Electrical system and equipment grounding shall be installed in accordance with NEC and shall conform to following, where applicable:
  - 1. Ground conductors shall be bare or green-insulated in accordance with NEC.
  - 2. Cable shall be soft-drawn copper or copper bar, sized in accordance with drawings and NEC, but not smaller than No. 12 AWG.

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3. Ground cable splices and joints inaccessible upon completion of construction shall meet requirements of IEEE 837 and shall be exothermic weld or compression system type.
4. Ground cable through exterior building walls not in conduit shall enter within 3' (1 m) below finished grade and shall be provided with water stop. Installation of water stop shall include filling space between strands with solder and soldering 12" (300 mm) copper disc over cable.
5. Ground cable near base of structure shall be in undisturbed earth and as far from structure as excavation permits, but not closer than 6" (150 mm).
6. Copper ground conductor in addition to conduit connection shall ground each piece of electrical equipment.
7. Copper or high-conductivity copper alloy ground lugs or clamps shall make ground connections to equipment and ground buses. Connections to enclosures not provided with ground buses or ground terminals shall be made by clamp-type lugs added under permanent assembly bolts or under new bolts drilled and added through enclosures other than explosionproof, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers not permitted.
8. Bond grounding system to water piping by connection to first flange inside building from main that will form good ground connection. Make connection with copper bar or strap by drilling and tapping flange and providing bolted connection.
9. Ground conductors on equipment shall be formed to contour of equipment and firmly supported.
10. Ground rods not described elsewhere shall be minimum 5/8" (16 mm) diameter by 10' (3.0 m) long, with copper jacket bonded to steel core.
11. Make connections to ground grid where shown on Drawings.
12. Verify connections by performing continuity checks.

**3.8 FIREPROOFING AND FIRE RATINGS**

- A. Maintain fire-resistive integrity during construction.
- B. Penetrations through fire-resistive structures shall be sealed with fire-resistive material compatible with construction penetration.

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- C. Where required by codes, local building officials, or fire marshal, furnish UL fire sealing systems and install in accordance with manufacturer's recommendations.

**3.9 STARTUP AND TESTING**

- A. Clean equipment interiors and exteriors prior to start-up and testing.
- B. Unless specified otherwise, tests performed shall be standard tests listed by ANSI/IEEE for intended equipment.
- C. Equipment shall be checked and placed in service ready for operation.
- D. Circuits shall be electrically tested after installation. Test power and motor circuits prior to final connection to equipment. Splices shall be complete prior to testing.
  - 1. Provide equipment and labor required for testing.
  - 2. Circuit failing to test satisfactorily shall be replaced or repaired, and retested at no additional cost to Owner.
  - 3. Check power and motor circuits, dc power, and control circuits for:
    - a. Correct terminations.
    - b. Continuity.
    - c. Unintentional shorts and grounds.
  - 4. Check power conductors for correct phasing.
  - 5. Motor circuits shall be checked for proper rotation and motors "bumped" to verify correct machine rotation.
  - 6. Control, instrumentation, and thermocouple wire shall be checked for correct termination, continuity, freedom from shorts or grounds, and identification.
  - 7. Current transformer wiring shall be loop checked by injecting current at one end of loop and checking with clip-on ammeter at each field termination point to assure continuity and phase identification.
  - 8. Voltage transformer wiring shall be tested by applying voltage at one point and checking with voltmeter phase rotation meter and phase angle meter at each field termination point to assure continuity, identification and phase shift.



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3.10 DEMONSTRATION

- A. Final start-up and check out shall be completed prior to Owner acceptance of project.
- B. Electrical installation shall be complete in every detail and capable of normal operation in presence of Owner or Owner's Representative to verify its readiness.

END 26 05 00

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**Section 26 05 00 – Common Work Results for Electrical**

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**Section 26 05 26 - Grounding and Bonding For Electrical Systems**

1. GENERAL

1.1 WORK INCLUDES:

A. Base Bid:

1. Design-Build Contractor shall provide:

- a. Grounding system requirements providing protection of equipment and personnel.

1.2 SYSTEM DESCRIPTION

- A. Grounding system includes, but is not limited to, rods, cable, connectors and miscellaneous hardware and materials.

1.3 QUALITY ASSURANCE

A. Manufacturer qualifications:

- 1. Grounding assembly manufacturer shall be manufacturer of major components of ground system.
- 2. Manufacturer shall be ISO certified.
- 3. When requested by Engineer, provide acceptable list of similar equipment installations complying with this Specification.

1.4 REGULATORY REQUIREMENTS

- A. Design, manufacture, and test ground system and accessories in accordance with applicable requirements of NFPA 70, IEEE STD 80, IEEE STD 81, IEEE STD 142, IEEE STD 837, and applicable state and local codes and regulations.
- B. Standards of foreign organizations shall not be used without written approval from Engineer.

1.5 SUBMITTALS

A. Product Data:

- 1. Product data sheets for each type of component.
- 2. Accessories list.
- 3. Ratings and nameplate information.

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4. Special installation tools list.

B. Quality assurance data:

1. Certified shop test reports.
2. Certified field installation data and reports.
3. Manufacturer's installation information.
4. Copies of component warranties.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare detailed packing lists and shipping notification for all items shipped.
- B. During delivery and storage, handle equipment to prevent damage.
- C. Store equipment in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

2. PRODUCTS

2.1 MANUFACTURERS

- A. FCI-Burndy.
- B. Erico.
- C. Galvan Industries
- D. Southern Grounding Products
- E. Harger Lightning & Grounding
- F. Thompson Lightning Protection, Inc.

2.2 MATERIALS

- A. Grounding materials shall be new and undamaged.
- B. Bare ground cable: Soft drawn copper in accordance with ASTM B3, Class A or B stranding, not less than No. 4/0 AWG (120 mm<sup>2</sup>) in accordance with ASTM B8. Ground conductor size shall be as shown on Drawings.
- C. Insulated ground conductors shall have green colored insulation.

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- D. Ground conductors shall be bare or have green colored insulation or marked with green colored tape or adhesive labels at each end and at every point where conductor is accessible.
- E. Connections shall be made using an exothermic welded process or compression system.
  - 1. Exothermic molds and weld metal shall be selected for connection and be made in strict accordance with manufacturer's instructions.
  - 2. Where compression type connections are used, provide tools and proper dies as recommended by manufacturer.
  - 3. Where flush ground plates are to be embedded in concrete, ground cable shall be exothermally welded to plate and plate firmly secured to concrete forms.
- F. Above-grade connections shall be provided as shown on Drawings.
- G. Above-grade clamps and other hardware used with grounding system shall be bronze or copper alloy.
- H. Above ground bolts, washers, and nuts shall be silicon bronze alloy or approved type of cadmium-plated steel.

3. EXECUTION

3.1 INSTALLATION / APPLICATION / PERFORMANCE / ERECTION

- A. Install at locations in accordance with manufacturer's recommendations.
- B. Coordinate interface installation with existing grounding systems.
- C. Connect electrical equipment to ground grid with ground electrode conductor. Electrical equipment shall be designated as metallic structures including equipment mounted thereon, instrument transformers, surge arrestors, transformers, breakers, enclosures, switchgear, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, operate continuously at ground potential, and provide low impedance path for possible ground fault currents.
- D. Install separate, green-insulated equipment grounding conductor in conduit with related phase and neutral conductor.
- E. Ground motors with ground conductor originating at ground lug in equipment where motor power is supplied and connected to motor

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frame inside motor terminal conduit box. Where motor has separately mounted starter or disconnect switch, ground conductor shall be bonded to starter and disconnect device enclosures and motor frame.

- F. Above-grade connections to permanent and removable equipment shall be exothermic-weld, bolted, or compression-connection type.
- G. Above-grade conductors:
  - 1. Install exposed conductors inconspicuously in vertical or horizontal positions on supporting structures.
  - 2. When located on irregular supporting surfaces or equipment, conductors shall run parallel to or normal to dominant surfaces.
  - 3. Conductors routed over concrete, steel, or equipment surfaces shall be kept in close contact with surfaces by using fasteners located at intervals not to exceed 3' (1 m).
- H. Conduits extending into equipment shall be grounded through grounding bushings in enclosure where terminated. Grounding bushings shall be wired together and connected internally to enclosure ground lug or ground bus with bare copper conductors.
- I. Conduits connected to metal enclosures shall be grounded to enclosure by either grounding bushing or double locknuts, with one conduit locknut on each side of enclosure, to provide continuous ground path back to source voltage. Provide grounding bushing for knockout holes in metal enclosures that are oversized, elongated, or deformed.
- J. Exothermic welds shall encompass 100% of cable end being welded and shall resist moderate hammer blows.

**3.2 FIELD QUALITY CONTROL**

- A. Tests shall be made with approved ground resistance tester in accordance with instrument manufacturer's instructions.
  - 1. Make measurements made in presence of Using Agency's Representative and record data.
  - 2. Tests shall be performed by personnel knowledgeable in ground system testing.

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3.3 EXAMINATION

- A. Verify Site conditions are acceptable for installation.
- B. Verify grounding and bonding system components are in good condition and undamaged.

END 26 05 26.

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**Section 26 05 29 – Hangers and Supports for  
Electrical Systems**

1. GENERAL

1.1 SECTION INCLUDES

A. Base bid:

1. Design-Build Contractor

- a. Hangers and supports for electrical equipment and systems.

1.2 RELATED DOCUMENTS

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

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. 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.

1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel slotted support systems.
  - 2. Threaded rods.

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Electrical Systems**

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.

C. Welding certificates.

1.6 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

2. PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. 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.

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- g. Wesanco, Inc.
- 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
- 3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
- 4. 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 hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1.) Hilti Inc.
      - 2.) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 3.) MKT Fastening, LLC.
      - 4.) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
  - 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout

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Electrical Systems**

capacities appropriate for supported loads and building materials in which used.

a. 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.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

**2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES**

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

**3. EXECUTION**

**3.1 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 required by scheduled in

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Electrical Systems**

NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) 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.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### 3.2 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 (90 kg).
- 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. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to

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lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.

6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
  7. To Light Steel: Sheet metal screws.
  8. 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 by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

**3.3 INSTALLATION OF FABRICATED METAL SUPPORTS**

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

**3.4 PAINTING**

- A. Touchup: Comply with requirements in Division 09 or minimally, 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 (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END 26 05 29

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**Section 26 05 33 – Small and Medium Phase Motors**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design Bid Contractor shall provide:

- a. Low-voltage, 3-phase, fractional and integral horsepower squirrel cage induction electric motors 1/2 to 200 hp.

1.2 WORK BY OTHERS

- A. Motor foundations and foundation anchor bolts.
- B. Receiving, unloading and storing of motors.
- C. Final placement and assembly.
- D. Power, control, and grounding connections.

1.3 ACTION SUBMITTALS

A. Shop Drawings:

- 1. Complete and accurate Data Sheets.
- 2. General description and technical data cut sheets.
- 3. Certified outline drawings that include dimensions, weight, lifting points, center of gravity, enclosure construction, and location of accessories.
- 4. Recommended long term and short term storage requirements and procedures.
- 5. List of recommended start-up and spare parts for each type of motor, including bearings.

1.4 CLOSEOUT SUBMITTALS

A. Manufacturer's operation and maintenance manuals. Provide, at minimum:

- 1. Final reviewed set of drawings listed above.
- 2. Operating and maintenance procedures.
- 3. Warranty information.

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1.5 QUALITY ASSURANCE

A. Manufacturer's qualifications:

1. Manufacturer shall manufacture major components of motor and shall be ISO certified.
2. Manufacturer shall have produced similar equipment for minimum period of 5 years.

B. Regulatory requirements:

1. Motors shall be in accordance with applicable requirements of NEMA MG-1, NFPA 70, IEEE 112, and UL 1004.
2. Standards of foreign organizations shall not be used without written approval from Engineer.

1.6 DELIVERY, AND HANDLING

- A. During delivery and handle equipment to prevent damage, denting, or scoring.
- B. Ship equipment to job Site for installation.

2. PRODUCTS

2.1 MANUFACTURERS

- A. Baldor.
- B. Ideal Electric.
- C. Lincoln Motors.
- D. Marathon.
- E. Reliance.
- F. Siemens.
- G. TECO - Westinghouse.
- H. Toshiba.
- I. U. S. Motors.

2.2 SYSTEM DESCRIPTION



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- A. Furnish motors either separately or as integral part of mechanical system. Motor horsepower and torque characteristics shall be coordinated with driven piece of equipment by manufacturer.
- B. Motor rated power shall exceed driven equipment maximum load by 15% unless otherwise agreed by User. Service factor shall not be considered in this calculation.

**2.3 ENCLOSURE SYSTEM**

- A. Provide weather enclosure and cooling class type as specified on Data Sheet. Furnish motors with frames 182T and above with lifting eyes arranged so lifting slings do not become entangled in accessories mounted on motor.
- B. Treat materials potentially exposed to process fluids with rust preventing compounds.
- C. Do not use copper or copper alloy for air coolers.
- D. Bolts and nuts exposed to environment shall be of galvanized steel.

**2.4 VOLTAGE AND FREQUENCY**

- A. Motors shall be capable of operating within design characteristics for system source voltage as specified on Data Sheets.
- B. Design motors for full-voltage, across-the-line starting unless specified otherwise.

**2.5 CHARACTERISTICS**

- A. Torque characteristics shall conform to standard NEMA design letter designation and shall be appropriate for mechanical load served. Motor speed and rotation shall be that required by the driven equipment. Motors shall have torque characteristics adequate to “break away” driven load and to accelerate load to rated speed in length of time that is at least 2 seconds less than the hot locked rotor thermal damage time of motor.
- B. Motor locked-rotor current shall not exceed 650% of full load current.
- C. Efficiency at rated load shall meet or exceed NEMA Premium efficiency levels.

**2.6 MOTOR FRAME**

- A. Type: Heavy-duty, using cast iron or welded steel construction.
- B. Machine sealing parts to high-accuracy to minimize breathing.

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- C. If specified for hazardous areas, motors shall be enclosed and UL-listed for class, division, and group designation in accordance with NEC Article 500.
- D. Motor frame, end brackets, fan covers, drip shields, and bearing housing shall be corrosion-resistant. Motor supporting feet shall be an integral part of frame.
- E. Provide motors with stainless steel replaceable automatic drainage fittings. Locate drain holes at low point of motor in final mounted position.
- F. Drill and tap for ground lug connection. Locate bolt holes on motor frame, external to, and on same side as terminal box. Provide hole size as follows:
  - 1. Motors up to 50 hp: 1/4-20 unified inch coarse thread (UNC).
  - 2. Motors over 50 hp and up to 200 hp: 3/8-16 UNC.
  - 3. Motors over 200 hp: 1/2-13 UNC.
- G. For interchangeability, multiple motors provided as part of same system or on same piece of equipment shall have similar motor frame sizes to minimize number of different frame sizes and associated mounting dimensions.
- H. Mount motor on equipment skid and provide provisions for alignment adjustments and belt tightening. Motor shall be factory mounted and aligned to equipment prior to shipment.

**2.7 STATOR AND STATOR ASSEMBLY**

- A. Insulation:
  - 1. Multiple dips and bakes of insulating varnish.
  - 2. Where tropicalization is specified on Data Sheets, provide additional dips and bakes of insulating varnish and either use of special insulating materials or varnish treatment to prevent growth of fungus and ingress of moisture.
- B. Windings shall be copper.
- C. Windings shall be random-wound coils with class of insulation as stated on Data Sheets.

**2.8 ROTOR AND SHAFT ASSEMBLIES**

- A. Motor shaft shall be machined, carbon steel capable of transmitting torque produced by motor.

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- B. Rotor cage shall be fabricated aluminum, or integrally die-cast aluminum.
- C. Rotor shall be epoxy-coated.
- D. Dynamically balance motors by one of following means:
  - 1. Drilling out parent metal in such a manner that structural strength of rotor is not weakened.
  - 2. Use balance washers securely pinned in place.
  - 3. Chiseling, sawing, or use of solder or similar deposit materials to achieve balance is not acceptable.

**2.9 BEARINGS**

- A. Anti-friction type bearings shall be grease lubricated and have minimum rated life L10 with a median life no less than 50% of L10 life, as defined by ABMA. Reliability of each bearing shall be greater than 90%.
- B. Ball bearings shall be vacuum-degassed steel, motor quality.
- C. Construct and provide bearing and bearing housing seals to prevent dirt or moisture from entering motor.
- D. Provide interior bearing caps or other suitable means to prevent lubricant from entering motor.
- E. Integrally cast bearing supports as part of motor end bell. Rabbet end bell to stator assembly to ensure proper bearing alignment and air gap spacing.
- F. Design bearings so damage does not occur by axial rotor movement during motor startup and shutdown.
- G. Shaft and bearings for belt-connected motor shall withstand normal belt pull of equipment furnished and momentary and continuous overloads due to acceleration caused by incorrect belt tension.
- H. Bearings for motors driving vertical pumps, including in-line pumps, shall be designed to carry 200% of maximum thrust, up and down, that pump develops during starting and stopping, and while operating at any capacity on rated performance curve.
  - 1. Minimum momentary up-thrust capacity shall be equal to 30% of down-thrust at rated capacity.
  - 2. Thrust bearings for in-line pump motors shall be the motor non-drive end bearing.

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- I. Motors rated 100 hp and above for nonVFD applications shall have non-drive end bearing insulated to prevent against circulating shaft current.
- J. Motors shall have metallic bearing isolators on each bearing.
- K. Furnish vertical motors coupled to vertical pumps with non-reversing ratchets and bolted couplings with case drip shields.

**2.10 LUBRICATION SYSTEM**

- A. System shall be capable of operating at least 8,000 hours without requiring addition of grease or complete change of grease.
- B. Provide system with readily accessible grease inlet and outlet plugs in bearing housings to enable regreasing while motor is in service.

**2.11 FANS**

- A. Fan material shall be nonsparking bronze alloy or conductive plastic. Aluminum, bronze, copper, or copper alloy not acceptable.

**2.12 SPACE HEATERS**

- A. Provide low surface-temperature space heaters for motors installed outdoors, and motors rated 25 hp or larger installed indoor or outdoor. Mount on inside of motor frame or winding end turns.
- B. Sheath temperature at 110% of rated voltage, when operating at ambient temperature, shall not exceed 200°C or cause motor insulation temperature to exceed 130 °C, whichever is more restrictive.
- C. Space heaters shall be rated and designed to operate at voltages as specified on Data Sheets. Space heaters shall be suitable for installation in hazardous areas as defined by NFPA, if motor is specified to be installed in a hazardous area.
- D. Route space heater power leads to dedicated terminal box for control and space heater leads.

**2.13 MOTOR TERMINAL BOXES**

- A. Equip each motor with terminal boxes.
- B. Size motor lead terminal box to allow for bending radius and stiffness of motor supply cables, and for terminating grounding conductor.

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1. Frame size 445T and below: Cast iron terminal box shall be at least twice usable volume specified in NEMA MG-1, and not less than 24 in<sup>3</sup> (393.3 cm<sup>3</sup>).
  2. Frame size exceeding 445T: Cast iron, cast steel, or steel plate terminal box sized according to NEMA MG-1, Figure 20-3.
- C. Motor leads shall have brass or stainless steel ferrules embossed with appropriate lead number, or leads imprint with lead number. Tagging of main leads shall be in accordance with MG-1, Part 2.
- D. Fit motor terminal box with neoprene gaskets.
- E. Main terminal boxes shall be capable of rotation in 90° increments to permit connection on any one of four sides.
- F. Provide motor lead seal and separator gasket between motor frame and terminal box.
- G. Provide main terminal boxes with threaded conduit entrances.
- H. Motor leads shall have oil-resistant insulation.
- I. Terminate main lead electrical connections with tinned lugs.

**2.14 IDENTIFICATION AND TAGGING**

- A. Securely attach embossed or stamped, stainless steel nameplates with stainless steel screws or pins.
- B. Nameplate shall contain standard information in accordance with NEMA MG-1 40.1 and as follows:
1. Year of manufacture.
  2. Type of bearing lubricant and specification number.
  3. Arrow indicating direction of rotation for main lead connections.
  4. Bearing type and manufacturer's part number.
- C. If identification number cannot be included on motor nameplate, provide separate stainless steel equipment identification nameplate in accordance with equipment identification as provided by User.
- D. Motor power and space heater circuits may be derived from different sources. Covers of motor terminal boxes containing space heater leads shall be provided with nameplate reading: "ISOLATE MOTOR AND HEATER CIRCUITS BEFORE REMOVING COVER".

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2.15 VARIABLE SPEED MACHINES

- A. Motors defined on the Data Sheet for variable speed application shall be inverter duty rated and operated over the speed range defined.
- B. Provided motors with external cooling fans to force cool the machine if the operational speed range defined on Data Sheet reduces integral fan performance below required levels to maintain maximum temperature rise.
- C. Electrically insulate both drive end and non-drive end bearings.

3. EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Motors furnished with space heaters shall have heaters connected to temporary source of power capable of being monitored during storage.
- C. Maintain temporary power until motors are installed in final position and normal power source is permanently energized.
- D. Store motors and components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.
- E. After machine is installed into final location but before startup, maintain motor space heaters electrical supply.
- F. Bump motor for proper rotation and run motor uncoupled from mechanical load for a minimum of 20 minutes prior to coupling to load.

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<b>DATA SHEETS LOW VOLTAGE MOTORS</b>		<b>Equipment Name: Air Compressor 1,2,3,4</b>	
		<b>Tag No.:</b>	<b>Rev.</b>
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
Motor Manufacturer	-	By Manufacturer	
Motor Catalog No.	-	By Manufacturer	
IEEE 841 design standards motor	Y/N	N	
<b>Ratings:</b>			
System Voltage ( 208, 240, 480, 600)	V	480	
Operating Frequency (50 or 60)	Hz	60	
Nameplate Voltage (200, 230, 460, 575)	V <sub>L</sub>	460	
Frame Size	-	By Manufacturer	
Number of Phases	Qty	3	
Rated Speed	RPM		
Rated Shaft Output	hp	7.5	
Driven Load (maximum)	hp	By Manufacturer	
Design Type (A, B, C, D, E)	-	By Manufacturer	
Locked Rotor Code Letter	-	By Manufacturer	
Protective Enclosure IP Code (NEMA MG-1 Part 5)	IP		
Minimum Efficiency (NEMA Defined)		Premium Efficiency	
Method of Cooling IC Code (NEMA MG-1 Part 6)	IC		
<b>Installation:</b>			
Maximum Site Design Ambient Temperature	°C	+40	
Minimum Site Design Ambient Temperature	°C	-25	
Site Altitude	ft	≤ 3300	
Unusual Service Conditions			
Minimum Insulation Class (B, F, or H )	-	F (minimum)	
Maximum Operating Temperature Rise (B, F, or H)	-	B (Maximum)	
Service Factor	-	1.15	
Duty Type (Continuous, short-time, or intermittent)	-	Continuous	
No. of Speeds	1,2, Variable		
No. of Windings	1,2		
Motor Starting Method	-		
Type of Speed Control	-		
Motor Rated for Use With VFD	Y/N	N	
Bearing Type	-	By Manufacturer	
Motor Space Heater required:	Y/N	N	
Rated Voltage	V		
Operating Voltage	V		
Wattage	W	By Manufacturer	
Weight	Lb	By Manufacturer	

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DATA SHEETS LOW VOLTAGE MOTORS		Equipment Name: Air Compressor 1,2,3,4	
		Tag No.:	Rev.
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
Nonreversing Ratchets	Y/N		

DATA SHEETS LOW VOLTAGE MOTORS		Equipment Name: Blower 1,2,3,4	
		Tag No.:	Rev.
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
Motor Manufacturer	-	By Manufacturer	
Motor Catalog No.	-	By Manufacturer	
IEEE 841 design standards motor	Y/N	N	
<b>Ratings:</b>			
System Voltage ( 208, 240, 480, 600)	V	480	
Operating Frequency (50 or 60)	Hz	60	
Nameplate Voltage (200, 230, 460, 575)	V <sub>t</sub>	460	
Frame Size	-	By Manufacturer	
Number of Phases	Qty	3	
Rated Speed	RPM	By Manufacturer	
Rated Shaft Output	hp	50	
Driven Load (maximum)	hp	By Manufacturer	
Design Type (A, B, C, D, E)	-	By Manufacturer	
Locked Rotor Code Letter	-	By Manufacturer	
Protective Enclosure IP Code (NEMA MG-1 Part 5)	IP		
Minimum Efficiency (NEMA Defined)		Premium Efficiency	
Method of Cooling IC Code (NEMA MG-1 Part 6)	IC		
<b>Installation:</b>			
Maximum Site Design Ambient Temperature	°C	+40	
Minimum Site Design Ambient Temperature	°C	-25	
Site Altitude	ft	≤ 3300	
Unusual Service Conditions			
Minimum Insulation Class (B, F, or H )	-	F (minimum)	
Maximum Operating Temperature Rise (B, F, or H)	-	B (Maximum)	
Service Factor	-	1.15	
Duty Type (Continuous, short-time, or intermittent)	-	Continuous	
No. of Speeds	1,2, Variable	Variable	
No. of Windings	1,2		
Motor Starting Method	-		
Type of Speed Control	-		



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<b>DATA SHEETS LOW VOLTAGE MOTORS</b>		<b>Equipment Name: Blower 1,2,3,4</b>	
		<b>Tag No.:</b>	<b>Rev.</b>
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
Motor Rated for Use With VFD	Y/N	Y	
Bearing Type	-	By Manufacturer	
Motor Space Heater required:	Y/N	Y	
Rated Voltage	V		
Operating Voltage	V		
Wattage	W	By Manufacturer	
Weight	Lb	By Manufacturer	
Nonreversing Ratchets	Y/N		

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DIVISION 26 - ELECTRICAL  
**Section 26 05 33.13 - Conduit for Electrical Systems**

1. GENERAL

1.1 WORK INCLUDES:

A. Base Bid:

1. Design Bid Contractor shall provide:

- a. Above grade conduit, wireway, boxes, and associated accessories for support, securing, and protection of electrical wiring.

1.2 RELATED WORK

A. Section 26 05 00 Common Work Results for Electrical

1.3 SYSTEM DESCRIPTION

A. Raceway systems and accessories include, but shall not be limited to:

1. Exposed and concealed conduit.
2. Elbows, fittings, and accessories.
3. Hardware for support, securing, and protection.
4. Wireways.

1.4 QUALITY ASSURANCE

A. Manufacturer's qualifications:

1. Manufacturer shall be manufacturer of major components within assembly and shall be ISO certified.
2. Manufacturer shall have produced similar equipment for a minimum period of 5 years.

B. Regulatory requirements

1. Equipment shall be designed and manufactured in accordance with applicable requirements of following: NFPA 70; ANSI C80.1, C80.3, C80.4, C80.5; UL 1, UL 6, UL 360, UL 651, UL 797, UL 870, UL 1242; and NEMA TC2, TC3, TC6, TC9, and RN1.
2. Equipment shall be listed with a nationally recognized testing laboratory (NRTL).

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3. Standards of foreign organizations shall not be used without written approval from Engineer.

**1.5 SUBMITTALS**

**A. Product Data:**

1. List of proposed materials identifying manufacturer and type to be furnished.
2. Manufacturer's catalog sheets, marked as necessary to indicate specific type, model or catalog number for equipment to be furnished for project.

**B. Quality assurance data:**

1. Component and accessories data sheets.
2. Installation information.

**C. Such other similar information as Engineer may request.**

**2. PRODUCTS**

**2.1 RIGID METAL CONDUIT - STEEL (RGS)**

- A. Material: Mild steel tube with continuous welded seam in accordance with ANSI C80.1, and UL 6.
- B. Exterior and Interior protective coating: Metallic zinc applied by hot-dip galvanizing or electro-galvanizing. Apply final coat of transparent zinc chromate to exterior. Exterior and interior coatings applied to conduit shall afford sufficient flexibility to permit field bending without cracking or flaking.
- C. Thread pitch shall conform to ANSI/ASME B1.20.1. Taper shall be 3/4"/ft (62.5 mm/m).
- D. Each length of conduit shall have a NRTL-listing label.
- E. Couplings, unions, and fittings: Threaded-type, galvanized steel.
- F. Conduit bodies: Threaded or threadless type, cast metal or malleable iron type with zinc or cadmium coating. Covers shall have solid gaskets and captive screw fasteners.
- G. Running thread not acceptable.

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2.2 INTERMEDIATE METAL CONDUIT (IMC)

- A. Material: High-grade sheet steel with continuous welded seam.
- B. External protective coating: Metallic zinc applied by hot-dip galvanizing or electro-galvanizing. Coating shall not flake or crack when conduit is bent. Internal coating of enamel or similar material resulting in smooth surface.
- C. Fittings: Threaded or threadless type, galvanized steel or malleable iron.
- D. Conduit bodies: Threaded-type, cast metal, or malleable-iron type, with zinc or cadmium coating. Covers shall have solid gaskets and captive screw fasteners
- E. Running thread not acceptable.

2.3 ELECTRICAL METALLIC TUBING (EMT)

- A. Material: Hot-dipped galvanized, high-grade steel with continuously welded seam.
- B. External protective coating: Metallic zinc applied by hot-dip galvanizing or electro-galvanizing. Coating shall not flake or crack when conduit is bent.
- C. Internal coating: Baked enamel or similar compound resulting in smooth surface.
- D. Fittings: Rust-resistant steel compression type. Connectors shall have insulated insert in throat. Die-cast aluminum material, and indent or set screw type, are not acceptable.
- E. Conduit bodies: Malleable iron for use with compression type fittings. Set screw type not acceptable.

2.4 LIQUID TIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Material: Mild steel, galvanized.
- B. Construction: One continuous length steel strip of uniform weight and thickness and shaped in interlocking convolutions; fabrication shall result in smooth interior surface.
- C. External coating: Provide outer jacket of tough extruded polyvinyl. Jacket shall be positively locked to steel core and be sunlight resistant and listed as oil resistant.
- D. Continuous integral grounding strip: Required in sizes 1-1/4" (31 mm) and smaller. Ground wire shall be required for larger sizes.

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- E. Fittings: Cadmium or zinc-plated steel or malleable iron. Compression type with tapered hub and synthetic rubber gasket and ground ferrule for making positive ground contact with steel core, designed to prevent outer jacket from pulling away from steel core. Connectors shall have insulated insert in throat. Suitable for grounding through 1-1/4" (31 mm) trade size, provide ground wire lug for sizes 1-1/2" (38 mm) and larger.

**2.5 RIGID NONMETALLIC CONDUIT – PVC**

- A. Material: PVC Schedule 40, and Schedule 80. Schedule 40 shall be rated for above-grade installation.
- B. Fittings, elbows, and accessories: Connect to conduit by solvent-type cement process. Material shall be same as conduit.
- C. Transition for connection of plastic conduit to rigid metal conduit shall be threadless solvent-type cement connection to PVC, with threaded connection to rigid metal conduit.

**2.6 PULLBOXES AND JUNCTION BOXES**

- A. General use areas, protected or indoor: Galvanized sheet steel with a metal thickness meeting UL 50. Provide removable covers attached with round head silicon bronze machine screws.
- B. Process or wet locations, indoor or outdoor: Galvanized steel or aluminum with gasketed covers attached with stainless steel hardware using raintight hubs.
- C. Where required for elbows, fittings, and accessories to be furnished by same manufacturer as conduit, boxes shall also be furnished by conduit manufacturer or by supplier approved by manufacturer.

**3. EXECUTION**

**3.1 INSTALLATION – GENERAL**

- A. Coordinate timing of installation and locations of raceway with other trades. Do not block access or impede construction.
- B. Locations of above grade raceway indicated on Drawings are approximate. Coordinate actual locations in field to avoid conflicts with other equipment.
- C. Areas designated for, but not limited to; access, maintenance, hatchway, tube removal, and expansion shall be kept clear of field-routed raceway.
- D. Exposed raceway runs shall be installed parallel or perpendicular to dominant surfaces with right-angle turns made with symmetrical bends or fittings.

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- E. Install exposed raceway minimum of 6" (150 mm) from outside surface of insulation and lagging on hot water pipes, steam pipes, and other heat sources. Install minimum of 12" (300 mm) from uninsulated heat sources. Avoid long runs parallel to heat sources.
- F. Use expansion fittings where necessary. When expansion or deflection will be greater than 6" (152 mm) or greater than fitting is designed to accommodate, provide junction boxes solidly mounted on each side of expansion joint and connect with flexible, liquidtight conduit, or adjust conduit sections to limit expansion to less than 6" (152 mm).
- G. Support raceway independently from equipment, and temporary or movable structures.
- H. At minimum, identify raceways at both ends with raceway numbers provided by Engineer. Markers shall be adhesive, UV-resistance type with 1" (25 mm) high lettering.

### 3.2 USES AND LIMITATIONS

- A. Refer to NEC for guidelines regarding use, and limitation of each type of conduit. Follow NEC except as specified otherwise herein, or as shown on Drawings.
- B. IMC: Use only for circuits rated 600 volts or less. Do not use in areas deemed corrosive. Minimum trade size 3/4".
- C. EMT: Use for concealed wiring in finished areas associated with lighting and small power circuits rated 600 volts or less. Do not use outdoors in concrete, or in damp or wet locations. Acceptable for use in nonhazardous, indoor, unfinished areas for lighting and communication, and specialty wiring. Minimum trade size 3/4".
- D. LFMC: 3/4" (19 mm) minimum size, 1/2" (13 mm) minimum size for single switch leg only; 5' (1.5 m) maximum length.
- E. PVC: Do not use schedule 40 PVC for exposed runs. Schedule 80 PVC sunlight-resistant conduit may be used for exposed runs if approved by Engineer.
- F. RMC: Use for exposed runs unless noted otherwise on plans.

### 3.3 RIGID CONDUIT

- A. Conduits not shown on Drawings shall be sized in accordance with NEC.
- B. Minimum trade size: 3/4".

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- C. Conceal conduit in finished areas.
- D. Drainage: Avoid water pockets in conduit runs; provide suitable fittings at low spots in exposed conduit where pockets cannot be avoided. Weep holes not permitted in conduit.
- E. Conduit ends:
  - 1. Cap spare conduits with fittings designed for intended use.
  - 2. Conduit terminating in panels or enclosures where exposed to entrance of foreign material shall be plugged with commercial duct-sealing compound around conductors.
  - 3. Cap conduit ends during construction to prevent entrance of foreign material.
- F. Where practicable, provide 3" (75 mm) stubbed up conduit for conduit entering into bottom of freestanding equipment. Coordinate locations with equipment. Terminate with grounding bushings.
- G. Clean and swab inside of conduit by mechanical means to remove foreign materials and moisture before wires or cables are installed. Cleaning method shall not damage interior surface of conduit.
- H. Bushings: Provide at termination of conduit not terminated in hubs and couplings. Insulating bushings with 150°C rated insulating inserts in metal housings shall be provided on conduit 1-1/4" (31 mm) and larger. Insulating bushings shall be grounding type. Standard bushings shall be galvanized.
- I. Apply coat of zinc chromate to zinc-coated conduits where protective coating is damaged.
- J. Couplings and unions:
  - 1. Threaded conduit couplings shall join metal conduit with conduit ends butted. Where standard threaded couplings cannot physically be used, join metal conduit using conduit unions or split couplings.
  - 2. Use ground-seat type, watertight unions where union may be submerged.
  - 3. Install coupling nut in upper-most union to prevent entrance of water into union when used in vertical or inclined conduit runs.
- K. Bends: Run of conduit shall not contain more than equivalent of three 90° bends, including offsets at outlets or fittings. Use only manufacturer-approved conduit bending equipment. Do not use deformed or crushed conduits.



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- L. Threads: Cut ends of conduit with saw; do not use wheel cutter. Conduit end shall have same number of threads as present from factory. Apply coat of zinc chromate to steel conduit threads and apply anti-seize compound containing powdered zinc or lubricating graphite to aluminum conduit threads.
- M. Use expansion joints as required such that no more than 6" (152 mm) allowance for expansion or contraction of conduit occurs.

**3.4 FLEXIBLE CONDUIT**

- A. Connect equipment that moves due to vibration, normal operation of mechanism, or thermal expansion, in relation to supported conduit using flexible conduit. Install junction boxes as required. Provide green ground wire.
- B. Flexible metal conduit 1-1/2" (38 mm) and larger shall be installed with external lugs and external grounding conductor.

**3.5 SPECIAL FITTINGS**

- A. Fittings installed outdoors or in damp locations shall be weathertight. Outdoor fittings shall be of heavy-duty construction.

**3.6 CONDUIT SUPPORTS**

- A. Supports of structural steel or manufactured framing members shall be fabricated from lightweight channel approved by manufacturer for intended use, provide required rods, anchors, inserts, clamps, spacers, shims, bolts and accessories.
- B. Clamps: Galvanized malleable iron 1-hole straps, beam clamps, or other device with necessary bolts and expansion shields.
- C. Adjustable hangers: Use to support horizontal runs only. Use trapeze-type supports for parallel runs of conduit. Install U-bolts at end of each run and at each elbow. Install conduit clamps every third intermediate hanger for each conduit. Hanger rods shall be 3/8" (10 mm) minimum diameter threaded galvanized steel rods.
- D. Conduits supports mounted on concrete surfaces: Fasten with self-drilling tubular expansion shell anchors with externally split expansion shells, single cone expanders, and annular break-off grooved chucking cones.

**3.7 PENETRATIONS**

- A. Provide required penetrations in floors, walls, or roofs. Penetrations shall be kept to minimum, as small as possible, and installed in neat manner.

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Surrounding surfaces damaged during installation of penetrations shall be included as part of this work.

- B. Seal penetrations in walls, floors, ceilings, and enclosures. Provide fire stops for electrical raceway penetrations. Maintain original fire rating that existed prior to commencement of work. Do not install fire seal for wire openings until interconnecting wiring of equipment is proven to operate properly.
- C. Sleeves:
  - 1. Provide for passage of conduits through walls, floors, or partitions. Set sleeves in masonry during construction; set sleeves through concrete before placement begins.
  - 2. Material: Rigid conduit or pipe securely fastened in position.
  - 3. Cut sleeve flush with floor where conduit enters equipment enclosure otherwise extend sleeve 3" (75 mm) above floor.
  - 4. Sleeves through exterior building walls: Install conduit in center of sleeve. Pack interior and exterior annular space around conduit with plastic backer rod sized to fit annular space in compression as recommended by backing manufacturer. Seal interior and exterior of joint with acrylic polymer sealant.
  - 5. Sleeves through waterproof construction shall be flanged type.
- D. Penetrations required after walls, floors, or ceilings are constructed shall be provided and grouted or sealed. Openings shall be core-drilled, do not jackhammer.
- E. Patch and finish openings made in existing walls and floors to match original material in composition and appearance.
- F. Cut or punch penetrations in wall panels. External penetration shall be flashed and calked to provide weather tight seal.
- G. Limit penetrations in roofs to applications where required for connection to specific piece of equipment. When required, flash and apply seal material after installation of conduit to provide weathertight bond and seal. Materials shall be compatible with roofing system.

**3.8 WIREWAY AND BOXES**

- A. Installed in accordance with manufacturer's recommendations.
- B. Connections shall be made such that they maintain NEMA rating of enclosure and system.

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- C. Locations and quantities shown on Drawings are approximate. Make adjustments as required to eliminate field interferences or to meet requirements of NEC. Provide Engineer with information regarding new locations.
- D. To access interior, locate to permit full removal of covers, or such that doors can be opened more than 100°. Mount at height as indicated, or as required by NEC, whichever is more restrictive.
- E. Support wireways and boxes independently of conduits by means of bolts, screws, rod hangers, and other suitable means.

END 26 05 33.13

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**SECTION 26 05 43 – Underground Ducts and Raceways**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build Contractor.

1. Install of underground electrical trench/duct banks to reconnect existing campus 2.4KV rated branch feeds.
2. Install of new manholes.

B. Alternate Bids: Not applicable.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Precast manholes.
3. Utility structure accessories.

1.3 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:

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- a. Include plans, elevations, sections, details, attachments to other work, and accessories.
- b. Include duct entry provisions, including locations and duct sizes.
- c. Include reinforcement details.
- d. Include frame and cover design and manhole chimneys.
- e. Include ladder details.
- f. Include grounding details.
- g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
- h. Include joint details.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- C. Product Certificates: For concrete and steel used in precast concrete manholes, as required by ASTM C858.
- D. Source quality-control reports.
- E. Field quality-control reports.

**1.6 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

**2. PRODUCTS**

**2.1 METAL CONDUIT AND FITTINGS**

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. Coated Steel Conduit: PVC-coated.
  - 1. Comply with NEMA RN 1.

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2. Coating Thickness: 0.040 inch (1 mm), minimum.

C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

**2.2 PRECAST MANHOLES**

A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

B. Comply with ASTM C858.

C. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.

D. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

E. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

F. Ground Rod Sleeve: Provide a 3-inch (75-mm) PVC sleeve in manhole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the duct entering the structure.

G. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

**2.3 UTILITY STRUCTURE ACCESSORIES**

A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A48/A48M, Class 30B cast aluminum with milled cover-to-frame bearing surfaces; diameter, 26 inches (660 mm) 29 inches (725 mm).

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

2. Cover Legend: Cast in. Selected to suit system.

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- a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
- 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
  - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C387, Type M, may be used.
  - b. Seal joints watertight using preformed plastic or rubber complying with ASTM C990. Install sealing material according to sealant manufacturers' written instructions.
- C. Manhole Sump Frame and Grate: ASTM A48/A48M, Class 30B, gray cast iron.
- D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
  - 1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
- E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (31-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.
- F. Pulling-in and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
  - 1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
- G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (31 mm) minimum at base.
  - 1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.
- H. Ground Rod Sleeve: 3-inch (75-mm) PVC sleeve in manhole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the ducts routed from the facility.
- I. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.



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1. Stanchions: T-section or channel with provisions to connect to other sections or channels to form a continuous unit; 1-1/2 inches (38 mm) in width by nominal 24 inches (600 mm) long; punched with 14 hook holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
  2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (450 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
  3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
  4. Cable Rack Assembly: Nonmetallic. Components fabricated from non-conductive, fiberglass-reinforced polymer.
  5. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with provisions to connect to other sections to form a continuous unit, with minimum of nine holes for arm attachment.
  6. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (500 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.
- J. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- K. Fixed Manhole Ladders: Arranged for attachment to wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from non-conductive, structural-grade, fiberglass-reinforced resin.
- L. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greaterTwo required.

**2.4 SOURCE QUALITY CONTROL**

- A. Test and inspect precast concrete utility structures according to ASTM C1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for

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specified tier ratings of products supplied. Tests of materials shall be performed by an independent testing agency.

1. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

3. EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

Coordinate elevations of duct and duct-bank entrances into manholes and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Feeders 600 V and Less: RNC Type EPC-40-PVC, concrete-encased unless otherwise indicated.
- B. Duct for Electrical Branch Circuits: RNC Type EPC-40-PVC, direct-buried unless otherwise indicated.
- C. Underground Ducts Crossing Paved Paths, Walks, Driveways and Roadways: RNC Type EPC-40 PVC, encased in reinforced concrete.
- D. Stub-ups: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Manholes: Precast concrete.
1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

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2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

**3.4 EARTHWORK**

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area after construction vehicle traffic in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

**3.5 DUCT AND DUCT-BANK INSTALLATION**

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown.
- B. Duct installation requirements in this Section also apply to duct bank. Install duct according to NEMA TCB 2.
- C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
  1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

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- F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) duct, and vary proportionately for other duct sizes. Retain "
- H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct, and vary proportionately for other duct sizes.
- I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet (3 m) outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- J. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- K. Pulling Cord: Install 200-lbf- (1000-N-) test nylon cord in empty ducts.
- L. Concrete-Encased Ducts and Duct Bank:
  - 1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
  - 2. Width: Excavate trench 12 inches (300 mm) wider than duct on each side.
  - 3. Width: Excavate trench 3 inches (75 mm) wider than duct on each side.
  - 4. Depth: Install so top of duct envelope is at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
  - 5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

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6. **Spacer Installation:** Place spacers close enough to prevent sagging and de-forming of duct, with not less than five spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
7. **Minimum Space between Duct:** 3 inches (75 mm) between edge of duct and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and communications ducts.
8. **Elbows:** Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
9. **Elbows:** Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
10. **Reinforcement:** Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
11. **Forms:** Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
12. **Concrete Cover:** Install a minimum of 3 inches (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inches (50 mm) between duct of like services, and 4 inches (100 mm) between power and communications ducts.
13. **Concreting Sequence:** Pour each run of envelope between manholes or other terminations in one continuous operation.
14. **Pouring Concrete:** Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

**M. Direct-Buried Duct and Duct Bank:**

1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for prepara-

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tion of trench bottoms for pipes less than 6 inches (150 mm) in nominal diameter.

2. Width: Excavate trench 12 inches (300 mm) wider than duct on each side.
3. Width: Excavate trench 3 inches (75 mm) wider than duct on each side.
4. Depth: Install top of duct at least 36 inches (900 mm) below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than fourfive spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
8. Install duct with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and communications duct.
9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches (100 mm) over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
  - a. Place minimum 3 inches (75 mm) of sand as a bed for duct. Place sand to a minimum of 6 inches (150 mm) above top level of duct.

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- b. Place minimum 6 inches (150 mm) of engineered fill above concrete encasement of duct.
- N. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches (300 mm) above all concrete-encased duct and duct banks and approximately 12 inches (300 mm) below grade]. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

**3.6 INSTALLATION OF CONCRETE MANHOLES AND BOXES**

**A. Precast Concrete Manhole Installation:**

- 1. Comply with ASTM C891 unless otherwise indicated.
- 2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
- 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

**B. Elevations:**

- 1. Manhole Roof: Install with rooftop at least 15 inches (375 mm) below finished grade.
- 2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.

**C. Drainage:** Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

**D. Manhole Access:** Circular opening in manhole roof; sized to match cover size.

- 1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
- 2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

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- E. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 071353 "Elastomeric Sheet Waterproofing." & Section 071354 "Thermoplastic Sheet Waterproofing." After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- F. Dampproofing: Apply dampproofing to exterior surfaces of manholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Hardware: Install removable hardware, including pulling eyes, cable stan-  
chions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- I. Field-Installed Bolting Anchors in Manholes: Do not drill deeper than 3-7/8 inches (97 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stan-  
chion.

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
  - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- (300-mm-) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
  - 3. Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."



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- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump.
  - 1. Sweep floor, removing dirt and debris.
  - 2. Remove foreign material.

END 26 05 43

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor shall provide:

- a. A fault current analysis, protective device coordination study, and recommended device settings based on selected equipment provided under this contract as well as the existing electrical system that remains. The power system consists of the secondary of the medium voltage transformer through 2400V to 480/277 volt loads and 208/120-volt panelboards. The trip settings shall be selected to achieve minimum arc flash ratings possible while still achieving coordination. Electrical Contractor is responsible for adjusting trip settings if necessary.
- b. Arc Flash Hazard analysis to include incident energy calculations, recommended PPE, and printing and installation of arc flash labels. Scope of the Arc Flash Hazard analysis shall include the main 2400 volt switchboard, all 2400 volt, 480 volt and 208/120 volt electrical distribution equipment downstream of the main switchboard including MCCs, ATS, disconnect switches, generators, and transformers.

1.2 QUALITY ASSURANCE

- A. System Coordinator: System coordination, recommended ratings and settings of protective devices, and design analysis shall be accomplished by a licensed State of Illinois professional electrical power engineer with a minimum of 3 years of current experience in the coordination of electrical power systems.
- B. System Installer: Calibration, testing, adjustment, and placing into service of the protective devices shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of two years of current product experience in protective devices.

1.3 SUBMITTALS

A. Report Submittals:

1. Fault Current Analysis
2. Protective Device Coordination Study
3. The study along with protective device equipment submittals. No time extensions or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed will be based on recommendations of this study. The

Using Agency or CDB shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study. The study shall be updated at the end of the project to reflect all changes including any recommendation that were implemented as a result of the study.

4. Equipment: Data consisting of manufacturer's time-current characteristic curves for individual protective devices, recommended settings of adjustable protective devices, and recommended ratings of non-adjustable protective devices.
5. Arc Flash Hazard Analysis

**B. Test Reports:**

1. Field Testing.
2. The proposed test plan, prior to field tests, consisting of complete field test procedure including tests to be performed, test equipment required, and tolerance limits, including complete testing and verification of the ground fault protection equipment, where used. Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls

**C. Certificates certifying that all devices or equipment meet the requirements of the contract documents.**

**D. Labels:**

1. Sample labels for the available fault current labeling.
2. Provide Arc flash equipment labels containing the information required by NPFA 70E, article 130.5 (D).
3. Labels shall be printed by a thermal transfer type printer with no field markings.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Devices and equipment shall be visually inspected when received and prior to acceptance from conveyance.
- B. Protect stored items from the environment in accordance with the manufacturer's published instructions.

C. Damaged items shall be replaced.

## 2. PRODUCTS

### 2.1 COORDINATED POWER SYSTEM PROTECTION

A. Analyses shall be prepared to demonstrate that the equipment selected and system constructed meets the contract requirements for ratings, coordination, and protection. Trip settings shall be selected to achieve minimum arc flash rating while still achieving coordination.

B. Analyses shall include a fault current analysis, a protective device coordination study, and an arc flash hazard analysis. The studies shall be performed by a licensed professional engineer with demonstrated experience in power system coordination in the last 3 years.

1. Scope of Analyses: The fault current analysis, protective device coordination study, and arc flash hazard analysis shall begin at the secondary of the medium voltage ComEd transformer and extend through all 2400V equipment, all 480V equipment and all 208V equipment as shown in the new one line diagram.
2. Determination of Facts: The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. Utilize the fault current availability from the new medium voltage transformer as a basis for fault current studies.
3. Single Line Diagram:
  - a. A single line diagram shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided.
  - b. Each bus, device or transformation point shall have a unique identifier. If a fault-impedance diagram is provided, impedance data shall be shown.
  - c. Location of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.
4. Fault Current Analysis:
  - a. Method: The fault current analysis shall be performed in accordance with methods described in IEEE 242, and IEEE 399.
  - b. Data: Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedance shall be those proposed. Data

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shall be documented in the report. Data shall be documented in the report.

- c. Fault Current Availability: Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

5. Coordination Study:

- a. The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions.
- b. The study shall include a description of the coordination of the protective devices in this project. A written narrative shall be provided describing: which devices may operate in the event of a fault at each bus; the logic used to arrive at device rating and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and relay settings.
- c. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction) shall be provided.
- d. Composite coordination plots shall be provided on log-log graph paper.

6. Arc Flash Hazard Analysis

- a. The arc flash hazard analysis shall be performed in accordance with methods described in the latest version of IEEE 1584 and NFPA 70E.
- b. The flash protection boundary and incident energy shall be calculated for all electrical distribution equipment replaced by this project including, but not limited to, switchgear, switchboards, motor control centers, panelboards, busways, etc.
- c. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined by using those working distances.
- d. Short circuit calculations and clearing times of the phase overcurrent devices shall be retrieved from the short circuit and coordination study model.

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- e. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. Incident energy calculations for multiple scenarios must be compared and the maximum incident energy for each equipment location shall be listed for in a single table.

7. Study Report:

- a. The report shall include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.
- b. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.
- c. The report shall document utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings.
- d. The report shall contain fully coordinated composite time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.
- e. The report shall contain, in tabular form, the following:
  - 1.) Device/bus name.
  - 2.) Bolted fault and arcing fault current levels.
  - 3.) Arc flash protection boundary distances.
  - 4.) Working distances.
  - 5.) PPE classes.
  - 6.) Arc flash incident energy levels.
- f. The report shall also include recommendations to reduce arc flash incident energy levels.
- g. The report shall provide the calculation performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

3. EXECUTION

3.1 SEQUENCING/SCHEDULING

- A. Studies required to be performed under this section shall commence after shop drawings have been reviewed for all electrical equipment being supplied under this contract.

3.2 INSTALLATION

- A. Install protective devices in accordance with the manufacturer's published instructions and in accordance with the requirements of NFPA 70 and IEEE C2.
- B. Arc Flash Hazard labels shall be installed in accordance with the requirements of NFPA 70E.

3.3 EXAMINATION

- A. After becoming familiar with details of the work, verify dimensions in the field, and advise the Engineer of any discrepancy before performing any work.

3.4 AVAILABLE FAULT CURRENT LABELING

- A. Provide permanent available fault current labels for each electrical service equipment furnished under this project in accordance with NEC 110.24, including transformers, panelboards, switchboards, switchgear, bus plugs, and disconnect switches.

3.5 ARC FLASH HAZARD LABELING

- A. Arc Flash Hazard labels shall be installed in accordance with the requirements of NFPA 70E.
- B. Labels shall be printed by a thermal transfer type printer with no field markings.

3.6 FIELD TESTING

- A. Safety: Provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. Replace any devices or equipment which are damaged due to improper test procedures or handling.
- B. Molded-Case Circuit Breakers: Circuit breakers shall be visually inspected, operated manually, and connections checked for tightness. Current ratings

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shall be verified and adjustable settings incorporated in accordance with the coordination study.

END 26 05 73



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**Section 26 13 13 – Medium-Voltage Metal-Clad Switchgear**

1. GENERAL

1.1 SECTION INCLUDES

A. Base Bid:

1. Design Bid Contractor shall provide:

- a. A Medium-voltage, arc-resistant, metal-clad switchgear and accessories rated 27 kV and below.

1.2 WORK BY OTHERS

- A. Switchgear foundations and supports.
- B. Receiving, unloading, and storage.
- C. Final placement, leveling, and assembly.
- D. External power, control, and grounding terminations.

1.3 INFORMATIONAL SUBMITTALS

A. Submit with Bid:

- 1. Completed Data Sheets.
- 2. Preliminary outline drawings of switchgear including, but not limited to:
  - a. Approximate dimensions of complete line-up.
  - b. Maximum achievable shipping split sections with dimensions.
  - c. Weight of complete line-up.
  - d. Weight of each shipping section.
- 3. List of proposed equipment including model numbers, description of breakers, current transformers, voltage transformers, fuses, relays, control switches, and other devices.
- 4. Information as defined in ANSI C37.12.
- 5. List of special equipment required for operation and maintenance of switchgear.
- 6. List of recommended “start-up” and “running” spare parts with prices.

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7. List of items requiring field assembly.
  8. Recommended long term and short-term storage requirements, and procedures.
  9. Copies of warranties.
  10. Geographical location of switchgear and breaker manufacturing facilities.
  11. Manufacturing schedule.
  12. Nearest geographical location of field service personnel.
  13. For arc-resistant switchgear, copies of type tests to meet IEEE C37.20.7.
  14. For arc-resistant switchgear typical information on size and type of arc relief ducting, including typical support information.
- B. Product Data: Complete instruction manuals and software for protective relays, metering equipment, instrumentation.
- C. Quality assurance data:
1. Certified shop test reports.
  2. Proposed test schedules.

1.4 ACTION SUBMITTALS

- A. Shop Drawings:
1. Complete and accurate Data Sheets.
  2. Certified outline and general arrangement drawing including front view, dimensions, floor plan, weight (shipping and installed), anchor locations, lifting points, center of gravity, enclosure construction, layout of accessories and shipping sections.
  3. For arc-resistant switchgear, provide certified drawings showing arc chute routing, type of material, supports, venting and signage.
  4. Certified drawings of cable termination compartments showing preferred locations for conduit entry/exit locations and indicating space available for cable terminations.
  5. Nameplate drawing.
  6. Nameplate schedule prior to fabricating nameplates.

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7. Mimic diagram prior to fabrication
8. Support details.
9. Equipment heat loss (Watts).
10. Elementary 3-line diagrams for switchgear, showing voltage transformer and current transformer primary and secondary circuits. Terminal block terminations, device terminal numbers, and internal diagrams shall be shown in detail. Typical drawings are not acceptable.
11. Breaker and relay schematic control diagrams. Provide specific schematic diagram for each breaker. Typical drawings are not acceptable.
12. Complete wiring diagrams showing connections of component devices and equipment.

B. Product Data:

1. Complete Bill of Materials.
2. Interface coordination details.
3. Information to be furnished as defined in ANSI C37.12.

C. Quality assurance data:

1. Inspection and factory testing schedule.
2. Current transformer saturation, excitation and ratio correction factor curves.
3. Certified copies of factory final test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance manuals. Provide at a minimum:

1. General description and technical data, including actual weights and dimensions.
2. List of instruments and accessories supplied, listing manufacturer, model number, operating ranges, and equipment tag numbers.
3. Receiving, storage, installation, handling, and testing instructions.
4. Operating and maintenance procedures.
5. Complete set of reviewed drawings that require no further action.

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6. Data Sheets modified to include field installation conditions.
7. Complete documentation of inspections and tests performed, including logs, curves, and certificates. Documentation shall note any replacement of equipment or components that failed during testing.
8. Recommended spare parts list, including circuit breakers.
9. Bill of Materials including nameplate information and shop order numbers for each item of equipment furnished.
10. Material Safety Data Sheets.
11. Instruction manuals including detailed erection sequence and procedures.

**1.6 MAINTENANCE MATERIALS**

- A. Provide complete set of special tools required for installation of equipment.
- B. Tools and their intended use shall be detailed in manufacturer's assembly instructions.

**1.7 QUALITY ASSURANCE**

- A. Qualifications: Manufacturer shall have produced similar equipment for minimum period of 10 years.
- B. Regulatory requirements:
  1. Metal-clad switchgear and related components shall be designed, manufactured, and tested in accordance with latest applicable standards of NEMA SG-4, NEMA SG-5, ANSI/IEEE C37.09, ANSI/IEEE C37.12 and ANSI/IEEE C37.20.2.
  2. For arc-resistant switchgear, standard ANSI/IEEE C37.20.7 applies in addition to above.
  3. Equipment manufactured and tested to other standards shall not be used without written approval from Engineer.

**1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Store in accordance with manufacturers' recommendations.
- B. Coordinate transportation with requirements of pertinent authorities.
- C. Ship switchgear for installation as completely assembled as practicable.  
Where switchgear is installed in separate building ship enclosure as complete

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as practicable with switchgear and components installed inside for ease of installation in field. If shipping splits are required, connections between splits for enclosure circuits and switchgear splits shall be clearly identified; junction and terminal boxes shall be provided at each connection point.

- D. Prepare detailed packing lists and shipping notification.
- E. Cover equipment and accessories and protected from damage during shipment. Materials used for shipping shall be acceptable for protecting equipment when manufacturer's recommended storage procedures are maintained.
- F. Power circuit breakers shall be shipped and packaged separately from switchgear structure.

**1.9 TEMPORARY POWER**

- A. Space heaters shall be connected to temporary source of power; capable of being monitored.
- B. Maintain temporary power until switchgear is installed and normal power source is permanently energized.

**2. PRODUCTS**

**2.1 MANUFACTURERS**

- A. ABB.
- B. Eaton/Cutler-Hammer.
- C. Siemens.
- D. Pedersen Power Products.
- E. Powell Electric.

**2.2 SYSTEM DESCRIPTION**

- A. Switchgear shall be a complete, coordinated factory assembly ready for installation, connection, and designed for operation at site ambient temperatures and elevations. Switchgear shall include instruments and equipment as specified herein and detailed on Data Sheets and Drawings.
- B. Attached Data Sheets specify major components and accessories to be provided. Data Sheets do not provide complete parts list or Bill of Materials for scope of work.

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- C. When one-line drawings, control schematics and layout drawings are furnished with specifications, drawings are preliminary and intended as an aid in understanding scope of equipment to be provided, unless specifically noted otherwise.
- D. If arc-resistant gear is specified, manufacturer will provide complete and coordinated arc chute plenum design including supports and vents. This shall include routing of arc chute to vent location as coordinated with Engineer.
- E. If arrangement has been furnished, and detailed engineering design by manufacturer requires rearrangement, coordinate new arrangement with Engineer prior to Bid or Drawing submittal.
- F. If arrangement changes after award of Contract, submit Drawings reflecting actual scope of work and configuration.

**2.3 ENCLOSURE**

- A. Switchgear assembly shall consist of individual free-standing vertical sections to form a rigid, metal-clad switchgear assembly.
- B. Vertical sections shall have metal side sheets of minimum 12-gage steel.
- C. Solid removable metal barriers shall isolate major primary sections.
- D. Provide safety shutter between bus compartment and breaker cubicle, which will close automatically when circuit breaker is disconnected from bus and removed from connected position.
- E. Metal work shall be free from burrs and sharp edges.
- F. Expandability:
  - 1. Switchgear shall be capable of future expansion as specified on Data Sheet without modification to existing switchgear structural members or bus work.
  - 2. Documentation shall provide adequate information for design of future extensions.
- G. Operating height for unit disconnects and other operable controls shall not be more than 6'-6" (2 m) above finished floor.
- H. Switchgear enclosure rating: As specified on Data Sheets.
- I. Gaskets shall be provided to seal doors, and filters shall be provided on all louvers to impede entrance of dust, and falling dirt. Filters shall be easily removable for maintenance.

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J. Cable entrances:

1. Depth of finished equipment shall be sufficient to allow for entrance, bending, and termination of cables.
2. Provide minimum clearance between terminal pads and cable entrance, as shown on Data Sheets for either top or bottom entrance.

K. Provide minimum distance of 36" (0.9 m) for termination of cables between cable termination point and window-type current transformer, or cable termination point and cable entrance location if window-type current transformers are not used.

2.4 DOORS

- A. Switchgear doors shall open minimum of 110° to allow for breaker removal with door-mounted relays.
- B. Doorstops and brackets with detents shall hold doors in fully open position.
- C. Front doors shall not open so far as to allow damage to devices mounted on adjacent doors.
- D. Front and rear doors shall be made from 12-gage heavy-duty formed steel with hand-operated triple door latches, and triple-hinges with provisions for padlocking.
  1. Front doors for switchgear with 2-high construction shall have separate doors for each compartment.
  2. Rear doors of vertical sections for single-high and 2-high construction shall have single, full-height removable door.

2.5 ARC-RESISTANT SWITCHGEAR

- A. Where switchgear has been specified to be arc-resistant on Data Sheets:
  1. Switchgear shall meet requirements of IEEE C37.20.7 for construction type shown on Data Sheets. Arc-resistant switchgear in accordance with any other standards will not be allowed.
  2. Switchgear shall have passed IEEE C37.20.7 tests for a minimum time duration of 0.5 second at rated short-circuit current.



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**B. Vents and chutes/ductwork:**

1. All vents, chutes/ductwork, and supports required to vent material and gasses associated with arc faults away from switchgear shall be provided by manufacturer.
2. Manufacturer shall provide method of venting arc fault byproducts out of equipment room. Coordinate with Engineer concerning location to which material and gasses are to be vented.
3. If switchgear is being placed in an on-site equipment room and is not being provided as part of a PDC, manufacturer shall, if indicated on Data Sheets, include site visit by a representative to take field measurements to coordinate design of ductwork, supports, and vents.
4. Manufacturer shall provide minimum room dimensions and other guidelines related to performance of arc-resistant switchgear.
5. Where venting is intended to penetrate an external wall or roof, vent shall be covered such that it meets all specified environmental requirements (e.g., rain-tight, dust-tight, vermin-proof).
6. Instrument compartments shall have doors that have been tested in accordance with IEEE C37.20.7.
7. Cooling vents may be provided in switchgear for ventilation or cooling purposes.
  - a. Design shall conform to applicable IEEE standard construction and pass requirements of IEEE C37.20.7 with respect to emission of ionized gas.
  - b. Design shall be constructed so accidental contact cannot compromise ability of design to withstand an arcing fault condition.
  - c. Design shall be constructed so material cannot become trapped within louver assembly and thereby prevent arc-resistant features from functioning.
8. When roof ventilation is required, provisions shall be included to prevent access by vermin.

- C. Switchgear shall be capable of extension from either end at a future date without modification to existing structural members unless otherwise noted. Means shall be provided to meet all requirements of exposed ends of switchgear assembly. Described means shall not prevent future additions to switchgear assembly and shall be tested to IEEE C37.20.7.**

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- D. Manufacturer shall provide signage in conformance with NEC Article 110.16 at location where material and gasses will be vented with following wording:  
“ DANGER – EXPLOSIVE VAPOR DISCHARGE VENT, KEEP AWAY”.

**2.8 AUXILIARY COMPARTMENTS**

- A. Bus voltage and current transformer mounted devices shall be wired to terminal blocks located in compartment. Overall switchgear-indicating instruments shall be mounted on door of compartment.
- B. Provide wiring required to termination points for outgoing supervisory connections.

**2.9 CIRCUIT BREAKER COMPARTMENTS**

- A. Each compartment shall have screw-type racking mechanism capable of manual operation by field-engaged crank. Each breaker shall have 3 defined stop positions in enclosure: “Connected,” “Test,” and “Withdrawn.”
1. Racking mechanism shall have mechanical interlocks to prevent insertion, or withdrawal, of circuit breaker with contacts closed.
  2. Provide interlocks to prevent breaker from closing between connected and test positions.
  3. If breaker contacts are closed, contacts shall be opened automatically and stored energy mechanism discharged prior to either inserting or removing breaker from connected position.
  4. Provisions shall be made for padlocking breaker in withdrawn position.
  5. Provisions shall be made to allow breaker-racking operation with compartment door closed.
  6. Each cubicle door shall be capable of being fully closed with breaker in withdrawn position.
  7. Breaker frame shall maintain ground connection in any position.
- B. Secondary control circuit contacts shall be stationary mounted within breaker compartment to mate with control circuit contacts on circuit breaker. Contacts shall remain engaged when breaker is racked into test position.
- C. Provide remote racking device(s) if specified on Data Sheets.

2.10 CIRCUIT BREAKERS

- A. Circuit breakers shall be vacuum interrupting horizontal draw-out type capable of being withdrawn. Ratings shall be as specified on Data Sheets. Breakers shall not be forced cooled in order to achieve maximum rating. Comply with latest version of ANSI C37.04 and C37.06. MVA rated breakers not acceptable.
- B. Operating mechanism:
  - 1. Operating voltage shall be in accordance with Data Sheets.
  - 2. Mechanically and electrically trip free.
  - 3. Mechanical operations counter: Visible at front of breaker assembly.
  - 4. Mechanism shall be capable of manual charging by use of handle.
- C. Mechanical indicator shall show breaker position and condition of stored-energy mechanism.
- D. Each breaker shall contain 3 vacuum interrupters, separately mounted in self-contained and self-aligning unit, which can easily be removed. Breaker shall be hermetically sealed in high-vacuum and be maintenance free.
  - 1. Mount unit on either glass polyester or epoxy supports.
  - 2. Provide contact wear gap indicator for each vacuum interrupter requiring no tools to indicate available contact life. Indicator shall be easily visible.
- E. Contacts:
  - 1. Contact surfaces shall be silver-to-silver, designed and fabricated to be self-aligning and to resist burning and deterioration.
  - 2. Breaker main contacts shall not touch or arc across into faulted circuit when breaker close signal is received while trip signal is being applied.
  - 3. Closing speed of moving contacts shall be independent of both control voltage and operator.
  - 4. Contacts shall have low current chopping characteristics.
  - 5. Primary disconnect contacts shall be "fingers" engaging cubicle stationary contacts when breaker is moved into operating position.
  - 6. Secondary control circuit contacts on breaker shall engage stationary control circuit contacts when breaker is moved into connected position.

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F. Breaker units of same type and ampere capacity shall be wired alike and shall be mechanically and electrically interchangeable.

G. Grounding:

1. Provide breaker frame grounding facility for grounding in connected and test positions.
2. Power circuit breaker ground connection shall be capable of carrying short-circuit rating of circuit breaker for minimum of 2 seconds and also be capable of withstanding peak current value or 2.7 times rated short circuit current of circuit breaker.

H. Provisions on breaker shall be made for operating mechanism-operated auxiliary switch contacts (MOC) (Device 52) and stationary truck-operated cell switch contacts (TOC) (Device 33).

I. Testing:

1. Provide testing station to permit checking of breaker controls and operation with breakers high-voltage side de-energized and isolated from switchgear bus.
2. Testing shall be done in fully withdrawn position. Control station shall be wall-mounted.

**2.11 AUXILIARY CONTACTS**

A. Each breaker shall be furnished with circuit breaker auxiliary contacts, MOCs, and TOCs as required to provide interlocking or control of auxiliary devices. In addition, provide spare contacts in quantities as specified on Data Sheets.

1. All spare contacts shall be wired to terminal blocks for ease of maintenance and access to external connection.
2. Furnish no less than 2 Type “a” and 2 Type “b” spare electrically separate auxiliary contacts mounted on breaker for remote interlocking service.

B. Auxiliary contacts shall be electrically separate. Each contact shall have 125VDC, 20-ampere minimum continuous current rating.

C. MOC contacts shall be activated by circuit breaker mechanism when circuit breaker is in “connected” position only. A minimum of 4 Type “a” and 4 Type “b” spare MOC contacts shall be provided unless larger quantity is specified on Data Sheets.

D. TOC contacts shall be activated by circuit breaker mechanism when circuit breaker is in “connected,” “test,” or “disconnected” position. A minimum of

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4 Type “a” and 4 Type “b” spare TOC contacts shall be provided unless larger quantity is specified on Data Sheets.

**2.12 BREAKER CONTROL**

**A. Location:**

1. When specified on Data Sheet, a separate breaker control cubicle section shall be provided with all breaker control switches for that switchgear lineup; otherwise, provide breaker control switch on breaker cubicle.
2. For arc-resistant switchgear, breaker control switches, CT and VT test switches shall be mounted on instrument compartment associated with that breaker cubicle.
3. When provided as part of this specification control shall be in accordance with typical schematic diagrams in regards to local trip, close, alarms, remote/local control switches etc.

**B. Breaker control switches:**

1. Provide each breaker with local control switch and breaker truck position switches arranged to provide following control of breaker operation.

Breaker Position	Remote		Local	
	Close	Trip	Close	Trip
Connected	Yes	Yes	No	Yes
Test	Yes	Yes	Yes	Yes

2. Each circuit breaker local control switch shall have trip-close escutcheon, center normal position, and spring return to normal from close and trip. Furnish with red and green indication lights as shown on Data Sheets. Circuit breaker control switches shall have pistol-grip handles.
3. Manufacturer: Electroswitch Series 24 or equal with indication as shown on Data Sheet.

**C. Trip and close circuits:**

1. Provide terminal pairs wired in trip and close circuits of each breaker for User furnished remote trip and close contacts.
2. Terminals shall be grouped adjacent to each other.
3. Unless specified otherwise, quantities shall be:
  - a. Trip circuit: 2 pairs.

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b. Close circuit: 2 pairs.

**2.13 CONTROL POWER**

- A. Furnish internal switchgear wiring to distribute single source of control power to each switchgear unit.
- B. Control power voltage: As specified on Data Sheets.
- C. For ac control power:
  - 1. When required by Data Sheets, provide control power transformer integral to switchgear line-up capable of providing required power.
  - 2. Provide each breaker with capacitive trip device that stores a minimum of two breaker operations in event of loss of ac control power.
  - 3. Each breaker shall be furnished with 1- or 2-pole, as required, DIN rail-mounted, miniature circuit breakers (MCB) as control power disconnecting and protective device.
  - 4. Provide one for closing circuit and one for tripping circuit.
  - 5. MCBs shall have contacts wired to I/O blocks for common external alarm indication of tripped MCB.
- B. For dc control power:
  - 1. Each breaker shall be furnished with 1- or 2-pole, as required, DIN rail-mounted, miniature circuit breakers (MCB) as control power disconnecting and protective device. Provide one set for closing circuit and one set for tripping circuit.
  - 2. MCBs shall have contacts wired to I/O blocks for common external alarm indication of tripped MCB.
- C. Power source for closing circuit shall be derived from load side of tripping circuit, such that open trip circuit will render closing circuit inoperable.
- D. Provide loss of voltage relay for breaker closing control voltage.
- E. Form C contact shall be wired to terminal blocks.
- F. Contact shall be used for remote indication.
- G. If required on Data Sheets provide self-contained dc control power system within line-up:
  - 1. Provide with voltage as indicated on Data Sheets.

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2. Batteries:

- a. Use sealed-type, maintenance-free, lead-acid, gel cell type batteries.
- b. Batteries furnished with minimum 10-year, pro-rated warranty.

3. Battery charger: Size to fully recharge batteries within 8 hours with batteries fully discharged, while simultaneously providing rated power for dc loads.

- a. Provide separate, full-height switchgear section for dc control power system.
- b. Dc distribution panel with required number of dc rated breakers.
- c. Provide required interface between breaker circuitry and relaying for compatibility with dc voltage supply.
- d. Provide ventilation or air conditioning for batteries in accordance with code requirements and to meet battery manufacturer's recommendations.

4. Alarms:

- a. Provide Form C contact for remote indication common alarm.
- b. Common alarm shall, at a minimum, include charger malfunction, overload on battery, low-battery voltage, and loss of dc power output.

2.14 MAIN BUS

- A. Switchgear main bus shall be copper bar, designed to continuously carry current as specified on Data Sheets without exceeding temperature rise requirements
- B. Bus shall meet requirements of latest version of ANSI C37.04, C37.06, and C37.09.
- C. Install with rigid, nontracking, fire-resistant, and nonhygroscopic insulating supports capable of withstanding mechanical forces imposed by short-circuit currents greater than or equal to momentary current rating of switchgear.
- E. To prevent destructive mechanical strains in bus supports and connections throughout full ambient temperature range as stated on Data Sheets, furnish expansion joints where necessary.
- F. Current-carrying connections shall be flat bar and completed by bolting together.

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- G. Unless otherwise stated on Data Sheets joints shall have silver-to-silver contact surfaces with minimum contact resistance.
- H. Design instrument transformer connections to permit removal and replacement of transformers without damage to connections.
- I. Insulation:
  - 1. Except at bolted terminations and connection points, coat bus with fluidized bed epoxy-type insulating material molded around and bonded to bus.
  - 2. Voltage rating of insulation shall be greater than or equal to highest voltage rating of switchgear.
  - 3. Bolted joints, expansion joints, external bus connections, terminals for external power cable connectors, and instrument transformer connections shall be insulated with removable boots.
  - 4. Design removable boots to overlap permanent bus or cable insulation minimum of 1" upon each conductor in connection insulated by boot.
  - 5. Furnish materials required to complete field connections, insulation of switchgear bus, and terminals.
- J. Orientation of bus when viewed from front of switchgear shall be A-B-C top-to-bottom, front-to-back, and left-to-right.
- K. Provide molded epoxy inserts for bus passing through barriers.

**2.15 GROUND BUS**

- A. Provide uninsulated copper ground bus with momentary rating at least equal to momentary rating of Switchgear.
- B. Connect switchgear equipment grounds to ground bus.
- C. Location of ground bus shall be as indicated on Data Sheets.
- D. Provide 2 ground cable connectors for attachment of stranded copper cable to each end of ground bus for external connection to grounding system in copper cable size as specified on Data Sheet.
- E. Each switchgear unit containing terminals for connection of metal-enclosed bus duct shall have provision for connecting bus duct ground bus to switchgear ground bus.



**2.16 FACTORY WIRING**

- A. Low-voltage control and instrument wiring shall be installed and tested at factory.
- B. Provide manufactured wiring harnesses to complete interconnection of switchgear groups in field for wiring across shipping splits.
- C. Contractor shall furnish and install, at own expense, missing wires or termination points, wiring not matching interconnection diagrams, or other deficiencies.
- D. Cable shall be selected for electrical and environmental conditions of installation, and suitable for unusual service conditions where encountered.
  - 1. Proper temperature application cable shall be used throughout, but shall not be less than 90°C rated.
  - 2. Conductors routed over hinges shall utilize extra flexible stranding.
  - 3. Cable insulation shall be rated for maximum service voltage utilized, but not less than 600 volts.
  - 4. Splices not acceptable.
- E. Panel, control cabinet, switchboard, motor control center, and switchgear wiring shall use flame-retardant, cross-linked polyethylene (XLP) or flame-retardant ethylene-propylene rubber (EPR) insulation meeting or exceeding requirements of UL 44 for Types SIS, and XHHW.
  - 1. Minimum size: No. 14 AWG.
  - 2. Conductors: Annealed bare copper Class B stranding passing IEEE 1202 and UL VW-flame test.
- F. Instrumentation wire shall use twisted shielded pairs/triads having flame-retardant, cross-linked polyethylene (XLPE) insulation, and chlorinated polyethylene (CPE) jacket.
  - 1. Minimum size: No. 16 AWG
  - 2. Conductor type: Annealed copper Class B stranding.
  - 3. Provide each pair/triad with shield.
  - 4. Shielding shall consist of aluminum-polyester tape and a flexible strand tin-coated No.18 AWG copper drain wire.

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5. Drain wire for each instrument cable shall be insulated with spaghetti sleeve. Terminate one end of shield wire on grounded terminal.
6. Cables shall pass IEEE 1202 and ICEA 70,000 Btu/hr vertical tray flame test. Each conductor shall pass UL VW-1 flame test.

G. Terminations:

1. Conductor terminal connectors: Insulated, ring tongue, compression type connectors properly sized for conductor and terminal.
  - a. Construct connectors of copper and tin-plate.
  - b. Interior surface of connector wire barrel shall be serrated; exterior surface of connector wire barrel shall be furnished with crimp guides.
2. Use noninsulated terminal connectors for conductors terminated on devices equipped with individual fitted covers, such as, but not limited to, control switches and lockout relays.
3. Provide connections requiring disconnect plug and receptacle type devices with factory-terminated conductors on each plug and receptacle.
  - a. Plugs and receptacles shall be factory-wired into junction boxes containing terminal blocks for external connections.
  - b. Conductors on disconnect portion of plug-receptacle assemblies shall be in common jacket.
4. Temporary wiring installed in factory for equipment testing shall be removed prior to shipment of equipment.
5. Current transformers shall terminate on shorting type terminal blocks and shall be shipped with shorting jumpers installed.
6. Terminal blocks: General Electric EB-25, or equal.
7. Spare auxiliary contacts, meter outputs, multifunction relay outputs and inputs, and spare control switch contacts shall be connected to terminal points to facilitate external connection.

H. If indicated on Data Sheets wire all internal wiring designated for connection to external control wiring to a terminal box located on top of switchgear or on side as designated.

I. Identification and labeling.

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1. Provide preprinted conductor identification sleeve on each end of each internal conductor.
2. Mark each sleeve with opposite end destination identification.
3. Conductor identification sleeves shall be UV-resistant, self-adhesive type or PVC, not less than 1/2" long.
4. Conductor identification shall be computer printed on sleeve with nonsmudging, permanent black ink. Hand written identification is not acceptable.
5. Each terminal block, terminal, conductor, relay, breaker, fuse block, and other auxiliary devices shall be permanently labeled to coincide with identification indicated on manufacturer's drawings.

**2.17 CURRENT TRANSFORMERS (CT)**

- A. In accordance with requirements of ANSI C57.13.
- B. CT mechanical and thermal limits shall withstand without damage momentary and short time ratings of circuit breakers with which used.
- C. Multi-ratio type, unless specified otherwise.
- D. Wire secondary leads out to shorting terminal blocks including leads from spare CTs and unused multiratio CT leads.
- E. Ground in accordance with C57.13.3.
- F. CT secondary circuits identified for metering or relaying devices not located in switchgear shall be grounded in switchgear using easily removable secondary ground straps.
- G. Manufacturer's drawings shall specifically state ground straps that should be removed if circuit will be grounded remotely.
- H. Unless indicated otherwise, CT polarity markings shall be toward circuit breaker.
- I. Separate CTs shall provide metering and protection functions, unless specified otherwise.

**2.18 VOLTAGE TRANSFORMERS (VT)**

- A. In accordance with requirements of ANSI C57.13.

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- B. Each set shall be draw-out type and removable with 4-stage cell interlock switch.
- C. Where physical size restrictions do not allow VTs to be mounted as draw-out assembly, VTs may be stationary mounted with primary fuses mounted as draw-out unit.
- D. Provide appropriate interlocks in accordance with ANSI standards for operator safety.
  - 1. Provide continuously maintained ground for transformer primary windings and fuses that is clearly visible when assembly is moved to “withdrawn” position.
  - 2. Disconnect and ground secondary circuit in “draw-out” position.
- E. Protect each transformer primary and secondary.
  - 1. Primary circuit:
    - a. Current-limiting fuses mounted on draw-out type removable carriage unit designed to isolate and ground potential circuits when unit is in fully withdrawn position.
    - b. Fuses shall meet requirements of NEMA SG2.
  - 2. Secondary circuit:
    - a. Relays and meters shall be kept on separate circuits, unless specified otherwise.
    - b. Each secondary circuit shall be protected by use of separate DIN rail-mounted miniature circuit breaker (MCB).
    - c. Each MCB shall be furnished with dry contact that changes state when breaker is tripped.
    - d. Contacts shall be wired to terminal blocks for use as alarm signal.
    - e. Wire contacts in parallel at terminal blocks to allow single external connection for common alarm condition.
- F. Ground in accordance with C57.13.3.
- G. Voltage transformers shall have accuracy rating as indicated on Data Sheets.

**2.19 LOCKOUT RELAYS**

- A. Mount lockout relays on breaker or breaker auxiliary compartment door.

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- B. Wire to trip breaker and simultaneously block closing of breaker.
- C. Rated operating trip voltage shall be capable of allowing coil operation at 75% of rated voltage.
- D. Furnish with required number of contacts to perform functions and with additional spare contacts for customer use in quantities as indicated on Data Sheets.
- E. Wire normal and spare contacts to terminal blocks.
- F. Provide all used and spare contacts with test switches wired in series to facilitate relay testing.
- G. Provide with local tripped indication and pistol-grip handle.
- H. Lockout relays shall be manually reset.
- I. Manufacturer: Electros witch Series 24 LOR with lighted target nameplate, or equal.

**2.20 PROTECTIVE RELAYS**

- A. Provide relays as shown on one-line diagrams. Relays shall be solid-state microprocessor-type; flush panel mounted self-contained units; operable from designated control power source.
- B. Relay functions, type and manufacturer: In accordance with Data Sheet.
- C. Programming of relay shall be from face of unit without requiring additional equipment. Programming of relay shall also be possible from lap top D. computer.
- D. Provide all software required for relay settings, communications, and oscillography as a Corporate perpetual license.
- E. Operation, troubleshooting, and trip indication information shall be displayed on unit face.
- F. Relays shall have built-in self-test functions with Form C relay failure alarm contact for remote indication. Separate Form C trip alarm contact shall also be furnished for remote trip indication.
- G. Provide relays in draw-out type or connectorized type cases, whenever available.
- H. Auxiliary relays shall be surface-mounted inside same switchgear cubicle in which it is used. Provide with following ratings:

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1. Relay: 300-volt minimum.
2. Coil: 115-volt.
3. Continuous duty.
4. Number of poles as required or as indicated on Drawings.

I. Contacts shall be universal or convertible type for connection as either normally open or normally closed, rated NEMA B150, minimum.

**2.21 METERS**

- A. Provide meter as shown on one-line diagrams and as indicated on Data Sheets. Meters shall be microprocessor-based, multifunction type.
- B. Metering unit shall provide local indication and be capable of remote communication for all functions.
- C. Programming of meters shall be from face of unit without requiring additional equipment.
- D. Provide all software required for meter settings or setup, communications, and oscillography as a Corporate perpetual license.
- E. Revenue quality meters shall have accuracy guaranteed by testing traceable to NBS. Revenue power meters shall meet requirements of ANSI C12.20.

**2.22 INDICATING LIGHTS**

- A. Provide LED-colored indicating lights as manufactured by Data Display Products, or equal. Clear LEDs with colored caps are not acceptable.
- B. Provide each breaker with at least following LEDs:
  1. Red LED: Illuminated when breaker is closed. Wire red light to monitor trip coil such that light will be out if trip coil continuity is lost.
  2. Green LED: Illuminated when breaker is open.
- C. Provide each lockout relay with an amber monitoring light.
  1. LEDs may be optionally integrated into LOR faceplate.
  2. Wire as follows:
    - a. Continuity light shall be illuminated to indicate LOR is ready to respond and coil continuity is intact. If coil fails, light shall go out and contact shall close to initiate alarm.

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- b. Trip indicator light shall illuminate when LOR has tripped, and shall stay lit until relay is reset regardless of whether trip signal is maintained or not.

**2.23 TEST SWITCHES**

- A. Provide test switches for all relay and meter VT, CT, and trip circuits.
- B. Relay and meter switches shall be industrial grade, manually operated, knife-blade type, 10-pole with voltage and current elements with screw-on cover for personnel protection. Switches shall be ABB FT-1, or equal.
- C. Identify each voltage and current switch by group and phase. Orientation shall be Phase A-B-C, left-to-right when looking at test switch from front.
- D. Extend voltage and current wiring for each relay and meter for incorporation into single test block.
- E. Lockout relay test switches shall be 10 single-pole voltage elements wired in series with coils and normally open contacts of relays. Provide screw-on cover for protection when not in use.
- F. Back-wire, unless installed in location requiring front-wired type.

**2.24 SURGE ARRESTERS**

- A. Provide station class, metal oxide surge arresters in quantities, and ratings as indicated on Data Sheets.
- B. Manufacturer: Ohio Brass, Cooper Power Systems, or equal.

**2.25 SWITCHGEAR ACCESSORY SET**

- A. Provide accessories for test, inspection, maintenance, and operation.
- B. Minimum one hand-crank or racking handle per switchgear line-up for moving breakers into “Connected,” “Test,” or “Disconnected” position.
- C. Wall-mounted test cabinet for testing electrically operated breakers complete with connecting cables and secondary couplers. Provide quantity as specified on Data Sheets.
- D. Tool for manually charging breaker closing spring and manually opening shutter.
- E. Test jumper for electrically operating breaker while out of compartment.
- F. One breaker maintenance closing device per switchgear line-up.

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- G. One test plug for draw-out relays per switchgear line-up.
- H. Provide dolly for circuit breaker transport for switchgear as indicated on Data Sheets. Dolly shall be combination cart and lifting device capable of removing and inserting breakers in both single- and 2-high switchgear. Dolly shall be suitable for transporting vacuum contactors or switchgear circuit breakers; portable, floor-supported with roller base.

**2.26 NAMEPLATES**

- A. Laminated black letters on white background, with 1/8" (3 mm) engraved letters securely fastened with minimum of 2 self-tapping, stainless steel screws. Coordinate nameplate information with Engineer after award of Contract.
- B. Provide nameplates to identify:
  - 1. Each externally visible devices including, but not limited to, protective relays, lockout relays, meters, switches, instruments, and indicating lights shall have nameplate on outside of switchgear and on inside of switchgear.
  - 2. Each externally invisible device shall have nameplate identifying device.
  - 3. Each vertical section shall have nameplate located on front and rear of switchgear. Nameplates shall include equipment description and identification number of equipment being served.
  - 4. Each switchgear line-up shall have main nameplate located on front and rear of switchgear with switchgear name and identification number.
- C. Caution nameplates: Yellow with black letters.
- D. Warning nameplates: Red with white letters.
- E. Provide nameplates for terminal blocks. Mark in accordance with manufacturer's instructions.
- F. Each internal device or component shall have identification marking in accordance with manufacturer's instructions.
- G. Nameplates and placards including warning signs and safety placards shall meet NFPA 70E requirements.

**2.27 BREAKER BUS TEST TERMINALS**

- A. If specified on Data Sheets, provide means for connecting test equipment directly to bus, located on load side of each breaker. Terminal shall be accessible without having to remove conductor insulation material.



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- B. Protect connection point with removable insulating boot material rated same voltage class as switchgear main bus.
- C. Provide same connection point on ground bus so phase conductors may be grounded for protection of personnel during maintenance.

**2.28 MIMIC DIAGRAMS**

- A. If specified on Data Sheets, provide mimic diagrams on front of each switchgear door that depicts interconnection of switchgear and associated equipment.
- B. Mimic diagrams shall be acceptable to Engineer prior to fabrication.

**2.29 SOURCE QUALITY CONTROL**

- A. Manufacturer shall submit proposed testing plan for complete switchgear and accessories for review and approval prior to performing testing.
- B. Switchgear shall be electrically and mechanically assembled into single line-up, inspected, and tested as single unit with actual project breakers installed in switchgear at factory prior to shipment. Notify User at least 30 days prior to final testing so arrangements can be made for User to witness tests.
- C. Perform following tests on equipment specified in accordance with latest edition of ANSI standards.
  - 1. Manufacturer's standard production inspections and testing on switchgear assemblies.
  - 2. Complete wiring check including function operation. Provide Engineer with certified copies of test data and reports.
  - 3. Polarity verification of phase-sensitive circuits including VT and CT circuitry.
  - 4. Test communications of devices including control devices, relays and meters.
  - 5. High-potential insulation check of main bus.
  - 6. Control wiring insulation check.
- D. Test breakers in accordance with ANSI C37.09.
- E. Arc-resistant design testing shall be performed in accordance with IEEE C37.20.7 using maximum short circuit current available for system or device

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rating as perspective. current available at incoming bus terminals of test sample.

- F. Relays shall have latest software installed and tested for functionality. Relays shall be programmed with protective function settings furnished by Engineer. Information needed from manufacturer by Engineer to set protection functions shall be furnished at least 4 weeks prior to factory testing of line-up.
- G. Relay and meter communications settings shall be selected and set according to equipment furnished. Coordinate with Engineer. Communications shall be shown to be fully functional prior to shipment.
- H. Test results shall indicate equipment meets specified standards before shipment can be made.

**2.30 PARALLELING AND UTILITY BREAKER CONTROL SECTION**

- A. The paralleling and utility breaker control section shall contain all devices for manual control of the utility feeder circuit breaker, utility feeder indication metering, and generator paralleling control equipment. Utility billing metering shall remain located at the utility feeder circuit breaker.
- B. Synchronizing Monitors: A solid-state generator-synchronizing monitor shall sense voltage, frequency, and phase angle of the generator to be paralleled. The monitors shall compare the voltage of the bus with that of the unit to be paralleled and initiate corrective action to cause the voltage difference to be reduced to less than 5% of nominal. Voltage adjustment shall be achieved by a motorized voltage adjusting potentiometer, as furnished by the engine-generator manufacturer. The monitor shall compare the frequency of the bus with that of the unit to be paralleled, and shall control the governor to cause the frequency of the unit to be paralleled to match within 0.2 hertz. The monitor shall also compare the phase angle of the bus with that of the unit to be paralleled and reduce the phase angle of the unit to be paralleled to a maximum of five electrical degrees at the instant the connection is made to the bus. Upon achievement of the appropriate phase angle, the generator circuit breaker shall close to parallel the unit. The monitor shall be mounted remotely in the control cabinet. Solid-state circuitry shall be used for all sensing and control functions. Interface circuits for control of voltage adjustment and circuit breaker closing shall be through relays.
- C. Synchroscope:
  - 1. Furnish with a selector switch and manual means of paralleling engine-generator sets for override of automatic system.
  - 2. Furnish with a synchronizing phase band limiter to sense and compare the phase angle difference in the generators, which are to be manually

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paralleled, and lock out the manual paralleling button within 15 degrees (electrical) of synchronism.

- D. A load demand monitor shall sense the load connected to the bus, and establish the proper number of engine-generators to operate and maintain the connected load with a minimum on-line reserve generating capacity of 10% of the rating of a single engine-generator. The load monitor shall also disconnect a generator from the bus whenever the on-line reserve capacity exceeds 110% of a single generator set. The load demand monitor shall be adjustable to initiate the addition and removal of a generator from the main bus. The load monitor shall maximize fuel economy while maintaining sufficient capacity to sustain the load.
- E. Alarms: Provide individual visual signals plus a common audible alarm and silencing circuitry. Provide a test switch which will momentarily actuate the visual and audible alarms. The following conditions shall be monitored:
  - 1. Low fuel level main storage tank shall be energized when the fuel oil level decreases to less than one-third of total capacity.
  - 2. Under-frequency failure.
  - 3. Controls not in automatic mode.
- F. Control Logic: The control logic shall be distributed between the Paralleling Control Section and each engine-generator control cubicle such that each engine-generator is capable of starting and paralleling to the bus in the event of receipt of a start signal from the Paralleling Control Section.
- G. Control power for the Paralleling Control Section shall be derived from the battery supply specified in this Section.
- H. The Paralleling and Utility Breaker Control section shall have a color touch screen operator interface panel (OIP) that allows the operator to view status and allows adjusting system variables. The Master Controller shall be an integrated controller and shall combine the touch screen interface, networking, and I/O into a single compact unit utilizing single programming software for all graphics and logic.
- I. The Master Controller shall provide the following features:
  - 1. The color touch screen OIP shall have at a minimum a resolution of 800 x 600, TFT, supporting 32768 different colors. System shall be a true controller with its own operating system and the reliability of an industrial Programmable Logic Controller. Windows PC based systems are not acceptable. The control logic shall be ladder.

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2. The Master Controller shall have portable memory in the form of a compact flash card to accommodate flash memory that is readily available in most electronic stores. The master controller shall have the capability of reading and updating the program from the compact flash card.
  3. The Master Controller shall have the capability of storing and capturing any of the displayed screens onto a compact flash card, in the form of JPEG or BMP files. The master controller shall also have the capability of reading any of these screen captures directly from the compact flash card.
  4. The Master Controller shall be powered with a 48 VDC control voltage using the battery supply specified in this Section.
  5. The Master Controller shall operate at the temperature range from -10 to 40 degree C, with humidity 5 to 95% non-condensing.
  6. The Master Controller shall be UL labeled and CE approved, including any ancillary power monitoring devices.
- J. The Master Controller shall have the following available screens:
1. Main Menu Screen: This screen shall provide system status and access to One-Line Diagram, Manual Paralleling, Three Phase Metering, Engine-Generator Control and Setup, Alarm Status, Event Log Data, System Control and Service screens.
  2. One-Line Diagram Screen: This screen shall display system paralleling configuration. The screen shall depict system configuration in a single line format and system status.
    - a. Circuit breaker position: Open/Closed.
    - b. Real time power values: Volts, amps, kW, PF, kVars and frequency.
  3. Manual Paralleling Control Screen: This screen shall provide manual paralleling control capability for each individual generator set.
    - a. Synchroscope Graphical: Real time 360-degree analog movement with digital display.
    - b. Manual raise/lower voltage and frequency.
    - c. Automatic voltage and frequency set points of generator.
    - d. Real time power values of generator / generator bus.
    - e. Generator circuit breaker position.

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- f. Ability to select generator set to be paralleled.
- g. Manual closing of generator circuit breaker.
- 4. Three Phase Metering Screen: Graphical analog (270 electrical degree) metering representation with digital display. Shall display metering for selected generator, feeder, or generator bus.
  - a. True RMS three-phase voltage, amps, kWatts, kV-Amps, kVars, PF, and frequency.
  - b. Engine battery voltage display.
  - c. Running Time Meter.
- 5. System Control Screen:
  - a. Engine priority, with Load Demand time delays.
  - b. Load Demand pick-up and drop-out kW levels.
  - c. Scrolling system status: Emergency mode, normal available, generator(s) on-line, generator failure, generator available, generator synchronizer active.
- 6. Alarm Status Screen: The following alarms and control shall be provided at a minimum. Generator alarms shall be provided for each engine-generator. The following colors shall be used for indication: Red (R), Amber (A)
  - a. Not in Automatic (R)
  - b. Emergency mode (A)
  - c. Generator circuit breaker alarm (A)
  - d. Low coolant temperature (A)
  - e. Low battery voltage (A)
  - f. Battery charger malfunction (A)
  - g. Engine overcrank (R)
  - h. Engine overspeed (R)
  - i. Engine low oil shutdown (R)

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- j. Engine high coolant temp shutdown (R)
  - k. Engine low coolant level shutdown (R)
  - l. Generator circuit breaker tripped (R)
  - m. Generator reverse power (R)
  - n. Generator under voltage (R)
  - o. Generator over voltage (R)
  - p. Generator under frequency (R)
  - q. Generator over frequency (R)
  - r. Generator loss of excitation (R)
  - s. Generator phase reversal (R)
  - t. Alarm reset button
  - u. Emergency stop button
7. Engine-Generator Control and Setup Screen: Provide for each engine-generator.
- a. Engine cool down timer setting.
  - b. Cycle crank attempts.
  - c. Cranking time delay.
  - d. Crank reset timer setting.
  - e. Number of actual crank attempts.
  - f. Actual cool down timer left.
  - g. Aynch mode switch OFF, auto, check, permissive.
  - h. Cycle crank logic enabled / disabled.
8. Event Data Log Screen: This screen provides viewing of events logged with time and date. Operator can acknowledge and clear alarms.
- a. Alarm history log of the last 64 events.
  - b. Alarm summary (active alarms and unacknowledged).

c. Active alarm indicator.

9. Service Screen: This screen provides for a service technician to set all paralleling parameters without the aid of a laptop computer. The operator shall be able to view all controlling outputs to the voltage regulators and speed controller, including all power parameters of all engine-generators on one screen.

## 2.31 PARALLELING OPERATION

### A. Emergency Mode:

1. Upon initiation of the automatic sequence, the normal distribution feeder circuit breaker shall open so the first generator connects to the emergency distribution system within the code required time.
2. Upon initiation of the automatic sequence, all engine-generators shall start. The first engine-generator to achieve 90% of nominal voltage and frequency shall be connected to the bus. The emergency automatic transfer switches within each building will transfer emergency loads to the emergency distribution system.
3. As the second generator starts, its synchronizer shall initiate control of voltage and frequency of the generator set with the bus. Upon synchronizing with the bus, the oncoming set shall be paralleled on the bus. The standby automatic transfer switches will be programmed with a time delay to avoid transferring the standby loads to the emergency distribution transformer until the second generator has been brought online and synchronized.
4. Once both generators have been brought online, the main utility circuit breaker (located remotely) shall open and the normal feeder circuit breaker shall close, energizing the normal distribution system. After a pre-set time delay, internal to the building automatic transfer switches, the transfer switches will return the building emergency and standby loads to the normal distribution system.
5. If the utility comes back online prior to energizing the normal distribution system, the generator bus shall not synchronize with the normal distribution system. After a pre-set time delay, internal to the building automatic transfer switches, the transfer switches shall return the building emergency and standby loads to the normal distribution system, under utility power.
6. If the utility comes back online after both the normal and emergency distribution system has been transferred to the generators, a five minute time delay shall be initiated. If the utility service stays online without

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interruption during that five minute time delay, the engine-generators shall synchronize with the utility and close the main utility circuit breaker (located remotely) to parallel with the utility.

7. Upon successful parallel operation with the utility, the engine-generators shall be disconnected from the bus, run for a cool down period, and shut down.

B. Exercising Mode: Incorporate controls so as to allow automatic and manual testing of each engine-generator.

1. Upon initiation of the automatic exercise sequence, all engine-generators shall be started. Upon achieving synchronism, each engine-generator shall be paralleled with the bus.
2. The engine-generators shall be operated in parallel with the utility for an adjustable period of time (15 to 60 minutes). Upon completion of this time period, the engine-generators shall be disconnected from the bus, run for a cool down period, and shut down.
3. The programming shall be capable of exercising each engine-generator individually or both engine-generators simultaneously.

C. Utility Peak Demand Reduction Mode: The system shall include control equipment which will operate the standby power system to reduce utility peak demand in the following way:

1. Upon initiation of an automatic sequence for utility peak demand reduction operation, all engine-generators shall be started. Upon achieving synchronism, each engine-generator shall be paralleled with the bus.
2. The engine-generators shall be operated in parallel with the utility until the end of the required peak demand reduction time period. Upon termination of the utility peak demand reduction operation, the engine-generators shall be disconnected from the bus, run for a cool down period, and shut down.

D. Manual Mode:

1. The engine-generators shall be capable of being operated manually.

3. EXECUTION

3.1 EXAMINATION

A. Verify Site conditions are acceptable for switchgear installation.

3.2 INSTALLATION



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- A. Install in accordance with manufacturer's requirements.
- B. Provide housekeeping pad under switchgear unless indicated otherwise, minimum 4" (100mm) high. Level pad to within manufacturer's tolerances such that switchgear can be installed directly on top of pad without additional leveling. Provide anchors and other hardware necessary. Anchor in place in accordance with manufacturer's instructions. Refer to Drawings for leveling requirements.
- C. Seal conduit, cable, and bus duct penetrations into switchgear with materials and methods designed for intended use maintaining NEMA rating of enclosure.
- D. Provide connections to ground grid, using fittings designed and rated for intended use.

**3.3 MANUFACTURER'S FIELD SERVICES**

- A. Provide manufacturer's field service representative to perform wiring interconnections between shipping splits.
- B. Provide manufacturer's field service representative for field commissioning services Relays shall be programmed in the factory using settings furnished by Engineer or User.

**3.4 TRAINING**

- A. If specified on Data Sheet, provide authorized representative of switchgear manufacturer to train User's maintenance personnel on procedures for startup and shutdown, troubleshooting, servicing, and preventive maintenance as follows:
  - 1. Duration: 2 days minimum.
  - 2. Review data in operating and maintenance manuals.
  - 3. Review normal maintenance and operating procedures.
- B. Instruction shall be provided on site and include all training documents.

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<b>DATA SHEETS MV METAL- CLAD SWITCHGEAR</b>		<b>Equipment Name: SG1 &amp; SG2</b>	
<b>DESCRIPTION</b>		<b>QTY/UNITS</b>	<b>SPEC DATA</b>
<b>VENDOR DATA</b>			
Switchgear Manufacturer	-	By Manufacturer	
Switchgear Catalog No.	-	By Manufacturer	
<b>ENVIRONMENTAL CONDITIONS:</b>			
Maximum Design Ambient Temperature	°C	40	
Minimum Design Ambient Temperature	°C	-30	
Site Altitude	ft	<3,300	
High Humidity	Y/N		
Corrosive	Y/N		
Salt-Laden	Y/N		
Seismic Condition			
<b>CHARACTERISTICS:</b>			
Rated Maximum Voltage	kV	4.76	
Nominal System Operating Voltage	kV	2.4	
Voltage Range Factor, K	n/a	K=1.0	
System Configuration	Delta/Wye	Delta	
Phase, Wire	Phase/Wire	3 Phase/3 Wire	
System Grounding Method		Ungrounded	
Frequency	Hz	60	
Rated Basic Impulse Lightning Level	kV BIL	60	
Main and Load Side Bus:			
Continuous Current Rating	A	1200	
Short-Circuit Current - Asym	kA (rms)	22	
Momentary Current Withstand Capability	kA, (peak)	58	
Incoming Power Connection		2400V	
Arc-Resistant Switchgear:	Y/N	N	
Arc-Resistant Construction in accordance with IEEE C37.20.7 (Type 2 or 2C)	-	N	
Site visit required for field measurements to support ductwork design.	Y/N	N	
Provide terminal box for termination of all external wiring.	Y/N	N	
<b>BUS BAR:</b>			
Phase and Ground Bus Material	-	Copper	
Phase Connection Plating Material	-	Silver	
Ground Bus Location	-	Bottom/Rear	
Phase Bus Dimensions	In.	By Manufacturer	
Ground Bus Dimensions	In.	By Manufacturer	
Ground cable lug size	AWG		
<b>STRUCTURE:</b>			
Arrangement	-		
Enclosure Rating	NEMA	1	
Enclosure Type	-	Indoor	
Number of Vertical Sections	Qty.	By Manufacturer	
Vertical Section Dimension (L x W x H)	In.	By Manufacturer	
Fully Assembled Structure Dimension (L x W x H)	In.	By Manufacturer	

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<b>DATA SHEETS MV METAL- CLAD SWITCHGEAR</b>		<b>Equipment Name: SG1 &amp; SG2</b>	
		<b>Tag No.: SWGR - #####</b>	
DESCRIPTION	QTY/UNITS	SPEC DATA	VENDOR DATA
External Control Wiring Terminal Box Required	Y/N	N	
Total Installed Weight	Lb.	By Manufacturer	
Color	-	ANSI 61	
Expansion Capability (Right, Left, Right and Left, Neither)	-		
Incoming Section	Bus/Cable	Cable	
<b>DOORS:</b>			
Dimension (L x W x H)	In.	By Manufacturer	
Hinged and Removable	Y/N	Y	
Lockable	Y/N	Y	
<b>AUXILIARY COMPARTMENT:</b>			
Terminals Wired in Close Circuit For User Use	Pairs	2	
Terminals Wired in Trip Circuit For User Use	Pairs	2	
Control Power:			
Voltage	Vac or Vdc	125 Vdc	
External Control Power Source	Y/N	Y	
Self Contained DC Control Power System	Y/N	N	
Control Power Transformer-	Y/N	N	
Rating	kVA	By Manufacturer	
Secondary Voltage	V	120/240 V	
<b>MOTOR AND SPACE HEATER POWER</b>			
Voltage	Vac	N/A	
External Heater Power Source	Y/N		
Internal Heater Power Source	Y/N		
Estimated Motor Space Heater Load	KW		
480V interposing relay required for space heater circuits.	Y/N		
<b>RELAYS</b>			
Manufacturer and Model Number		See Drawings	
Quantity		See Drawings	
Test Switches	Qty	See Drawings	
Manufacturer/Model	-	ABB FT-1	
Application	-	All current and voltage inputs as well as all trip outputs	
<b>INDICATION METERS</b>			
Manufacturer and Model Number	-	See Drawings	
Quantity	-	See Drawings	
Installation Locations	-	See Drawings	
Revenue Metering Quality	Y/N	N	
Mounting	-	Semi-flush	
Drawout	Y/N	Y	

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<b>DATA SHEETS MV METAL- CLAD SWITCHGEAR</b>		<b>Equipment Name: SG1 &amp; SG2</b>	
		<b>Tag No.: SWGR - #####</b>	
DESCRIPTION	QTY/UNITS	SPEC DATA	VENDOR DATA
Data Communication	-		
Quantity of Analog Outputs	-		
Test Switches	Qty		
Manufacturer/Model	-	By Manufacturer	
Application	-	All current and voltage inputs	
<b>METERING</b>			
Manufacturer and Model Number	-	By Manufacturer	
Quantity	-	By Manufacturer	
Revenue Metering Quality	Y/N	Y	
Mounting	-	Semi-flush	
Drawout	Y/N	Y	
Data Communication	-		
Quantity of Analog Outputs	-		
Test Switches	Qty		
Manufacturer/Model	-	By Manufacturer	
Application	-	All current and voltage inputs	
<b>VOLTAGE TRANSFORMERS:</b>			
Manufacturer and Model Number	-		
Voltage Ratio	-	20:1	
Accuracy Rating	-	0.3W XYZ, 1.2ZZ	
Bus VT Quantity	-		
Line VT Quantity	-		
<b>COMMUNICATIONS EQUIPMENT</b>			
Relay Communications Processor			
Metering Communications Multiplexer			
Control Processor			
Fiber Optic Transceivers			
I/O Blocks			
Spare Terminal Blocks	Qty	20%	
<b>ACCESSORIES:</b>			
Wall Mounted Test Cabinets	Qty		
Breaker Racking Crank	Qty		
Breaker Dolly	Qty		
Remote Racking Device	Y/N	Y	
Length of Cord	ft	50	
<b>BREAKER CUBICLE:</b> (USE BREAKER DESIGNATION TO INDICATE LIKE BREAKERS; LIST OUT EACH UNIQUE BREAKER CUBICLE AS REQUIRED)			
Model Number	-	By Manufacturer	
Continuous Current Rating	A	1200	
Voltage Range Factor, K	n/a	K=1.0	
Short Circuit Interrupting Current	kA, sym	22	
Closing and Latching Capability	kA, peak	58	
Protection Relay	Model No.		

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<b>DATA SHEETS MV METAL- CLAD SWITCHGEAR</b>		<b>Equipment Name: SG1 &amp; SG2</b>	
		<b>Tag No.: SWGR - #####</b>	
DESCRIPTION	QTY/UNITS	SPEC DATA	VENDOR DATA
Relay Test Switches	Qty		
Lockout Relay	Qty		
Continuity Light Color	---	Green	
Trip Indication	----	Amber	
Lockout Test Switches	Qty		
Multifunction Meter	Model No.		
Metering Test Switches	Qty	By Manufacturer	
Current Transformers -			
Bus Side:	Qty	By Manufacturer	
Ratio			
Accuracy			
Load Side:	Qty	By Manufacturer	
Ratio			
Accuracy			
LED Indicating Lights (separately mounted)	Qty	1 set	
Red Indicating Light (Breaker Closed)	Y/N	Y	
Green Indicating Light (Breaker Opened)	Y/N	Y	
Amber Indicating Light (Breaker Trip Coil Monitor)	Y/N	N	
Trip Coil Monitor	Y/N	Y	
Spare MOC contacts	Qty	8 N.C and 8 N.O.	
Spare TOC contacts	Qty	4 N.C and 4 N.O.	
Spare Lockout Relay contacts	Qty	10 N.C and 10 N.O.	
Breaker Test Terminals	n/a	N	
Breaker Control Switch	Model No.	By Manufacturer	
With Red LED (Breaker Closed)	Y/N	Y	
With Green LED (Breaker Opened)	Y/N	Y	
With Amber LED (Breaker Trip Coil Monitor)	Y/N	N	
Cable or Bus Entry Location			
Surge Protection:	Y/N	Y	
Surge Arrester Class	Type	By Manufacturer	
Surge Arrester Duty Cycle Voltage	kV rms		
Surge Arrester MCOV	kV rms		
Surge Arrester TOV	kV rms		
Surge Capacitors	Qty/Type		
Cable Lug Size/Qty Per Phase			
Minimum Clearance Between Terminal Pads and Cable Entrance	in	33	
User's Instructions			

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DATA SHEETS MV METAL- CLAD SWITCHGEAR		Equipment Name: MSG Tag No.: SWGR - #####	
DESCRIPTION	QTY/UNITS	SPEC DATA	VENDOR DATA
Switchgear Manufacturer	-	By Manufacturer	
Switchgear Catalog No.	-	By Manufacturer	
<b>ENVIRONMENTAL CONDITIONS:</b>			
Maximum Design Ambient Temperature	°C	40	
Minimum Design Ambient Temperature	°C	-30	
Site Altitude	ft	<3,300	
High Humidity	Y/N		
Corrosive	Y/N		
Salt-Laden	Y/N		
Seismic Condition			
<b>CHARACTERISTICS:</b>			
Rated Maximum Voltage	kV	4.76	
Nominal System Operating Voltage	kV	2.4	
Voltage Range Factor, K	n/a	K=1.0	
System Configuration	Delta/Wye	Delta	
Phase, Wire	Phase/Wire	3 Phase/3 Wire	
System Grounding Method		Ungrounded	
Frequency	Hz	60	
Rated Basic Impulse Lightning Level	kV BIL	60	
Main and Load Side Bus:			
Continuous Current Rating	A	2000	
Short-Circuit Current - Asym	kA (rms)	22	
Momentary Current Withstand Capability	kA, (peak)	58	
Incoming Power Connection		2400V	
Arc-Resistant Switchgear:	Y/N	N	
Arc-Resistant Construction in accordance with IEEE C37.20.7 (Type 2 or 2C)	-		
Site visit required for field measurements to support ductwork design.	Y/N	Y	
Provide terminal box for termination of all external wiring.	Y/N	Y	
<b>BUS BAR:</b>			
Phase and Ground Bus Material	-	Copper	
Phase Connection Plating Material	-	Silver	
Ground Bus Location	-	Bottom/Rear	
Phase Bus Dimensions	In.	By Manufacturer	
Ground Bus Dimensions	In.	By Manufacturer	
Ground cable lug size	AWG		
<b>STRUCTURE:</b>			
Arrangement	-		
Enclosure Rating	NEMA	1	
Enclosure Type	-	Indoor	
Number of Vertical Sections	Qty.	By Manufacturer	
Vertical Section Dimension (L x W x H)	In.	By Manufacturer	
Fully Assembled Structure Dimension (L x W x H)	In.	By Manufacturer	

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<b>DATA SHEETS MV METAL- CLAD SWITCHGEAR</b>		<b>Equipment Name: MSG</b>	
		<b>Tag No.: SWGR - #####</b>	
DESCRIPTION	QTY/UNITS	SPEC DATA	VENDOR DATA
External Control Wiring Terminal Box Required	Y/N	N	
Total Installed Weight	Lb.	By Manufacturer	
Color	-	ANSI 61	
Expansion Capability (Right, Left, Right and Left, Neither)	-		
Incoming Section	Bus/Cable	Cable	
<b>DOORS:</b>			
Dimension (L x W x H)	In.	By Manufacturer	
Hinged and Removable	Y/N	Y	
Lockable	Y/N	Y	
<b>AUXILIARY COMPARTMENT:</b>			
Terminals Wired in Close Circuit For User Use	Pairs	2	
Terminals Wired in Trip Circuit For User Use	Pairs	2	
Control Power:			
Voltage	Vac or Vdc	125 Vdc	
External Control Power Source	Y/N	Y	
Self Contained DC Control Power System	Y/N	N	
Control Power Transformer-	Y/N	N	
Rating	kVA	By Manufacturer	
Secondary Voltage	V	120/240 V	
<b>MOTOR AND SPACE HEATER POWER</b>			
Voltage	Vac	N/A	
External Heater Power Source	Y/N		
Internal Heater Power Source	Y/N		
Estimated Motor Space Heater Load	KW		
480V interposing relay required for space heater circuits.	Y/N	N	
<b>RELAYS</b>			
Manufacturer and Model Number		See Drawings	
Quantity		See Drawings	
Test Switches	Qty	See Drawings	
Manufacturer/Model	-	By Manufacturere	
Application	-	All current and voltage inputs as well as all trip outputs	
<b>INDICATION METERS</b>			
Manufacturer and Model Number	-	See Drawings	
Quantity	-	See Drawings	
Installation Locations	-	See Drawings	
Revenue Metering Quality	Y/N	N	
Mounting	-	Semi-flush	
Drawout	Y/N	Y	

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<b>DATA SHEETS MV METAL- CLAD SWITCHGEAR</b>		<b>Equipment Name: MSG</b>	
		<b>Tag No.: SWGR - #####</b>	
DESCRIPTION	QTY/UNITS	SPEC DATA	VENDOR DATA
Data Communication	-		
Quantity of Analog Outputs	-		
Test Switches	Qty		
Manufacturer/Model	-	By Manufacturer	
Application	-	All current and voltage inputs	
<b>METERING</b>			
Manufacturer and Model Number	-		
Quantity	-		
Revenue Metering Quality	Y/N	Y	
Mounting	-	Semi-flush	
Drawout	Y/N	Y	
Data Communication	-		
Quantity of Analog Outputs	-		
Test Switches	Qty		
Manufacturer/Model	-	By Manufacturer	
Application	-	All current and voltage inputs	
<b>VOLTAGE TRANSFORMERS:</b>			
Manufacturer and Model Number	-		
Voltage Ratio	-	20:1	
Accuracy Rating	-	0.3WXYZ, 1.2ZZ	
Bus VT Quantity	-		
Line VT Quantity	-		
<b>COMMUNICATIONS EQUIPMENT</b>			
Relay Communications Processor			
Metering Communications Multiplexer			
Control Processor			
Fiber Optic Transceivers			
I/O Blocks			
Spare Terminal Blocks	Qty	20%	
<b>ACCESSORIES:</b>			
Wall Mounted Test Cabinets	Qty		
Breaker Racking Crank	Qty		
Breaker Dolly	Qty		
Remote Racking Device	Y/N	Y	
Length of Cord	ft	50	
<b>BREAKER CUBICLE:</b> (USE BREAKER DESIGNATION TO INDICATE LIKE BREAKERS; LIST OUT EACH UNIQUE BREAKER CUBICLE AS REQUIRED)			
Model Number	-	By Manufacturer	
Continuous Current Rating	A	2000	
Voltage Range Factor, K	n/a	K=1.0	
Short Circuit Interrupting Current	kA, sym	25	
Closing and Latching Capability	kA, peak	65	
Protection Relay	Model No.		



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<b>DATA SHEETS MV METAL- CLAD SWITCHGEAR</b>		<b>Equipment Name: MSG</b>	
		<b>Tag No.: SWGR - #####</b>	
<b>DESCRIPTION</b>	<b>QTY/UNITS</b>	<b>SPEC DATA</b>	<b>VENDOR DATA</b>
Relay Test Switches	Qty		
Lockout Relay	Qty		
Continuity Light Color	---	Green	
Trip Indication	----	Amber	
Lockout Test Switches	Qty		
Multifunction Meter	Model No.		
Metering Test Switches	Qty		
Current Transformers -			
Bus Side:	Qty		
Ratio			
Accuracy			
Load Side:	Qty		
Ratio			
Accuracy			
LED Indicating Lights (separately mounted)	Qty	1 set	
Red Indicating Light (Breaker Closed)	Y/N	Y	
Green Indicating Light (Breaker Opened)	Y/N	Y	
Amber Indicating Light (Breaker Trip Coil Monitor)	Y/N	N	
Trip Coil Monitor	Y/N	Y	
Spare MOC contacts	Qty	8 N.C and 8 N.O.	
Spare TOC contacts	Qty	4 N.C and 4 N.O.	
Spare Lockout Relay contacts	Qty	10 N.C and 10 N.O.	
Breaker Test Terminals	n/a	N	
Breaker Control Switch	Model No.	By Manufacturer	
With Red LED (Breaker Closed)	Y/N	Y	
With Green LED (Breaker Opened)	Y/N	Y	
With Amber LED (Breaker Trip Coil Monitor)	Y/N	N	
Cable or Bus Entry Location			
Surge Protection:	Y/N	Y	
Surge Arrester Class	Type	By Manufacturer	
Surge Arrester Duty Cycle Voltage	kV rms		
Surge Arrester MCOV	kV rms		
Surge Arrester TOV	kV rms		
Surge Capacitors	Qty/Type		
Cable Lug Size/Qty Per Phase			
Minimum Clearance Between Terminal Pads and Cable Entrance	in	33	
User's Instructions			

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1. GENERAL

1.1 SECTION INCLUDES

- A. The Design-Build Contractor shall furnish and install, where indicated on the drawings, a complete standby power generation and load management power distribution and control system. The emergency transfer and load management switchgear shall be a medium voltage metal-clad switchgear. The emergency transfer and load management switchgear shall be medium voltage metal-clad switchgear structures as specified herein and as shown on the contract drawings.
- B. The emergency transfer and load management switchgear specified in this section shall be by the same manufacturer as the generator sets and furnished with the generator sets by the generator supplier as a total system.
- C. In order to assure maximum equipment uptime and best service response to the owner, the generator set manufacturer shall have an authorized dealer with complete generator and switchgear parts and service available on a 24 hour emergency service basis within a 50-mile radius of the project site.

1.2 REFERENCES

- A. The metal-clad switchgear and all components shall be designed, manufactured, and tested in accordance with the latest applicable standards of NEMA SG-4 and SG-5, and but not limited to, ANSI/IEEE 37.20.2.

1.3 SUBMITTALS FOR REVIEW/APPROVAL

- A. The following information shall be submitted to the Engineer:
  - 1. Master drawing index
  - 2. Front view elevation
  - 3. Floor plan
  - 4. Top view
  - 5. Single line diagram
  - 6. Schematic diagram
  - 7. Nameplate schedule
  - 8. Component list

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9. Conduit entry/exit locations
  10. Assembly ratings including:
    - a. Short-circuit rating
    - b. Voltage
    - c. Continuous current
    - d. Basic impulse level for equipment over 600 volts
  11. Major component ratings including:
    - a. Voltage
    - b. Continuous current
    - c. Interrupting ratings
  12. Cable terminal sizes.
  13. Product data sheets.
  14. Field control wiring diagrams
  15. Sequence of operation description
- B. Where applicable the following additional information shall be submitted to the Engineer:
1. Busway connection
  2. Connection details between close-coupled assemblies
  3. Composite floor plan of close-coupled assemblies
  4. Key interlock scheme drawing and sequence of operations
  5. Descriptive bulletins

1.4 SUBMITTALS - FOR CONSTRUCTION

- A. The following information shall be submitted for record purposes:
1. Final as-built drawings and information for items listed in paragraph 1.03
  2. Wiring diagrams

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3. Certified production test reports
  4. Installation information including equipment anchorage provisions
  5. Seismic certification.
- B. The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process.

**1.5 QUALIFICATIONS**

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. In order to assure maximum equipment uptime and best service response to the owner, the generator set manufacturer shall have an authorized dealer with complete generator and switchgear parts and service available on a 24-hour emergency service basis within a 50-mile radius of the project site. The switchgear manufacturer shall also have an authorized service organization within 50-miles of the project site.
- E. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of Uniform Building Code (UBC) for zone 4 application.

**1.6 REGULATORY REQUIREMENTS**

**1.7 DELIVERY, STORAGE AND HANDLING**

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.
- B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.

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- C. Switchgear shall be equipped to be handled by crane. Where cranes are not available, switchgear shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.
- D. Switchgear being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition. If stored outdoors, indoor gear shall be covered and heated, and outdoor gear shall be heated.

1.8 OPERATION AND MAINTENANCE MANUALS

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

2. PRODUCTS

2.1 MANUFACTURERS

- A. Caterpillar
- B. Eaton
- C. Siemens

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.2 RATINGS

- A. The switchgear described in this specification shall be designed for operation on a 5 kV, three-phase, 3-wire, 60-hertz system.
- B. Each circuit breaker shall have the following ratings:

Maximum Voltage: 5 kV  
BIL Rated: 60 kV Peak  
Continuous Current (5/15 kV): Amperes 2000

Short-Circuit Current at rated Maximum kV: 63 kA RMS SYM  
Rated Voltage Range Factor K: 1.0  
Closing and Latching Capability: 170 kA Crest

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Maximum symmetrical Interrupting and Three Second Rating: 63 kA RMS  
SYM

Nominal 3-Phase MVA Class: 500 MVA

Rated Interrupting Time: Five cycles

**2.3 CONSTRUCTION**

- A. The switchgear assembly shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted to form a rigid metal-clad switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit. Two rear covers shall be furnished for each vertical section for circuit isolation and ease of handling. Hinged rear doors, complete with provisions for padlocking, shall be provided.
- B. The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position or out of the cell. Provide rails to allow withdrawal of each 5kV circuit breaker for inspection and maintenance without the use of a separate lifting device.

**2.4 BUS**

- A. The main bus shall be copper and have fluidized bed epoxy flame-retardant and track-resistant insulation. The bus supports between units shall be flame-retardant, track-resistant, glass polyester for 5-kV class. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. Main bus for 5 KV shall be rated 2000 amperes. Insulated copper main bus shall be provided and have provisions for future extension. All bus joints shall be plated, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests.
- B. A copper ground bus shall extend the entire length of the switchgear.
- C. An insulated bare fully rated neutral bus shall extend the entire length of the switchgear.

**2.5 WIRING/TERMINATIONS**

- A. The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations and a minimum of 10% spare terminals shall be provided. One control circuit cutout device shall be provided in each circuit breaker housing. Switchgear secondary wire shall be #14 AWG, type SIS rated

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600-volt, 90 degrees C, furnished with wire markers at each termination. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.

- B. Incoming line and feeder cable lugs of the type and size indicated elsewhere shall be furnished.

## 2.6 CIRCUIT BREAKERS

- A. The circuit breakers shall be horizontal draw out type, capable of being withdrawn on rails. The breakers shall be operated by a motor-charged stored energy spring mechanism, charged normally by a universal electric motor and in an emergency by a manual handle. The primary disconnecting contacts shall be silver-plated copper.
- B. Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, self-aligning pole unit which can be removed easily. The vacuum interrupter pole unit shall be mounted on glass polyester supports for 5 kV class. A contact wear gap indicator for each vacuum interrupter, which requires no tools to indicate available contact life, shall be easily visible when the breaker is removed from its compartment. The current transfer from the vacuum interrupter moving stem to the breaker main conductor shall be a non-sliding design. The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance.
- C. The secondary contacts shall be silver-plated and shall automatically engage in the breaker operating position, which can be manually engaged in the breaker test position.
- D. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from housing and to discharge stored energy mechanisms upon insertion or removal from the housing. The breaker shall be secured positively in the housing between and including the operating and test positions.
- E. The breakers shall be electrically operated by the following control voltages: 48volt DC close and 48volt DC trip.

Each breaker shall be complete with control switch and red and green indicating lights to indicate breaker contact position.

- F. DC control voltage shall be supplied with the emergency transfer and load management switchgear.



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2.7 PROTECTIVE RELAYS

- A. The switchgear manufacturer shall furnish and install, in the metal-clad switchgear, the quantity, type and rating of protection relays as indicated on the drawings and described hereafter in this specification.
- B. Protective relays for the generator circuit breakers and utility main circuit breakers shall be provided with protective relays as indicated on the drawings and as specified under the Switchgear Control System paragraphs following.
- C. Protective relays for distribution circuit breakers shall be provided with microprocessor-based relays as shown on the drawings and as specified below.
- D. Microprocessor-Based Protective Relay
  - 1. Relays for phase time overcurrent, instantaneous overcurrent and ground fault protection, ANSI 50/51, 50/51G, or 50/51N, shall be incorporated into a single device having all the features and functions herein specified.
  - 2. The relay shall be a solid-state microprocessor-based multifunctional type that operates from the 5-ampere secondary output of current transformers. The relay shall provide ANSI 50/51N protective functions for each of the three (3) phases, and ANSI 50/51N or 50/51G ground fault protection functions as shown on the plans or as determined by the coordination study. The relay shall be true RMS sensing of each phase and ground. Ground element shall be capable of being utilized in residual, zero sequence, ground source connection schemes, or deactivated.
  - 3. The primary current transformer rating being used for phase and ground protection feeding the device shall be programmable for current transformers with primary current ratings from 5 through 5,000 amperes.
  - 4. Both the phase and ground protection curves shall be independently field-selectable and programmable with or without load. Curves shall be selectable from the following:

IEEE: Moderately inverse, very inverse, extremely inverse

IEC: A, B, C or D

Thermal: Flat,  $I_t$ ,  $I_2t$ ,  $I_4t$

Thermal curves shall be similar to those on low voltage trip units for close coordination with downstream devices. Selectable short delay pickup and short delay time settings shall also be provided. The phase instantaneous overcurrent trip shall have field-programmable pickup points from 1.0 to 25

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times current transformer primary rating or NONE. In addition, a field-selectable (ON or OFF) discriminator circuit shall be included such that when phase instantaneous overcurrent has been programmed to NONE, the discriminator circuit shall protect against currents exceeding 11 times current transformer primary rating, only when the breaker is being closed and shall be deactivated after approximately 8 cycles.

5. The relay shall be field-configurable to have either of the following function combinations assigned to its two type “a” contacts: 1) one contact assigned ANSI 51 phase and ANSI 51 ground and the other contact assigned ANSI 50 phase and ANSI 50 ground; 2) one contact assigned ANSI 51/50 phase and the other contact assigned 51/50 ground.
6. The relay shall have a built-in alphanumeric display capable of displaying the following information with metering accuracy of +/- one (1) percent of full scale (In) from 0.04 x In to 1 x In and +/- two (2) percent of full scale (In) from 1 x In to 2 x In:
  - a. Individual phase currents
  - b. Ground current
  - c. Cause of trip
  - d. Magnitude and phase of current causing trip
  - e. Phase or ground indication
  - f. Peak current demand for each phase and ground since last reset
  - g. Current transformer primary rating
  - h. Programmed phase and ground set points.
7. Relay shall have the following features:
  - a. Integral manual testing capability for both phase and ground protection function. Testing shall be selectable to either operate contact outputs or not operate output contacts.
  - b. Zone selective interlocking capability for short time and ground fault protection. This function shall be provided and factory wired. Where zone selective interlocking is not an integral part of the protective device, a full bus differential scheme shall be required for both phase and ground in addition to specified time overcurrent and instantaneous overcurrent phase and ground fault protection. Bus differential scheme shall be provided with separate differential current transformers for all

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incoming and outgoing loads, as well as appropriate differential relays (ANSI 87 and 87G) as approved by the Engineer.

- c. Continuous self-testing of internal circuitry
  - d. Unit failure alarm contact for customer use
  - e. Programmable lockout/self reset after trip function
  - f. Programmable set points for device curve selection
  - g. Programmable inputs, such as current transformer ratios
  - h. Access to program and test modes shall be via sealable hinged cover for security.
8. Relay shall be suitable for operating temperatures from -30 degrees to 55 degrees C. Relay shall be suitable for operating with humidity from 0 to 95% relative humidity (non-condensing).
9. Relay shall have communication capability via local area. Relay shall be capable of the following over the communication network:
- a. Ability to transmit all information contained in the relay such as currents, set points, cause of trip, magnitude of trip current, and open-close trip status
  - b. Ability to close and open the associated breaker with proper access code from remote location over the communication network when the relay is DIP switch configured in remote close/open mode.
10. Relay alarm and/or trip contacts shall not change state if power is lost or an undervoltage occurs. These contacts shall only cause a trip upon detection of an overcurrent or fault condition based upon programmed settings. A “protection OFF” alarm shall be provided which is normally energized when the relay is powered and the self-diagnostics indicates the unit is functional. Upon loss of power or relay failure, this alarm relay shall be de-energized providing a failsafe protection OFF alarm.
11. The relay shall be suitable for operating on control power with a nominal input voltage of 24V, or 48 to 250V DC or 12 to 240V AC ( 60 Hz). When AC control power schemes are shown on the drawings, in addition to control power transformer or remote-control power shown or herein specified, dual-source power supply shall be included.

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12. Provide a dual-source power supply (DSPS) for each relay when operated from standard 120V AC, or 240V AC, 60 Hz, auxiliary control power which is normally connected and available. The DSPS shall operate solely from the breaker main current transformers (CTs) during a fault condition, if the normally connected auxiliary AC voltage is not available. A battery or UPS as power shall not be required for reliable tripping under all fault conditions. The DSPS shall operate anytime there is a fault, even after an extended power outage. When the standard auxiliary power supply is not available, the DSPS shall provide enough power to operate the overcurrent relay in the tripped state with currents greater than 1.8 per unit rated secondary current, 9A with a single-phase current, 1.2 per unit secondary current or 6A with three-phase currents. There shall be no effect on the overcurrent relay trip time accuracy when the DSPS switches from normal AC voltage to fault-current power.
13. Provide the relay in a drawout case allowing for removal and replacement of the relay unit without disruption of the wiring. The drawout case shall have quick release operation with two-stage disconnect operation. The removal of the relay inner chassis shall disconnect the trip circuits and short the CT secondaries before the unit control power is disconnected. All voltage inputs, discrete inputs and contact outputs shall be disconnected while maintaining security against false tripping. Upon insertion of the relay inner chassis, the control power connections shall be made before the trip circuits are activated to provide additional security against false tripping. Drawout case terminals shall accommodate a bare wire connection, spade or ring terminals. A spare self-shorting contact on the terminal block shall be available to provide alarm indication and/or tripping of circuit breaker upon removal of the relay from the case.

**2.9 AUXILIARY DEVICES**

- A. Ring type current transformers shall be furnished as indicated on the contract drawings. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. Their accuracy rating shall be equal to or higher than ANSI standard requirements. The standard location for the current transformers on the bus side and line side of the 5-kV breaker units shall be front accessible to permit adding or changing current transformers without removing high-voltage insulation connections. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.
- B. Voltage and control power transformers of the quantity and ratings indicated in the detail specification shall be supplied. Voltage transformers shall be mounted in draw out drawers contained in an enclosed auxiliary compartment. Control power transformers up to 15 kV, 15 kVA, single-phase shall be mounted in draw out drawers.

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- C. A mechanical interlock shall be provided to require the secondary breaker to be open before the CPT drawer or CPT primary fuse drawer can be withdrawn.

2.10 UTILITY METERING

- A. Where shown on drawings, provide separate barriered-off utility metering compartment or structure complete with hinged sealable door. Bus work shall include provisions for mounting utility company current transformers and potential transformers as required by the utility company. Provide service entrance label and provide necessary applicable service entrance features per NEC and local code requirements.

2.11 ENCLOSURES

- A. The switchgear described in these specifications shall be indoor construction, with devices arranged as shown on contract drawings.

2.12 NAMEPLATES

- A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum. Furnish master nameplate for each switchgear lineup giving information in accordance with IEEE Std C37.20.2-1999, section 7.4.1. Circuit nameplates shall be provided with circuit designations as shown on purchaser's single-line diagrams.
- B. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2.13 FINISH

- A. The finish shall consist of a coat of gray (ANSI-61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal and external parts. The coating shall have corrosion resistance of 600 hours to 5% salt spray.

2.14 ACCESSORIES

- A. The switchgear manufacturer shall furnish accessories for test, inspection, maintenance, and operation, including:
  - 1. One – Maintenance tool for manually charging the breaker closing spring and manually opening the shutter

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2. One – Levering crank for moving the breaker between test and connected positions
3. One – Test jumper for electrically operating the breaker while out of its compartment
4. One – Breaker lifting yoke used for attachment to breaker for lifting breaker on or off compartment rails, when applicable
5. One – Set of rail extensions and rail clamps, when applicable
6. One – Portable lifting device for lifting the breaker on or off the rails
7. One – Ramp for rolling breaker mounted in lower compartment directly onto the floor
8. One – Test cabinet for testing electrically operated breakers outside housing
9. One – “Dockable” transport dolly for moving breaker about outside its compartment
10. One – Electrical levering device.

**2.15 SWITCHGEAR CONTROL SYSTEM**

- A. A Switchgear System shall be provided to facilitate overall system operation including automatic standby operation, monitoring and control of the generator sets including start/stop, alarm/fault monitoring, synchronizing, generator kW load sharing, generator kVAR load sharing, generator loading/unloading, load shed/add, and protective relaying as listed in the following paragraphs.
- B. The Switchgear Control System shall utilize true distributed processing technology to maximize system fault tolerance. A Distributed Processing Switchgear Control System is defined as, but not limited to, the use of separate processors for each power source, and a separate processor dedicated to touchscreen Human/Machine Interface (HMI) operation.
- C. The Switchgear Control System shall be by the same manufacturer as the switchgear and generator sets in order to ensure a complete and coordinated system.
- D. A control system utilizing standard electro-mechanical control devices, relays, and individual discrete meters for each function specified in the following paragraphs is acceptable.

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2.16 GENERATOR SYSTEM FEATURES

- A. Generator Control features shall be provided for each generator shown on the drawings. Generator Controls shall include the features and functions listed below.
- B. Engine Instrumentation
  - 1. Provide the following auxiliary devices for each generator.
    - a. Watt/Var Transducer.
    - b. Three - Fused Potential Transformers.
    - c. Three - Current Transformers with shorting block.
- C. Generator Protective Relaying
  - 1. Protective Relay functions shall be solid state or microprocessor, high reliability, industrial grade unless specific models are indicated below.
  - 2. Provide the following protective relay functions for each generator.
    - a. Under/Over Voltage (27/59) Relay, 3-phase, percent adjustable, percent reset, with time delay, Utility grade
    - b. Over/Under Frequency (81 O/U) Relay, single phase, percent adjustable, percent reset, with time delay, Utility grade
    - c. Reverse Power (32) Relay, 3-phase, percent adjustable with time delay, Utility grade
    - d. Loss of Field (Reverse VAR, 40) Relay, 3-phase, percent adjustable with time delay, Utility grade
    - e. Automatic Synchronizer (15/25), Utility grade
    - f. Manual Paralleling Synch Check (25), Utility grade
    - g. Var/Power Factor Controller (90 PF), Utility grade
- D. Generator set Protection and Local Annunciation
  - 1. Provide an annunciation and shutdown interface module for applicable generator set monitoring and fault shutdown. The local Annunciator display module shall contain individual annunciation windows. All windows shall be simultaneously displayed. Alphanumeric scrolling or sequential displays are not acceptable. Annunciation shall comply with

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NFPA 110 requirements. The Annunciator shall be provided with separate Horn Silence and Acknowledge controls. Annunciation shall conform to ISA F3A standards.

2. The Annunciator Display shall be equipped with a fast pulse horn (rated 80-95 dbA at two feet), a Horn Silence Push-button and an Acknowledge Push-button. Any Pre-Alarm or Shutdown Alarm shall cause the Alarm Horn to sound until the Horn Silence button is depressed. Any subsequent alarms shall re-sound the horn. The display shall operate such that any alarm point shall “flash” until acknowledged. One press of the Acknowledge button shall return alarm points to “steady on” except the “first in” alarm, which shall remain flashing. A second press of the Acknowledge button shall return the “first in” alarm point to “steady on”.
3. Status and Pre-Alarm points shall reset automatically as the alarm condition is cleared. Shutdown Alarm points shall cause the generator set to shut down and the generator main to trip open. The generator main is then “locked out” until the cause of the shutdown is corrected, the Engine Control Switch is placed in Off/Reset, and then placed back in Auto or Manual operation. The Annunciator Display shall also be equipped with a Lamp Test Pushbutton.
4. Local Annunciation
  - a. Status, Light Only (Non-Latching)
    - 1.) ECS Not in Auto (Red)
    - 2.) ECS in Auto (Green)
    - 3.) ECS in Manual (Green)
    - 4.) Emergency Mode (Red)
    - 5.) Gen Circuit Breaker Closed (Red)
    - 6.) Gen Circuit Breaker Open (Green)
    - 7.) Engine Stopped (Green)
    - 8.) Engine Running (Red)
    - 9.) Engine Cooldown (Amber)
  - b. Pre-Alarm, Light and Horn (Non-Latching)
    - 1.) Pre-High Coolant Temp (Amber)



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- 2.) Pre-Low Oil Pressure (Amber)
- 3.) Low Coolant Temp (Amber)
- 4.) Engine Battery Low Voltage (Amber)
- 5.) Engine Battery High Voltage (Amber)
- 6.) Battery Charger Failure (Amber)
- 7.) Engine Low Fuel (Amber)
- 8.) Gen Fail to Synch (Amber)
- c. Shutdown Alarm, Light and Horn (Latching)
  - 1.) Engine Overcrank (Red)
  - 2.) Engine Overspeed (Red)
  - 3.) Engine Low Oil Pressure (Red)
  - 4.) Engine High Coolant Temp (Red)
  - 5.) Engine Low Coolant Level (Red)
  - 6.) Engine Remote Emergency Shutdown (Red)
  - 7.) Gen Circuit Breaker Tripped (Red)
  - 8.) Gen Loss of Field (Red)
  - 9.) Gen Reverse Power (Red)
  - 10.) Gen Undervoltage (Red)
  - 11.) Gen Over voltage (Red)
  - 12.) Gen Under frequency (Red)
  - 13.) Gen Over frequency (Red)

E. Generator Set Control, Automatic and Manual Paralleling

- 1. Each Generator set shall be provided with a separate microprocessor based, Automatic Control Module. This module shall be capable of operations independent of all other automatic control modules in the system. The Automatic Control Module shall control all aspects of Generator set

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operation including, but not limited to, voltage control, speed control, automatic engine starting and stopping, synchronization, load sharing, VAR sharing, cross current compensation, and generator circuit breaker control. One Generator set control PLC for multiple generator set control is not acceptable. The Automatic Control Module will independently monitor all voltage, current, and power parameters for it's associated Generator set. It will maintain high speed communications links with all other Automatic Control Modules and the associated Generator set control system.

2. Provide for control of each generator set the following devices and accessories.
  - a. Automatic Control Module
  - b. High Speed Power Transducer
  - c. Engine Control Switch (off reset/auto/manual/cool down)
  - d. Emergency Stop Push-button
  - e. Synch Mode Selector Switch (off/auto/manual/check)
  - f. Circuit Breaker Control Switch with open and closed indicating lights
  - g. Speed Control Potentiometer
  - h. Voltage Adjust Potentiometer
  - i. Best DC Source Selector System
  - j. Control Relaying and switching as required.
  - k. NEC Standard rejection type Fuses
  - l. Nameplates, fuse blocks, terminal boards and instrument wiring harness.  
Provisions for customer interface wiring

2.18 TIE BREAKER CONTROL

- A. Tie breaker control features shall be provided.

2.19 SYSTEM CONTROL

- A. Generator Demand Priority Control

1. The System Controls shall include a Generator Demand Priority Control function to automatically match the on-line generator capacity to the loads to avoid unnecessary operation of all the generators when the loads are low.

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2. The following controls shall be provided for each generator:
  - a. User-settable Generator Priority Selector
  - b. Status indicator for the Generator Priority Selected
  - c. Status indicator for generator On-line or Off-line
3. The Generator Demand Priority Control shall have the following controls:
  - a. Generator Demand Priority Control Switch (On/Off)
  - b. User-settable Generator Remove % (as a function of a single generator capacity)
  - c. User-settable Generator Remove Delay
  - d. User-settable Generator Add % (as a function of a single generator capacity)
  - e. User-settable Generator Add Delay
4. Upon entrance into Emergency or Load Management modes, all generators shall be started and paralleled to the bus. After the Remove Time Delay, generators shall be removed from the bus as a function of the generator percentage loading by the user selected Generator Remove time delay. Generators shall be removed from the bus in descending priority. Should the generator percentage loading increase to the user selected Generator Add limits for the user selected Add Delay, the next generator will be started, synchronized and paralleled to the bus. Generators shall be added to the bus in ascending priority order. Should the generator plant ever reach 95% loading, the next priority generator shall be started and added to the bus with no time delay.

**B. Functional Sequence of Operations**

1. The System Controls shall be designed and integrated with the other specified control components to provide a completely functional total system which shall automatically perform the following generally described sequence of operations:

**C. Automatic/Standby (Utility) Mode**

1. The utility main is closed serving utility power to the bus.
2. The generator mains are open.

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3. The automation is standing by to act in response to a utility failure.
  - a. Emergency (Generator) Mode
4. Utility Failure
  - a. Utility protective relaying senses utility voltage or frequency out of tolerance.
  - b. The utility main is opened.
  - c. A run request is sent to the generator plant.
  - d. The first generator up to voltage and frequency is closed to the bus.
  - e. The emergency tie is closed
  - f. The remaining generators are synchronized and paralleled to the bus as they come up to voltage and frequency.
  - g. The system is now in Emergency Mode.
5. Utility Restoration and Exit from Emergency Mode
  - a. Utility protective relaying senses utility voltage and frequency within tolerance.
  - b. Following a 30 minute time delay (which can be abbreviated by the operator) to assure that the utility power source is stable, the generator plant is passively synchronized and paralleled to the utility source.
  - c. The generator plant is soft ramp unloaded until the utility source is nominally serving the entire system load.
  - d. The emergency tie is closed
  - e. The generator mains are opened.
  - f. The generators are allowed to run for their programmed cool down period.
  - g. The system is now back in Automatic/Standby (Utility) Mode.
6. Closed Transition to Emergency Mode
7. Entry

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- a. The operator places the System Mode Selector Switch into the Closed Xfer to Emergency position.
  - b. A run request is sent to the generator plant.
  - c. The first generator up to voltage and frequency is closed to the bus at no load.
  - d. The remaining generators are synchronized and paralleled to the bus at no load as they come up to voltage and frequency.
  - e. [When all generators are on the bus they are soft ramp loaded until the generator plant is serving nominally the entire load on the bus and the utility main is opened][When all generators are on the bus, they are paralleled across the Emergency Tie Breaker. They are then soft ramp loaded until the generator plant is serving nominally all of the load on the bus and the utility main is opened].
  - f. The system is now running in Emergency Mode.
8. Exit from Emergency Mode
- a. The operator removes the System Mode Selector Switch from Emergency position and returns it to the Auto position.
  - b. Following a 30 minute time delay (which can be abbreviated by the operator), the generator plant is passively synchronized and paralleled to the utility source.
  - c. The generator plant is soft ramp unloaded until the utility source is nominally serving the entire system load.
  - d. The generator mains are opened
  - e. The generators are allowed to run for their programmed cool down period.
  - f. The system is now back in Automatic/Standby (Utility) Mode.
9. Load Management Mode
10. Entry
- a. Import Limit - The user sets the Maximum Utility Import Set point to the desired maximum utility demand that is to be allowed during Load Management][Base Loading - The user sets the desired load in kW that he wants the generator plant to assume

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- b. The user places the System Mode Selector Switch in the Load Management position.
- c. A run request is sent to the generator plant.
- d. The generator is allowed to run for a five minute warm-up time (which can be abbreviated by the operator).
- e. The generators are synchronized and paralleled to the bus at no load after completion of the warm-up time.
- f. When all generators are on the bus they are soft ramp loaded until the generator plant is serving nominally the required amount of the load on the bus to reduce the utility demand to . Import Limit
- g. The generator output is dynamically adjusted to maintain the . [Import LimitSet point. If at any time the system is unable to maintain the Import Limit, the Set point Exceeded alarm shall be sounded.
- h. Should the utility fail at any time during Load Management operation, the utility protective relays shall cause the utility main to open and be locked out, thus placing the system in Emergency Mode until the Utility is restored (as described in Emergency Mode exit).

11. Exit

- a. The operator removes the System Mode Selector Switch from Load Management position and returns it to the Auto position.
- b. The generator plant is soft ramp unloaded until the utility source is nominally serving the entire system load and the generator mains are opened.
- c. The generators are allowed to run for their programmed cool down period.
- d. The system is now back in Automatic/Standby (Utility) Mode.

12. Remote Annunciation

- a. An NFPA compliant remote annunciator shall be provided by the generator set supplier.

13. Remote Power Monitoring System

- a. A PC based Remote Power Monitoring and Control System shall be provided to monitor breaker status, alarms, metering and other operating

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parameters. All control functions displays metering and other information described in Sections of these specifications shall be available to the operator of the Remote Power Monitoring and Control System.

- b. The Remote Monitoring and Control System shall be designed such that its operation will not in any way impede the selected automatic operation of the System Control. Any failure of the Remote Monitoring and Control System shall have no impact to the automatic operation of the System Control.
- c. The Remote Monitoring and Control System shall communicate with the System Control via high speed network. Acceptable communications means shall include modem, Ethernet, wireless modem, cable modem and Frame Relay network.
- d. The PC based Remote Monitoring and Control System shall be provided with color graphic screen presentations as listed below:
  - 1.) Generator Metering Screen for each generator that shall display all of the electrical metering functions listed above utilizing analog meter graphical presentation.
  - 2.) Engine Meter/Gauge Screen for each generator that shall contain all of the engine gauges and meters listed above utilizing analog meter graphical presentation. The meters that are shown to be digital only shall utilize an alphanumeric display.
  - 3.) Generator set Annunciation Screen for each generator that shall contain each of the Status, Pre-Alarm and Shutdown points listed above.
  - 4.) Utility Metering Screen that shall contain all of the electrical metering functions listed above utilizing analog meter graphical presentation.
  - 5.) System Metering Screen that shall contain all of the electrical metering functions listed above utilizing analog meter graphical presentation.
  - 6.) System/Utility Annunciation Screen that shall contain all of the Status and Alarm points above.
  - 7.) System Control Screen which shall contain:
  - 8.) System Mode Selector Switch (Manual/Auto/Closed Transition to Emergency/Load Management)

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- 9.) Utility Fail Test Switch (Test/Normal)
- 10.) Emergency Stop Button
- 11.) Generator Demand Priority Control Switch (On/Off)
- 12.) Load Shed Control Status Screen
- 13.) The Load Shed Control Screen shall display the following information for each Essential Load Shed Priority:
  - Shed Delay Timer setting
  - Add Delay Timer setting
  - Shed/Auto/Add Selector
  - Status indicators to show whether the Priority Level is added or shed
  - Load Shed Control Switch (On/Off)
  - Display of the User-settable Load Shed % (as a function of on-line generator capacity)
  - Display of the User-settable Load Add % (as a function of on-line)
  - Display of the User-settable Bus Under frequency Set point and time delay
  - Bus Under frequency Reset Pushbutton
  - The Generator Demand Priority Control and Status Screen shall have the following control and display for each generator:
- 14.) User-settable Generator Priority Selector
- 15.) Status indicator for the Generator Priority Selected
- 16.) Status indicators for Generator On-line or Off-line
- 17.) Generator Demand Priority Control Switch (On/Off)
- 18.) Display of the User-settable Generator Remove % (as a function of a single generator capacity)
- 19.) Display of the User-settable Generator Remove Delay



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- 20.) Display of the User-settable Generator Add % (as a function of a single generator capacity)
- 21.) Display of the User-settable Generator Add Delay
- 22.) Bar graph display of the total Bus kW with annotations which indicate when the next priority generator will be added to or removed from the bus.

3. EXECUTION

3.1 FACTORY TESTING

- A. The switchgear shall be completely and functionally tested in the manufacturer's facility prior to shipment. For systems shipped in multiple sections, the switchgear shall be quality tested utilizing the plug-together wiring system which shall be unplugged prior to shipment and plugged together again when the equipment is installed in order to maintain the integrity of the manufacturer's quality assurance testing.
- B. The following standard factory tests shall be performed on the circuit breaker element provided under this section. All tests shall be in accordance with the latest version of ANSI standards.
  - 1. Alignment test with master cell to verify all interfaces and interchangeability
  - 2. Circuit breakers operated over the range of minimum to maximum control voltage
  - 3. Factory setting of contact gap
  - 4. One-minute dielectric test per ANSI standards
  - 5. Final inspections and quality checks
- C. The following production test shall be performed on each breaker housing:
  - 1. Alignment test with master breaker to verify interfaces
  - 2. One-minute dielectric test per ANSI standards on primary and secondary circuits
  - 3. Operation of wiring, relays and other devices verified by an operational sequence test
  - 4. Final inspection and quality check.

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- D. The manufacturer shall provide three (3) certified copies of factory test reports.
- E. Factory tests as outlined above shall be witnessed by the owner's representative.
  - 1. The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed.
  - 2. The manufacturer shall include the cost of transportation and lodging for up to three (3) owner's representatives. The cost of meals and incidental expenses shall be the owner's responsibility.

**3.2 FIELD QUALITY CONTROL**

- A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section for a period of five (5) working days. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- B. The manufacturer's representative shall provide inspection of the final installation. The manufacturer's representative shall perform site start-up and functional checkout of the Switchgear. Upon completion of the manufacturer's start-up and checkout, the manufacturer shall demonstrate to the customer all the automated sequences of operation as specified herein.
- C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report.

**3.3 MANUFACTURER'S CERTIFICATION**

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
- B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

**3.4 TRAINING**

- A. The Contractor shall provide a training session for up to five (5) owner's representatives for five (5) normal workdays at a jobsite location determined by the owner.
- B. Upon successful completion of a demonstration of the automated sequences of operation by the manufacturer and acceptance by the customer, the

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manufacturer shall provide an eight-hour "hands-on" training course for the customer's operating personnel which shall cover the following topics:

1. Overall System Description and Theory of Operation
2. Automatic Operation
3. Manual Operation
4. Safeties and Protective Relaying
5. Recommended System Check Lists and Log Sheets
6. Recommended Preventive Maintenance

C. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, circuit breaker, protective devices, and other major components.

**3.5 INSTALLATION**

- A. The Contractor shall install all equipment per the manufacturer's recommendations and contract drawings.
- B. All necessary hardware to secure the assembly in place shall be provided by the contractor.

**3.6 FIELD ADJUSTMENTS**

- A. The relays shall be set in the field by:
  1. The Contractor in accordance with settings designated in a coordination study of the system as required elsewhere in the contract documents.

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1. GENERAL

1.1 SECTION INCLUDES

A. Base Bid:

1. Design Bid Contractor shall provide:
  - a. Low-voltage variable frequency drive (VFD) designed for use on 3-phase squirrel cage induction motor.

1.2 INFORMATIONAL SUBMITTALS

A. Product Data:

1. Completed Data Sheets for each different drive provided. Identify any special accessories required to match with driven load.
2. Complete list and accompanying data for any special equipment required for operation and maintenance of VFD.
3. Receiving, storage, installation, and testing instructions.

B. Quality assurance data:

1. Submittal document index and submittal schedule.
2. Plots of typical efficiency vs. speed and torque curves.
3. Harmonic analysis calculations specific to each installation showing total harmonic voltage and current distortion at PCC. Information to demonstrate that harmonic currents generated by drives will not cause power distribution system to experience harmonic distortion exceeding limits recommended by IEEE Standard 519. Describe product features and equipment furnished to meet harmonic distortion requirements of this Specification.
4. Mean Time-to-Failure data.
5. Standard production testing procedures for drives, certified factory test data and results after completion of factory testing.

1.3 ACTION SUBMITTALS

A. Shop Drawings:

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1. Certified outline, general arrangement, assembly, and installation drawings, that includes front view, dimensions, and weight.
2. Elementary diagrams (3-line diagrams) and schematic control diagrams of complete VFD system showing terminal block terminations, device terminal numbers and internal wiring diagrams.
3. Certified drawings of cable termination compartments showing preferred locations for conduit entry/exit locations and indicating space available for cable terminations.
4. Nameplate drawing.

**1.4 CLOSEOUT SUBMITTALS**

**A. Operation and maintenance manuals. Provide, at minimum:**

1. Final copies of documents listed above.
2. Operating and maintenance procedures.
3. Spare parts lists with pricing.
4. Installation field reports and Data Sheets updated to reflect field installation conditions
5. Copies of warranty.

**1.5 QUALITY ASSURANCE**

- A. Design and manufacture according to latest editions of applicable NEMA, UL, NFPA, IEEE, and ANSI standards.
- B. Manufacturer shall be ISO 9001 certified and shall have produced similar electrical equipment for minimum period of 5 years.
- C. When requested by Engineer, provide acceptable list of similar equipment installations complying with requirements of this specification.
- D. Completed drive shall be tested for at least 3 hours with induction motor connected.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. During delivery and storage, handle equipment to prevent damage, denting, or scoring.

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- B. Store equipment and components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

2. PRODUCTS

2.1 MANUFACTURERS

- A. ABB.
- B. Allen Bradley.
- C. Cutler-Hammer.
- D. Danfoss.
- E. Robicon.
- F. Toshiba.

2.2 SYSTEM DESCRIPTION

- A. VFD shall convert incoming fixed frequency 3-phase ac power into variable frequency and voltage for controlling speed of 3-phase ac motor.
- B. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for eliminating need for motor derating.
- C. VFD shall be sinusoidal PWM type drive with sensor-less torque vector control capability. Control techniques other than PWM, not acceptable.
- D. Components:
  - 1. Full-wave diode rectifier to convert supply ac to fixed dc voltage.
  - 2. Dc link capacitors.
  - 3. Insulated Gate Bipolar Transistor (IGBT) power section, dual rated for either variable or constant torque applications.
  - 4. VFD shall be microprocessor-based with LED and LCD display to monitor operating conditions.
  - 5. Separate control and power terminal boards.
- E. VFD shall be of modular construction for ease of access to control and power wiring, and maintenance.

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- F. Provide in NEMA 1 enclosure for use in normal, nonhazardous industrial environment. Enclosure doors shall include electromechanical interlocking system with safety switch and electrical interlocks tied to main breaker. Whenever doors are open, safety ground switch shall connect plus, minus, and neutral dc buses to ground to ensure stored energy is discharged.

**2.3 DESIGN REQUIREMENTS**

- A. Where manufacturer determines an input drive transformer, input filter, or output filter is required to meet installation requirements, they shall also be provided.
- B. Point of Common Coupling (PCC) shall be defined as terminals on input side of circuit breaker directly feeding each individual drive.
- C. Total Harmonic Distortion (THD) at each PCC shall not exceed 5%, as recommended for General Systems as listed in Table 10.2 of IEEE Standard 519.
- D. Harmonic current distortion at PCC shall not exceed limits listed in Table 10.3 of IEEE Standard 519.
- E. Design drive to provide 50,000 hours mean time between failures (MTBF) when specified preventative maintenance is performed.
- F. Design motors furnished to meet NEMA MG1, Part 31 for VFD service.
- G. Symbols shall conform to ANSI Y32.2/IEEE 315/CSA Z99.
- H. Printed circuit boards shall be completely tested and burned-in, in accordance with UL347A before being assembled into completed VFD.

**2.4 INPUT POWER**

- A. System shall be capable of maintaining rated torque and speed with bus voltage deviations of  $\pm 10\%$  and frequency deviations of  $\pm 5\%$ .
- B. Line notching, transients, and harmonics on incoming line shall not affect VFD performance.
- C. Below 70% bus voltage, motor will be allowed to coast. If bus voltage is restored within 2 seconds, system can be started, if selected. If bus voltage is not restored within 2 seconds, system shall be automatically shut down. Automatic or manual restart shall be selectable from control panel.
- D. VFD shall have provisions for input line reactor to be incorporated into VFD enclosure.

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E. Drive efficiency shall be 95% or higher at rated load.

**2.5 OUTPUT POWER**

A. Operating mode:

1. Frequency at 60 Hz and below: Constant volts per Hz mode.
2. Above 60 Hz: Selectively operate in either constant volts per Hz mode or constant voltage extended frequency mode.

B. Rated output voltage: Programmable for either 80 to 240 volts or from 320 to 480 volts depending on 3-phase motor nameplate rating.

C. VFD shall be capable of minimum of 110% of rated full-load current \*for 60 seconds,\*\*in continuous operation,\* in accordance with NEC Table 430.250.

**2.6 OPERATING RANGE**

A. Speed range: 6 to 60 Hz. Both minimum and maximum speeds shall be field-adjustable.

B. VFD shall not have electrical resonance within operating speed range.

C. VFD shall be able to speed search and immediately pick up spinning motor in either forward or reverse direction.

**2.7 TORSIONAL REQUIREMENTS**

A. VFD, motor, and equipment load shall not develop adverse speed dependent oscillations.

**2.8 NOISE**

A. Drive shall not cause motor audible noise to increase more than 3 dB at 3' (1 m) above rated noise level for operation on full voltage starter.

**2.9 MINIMUM DISPLACEMENT POWER FACTOR**

A. PF 0.90 lagging, or higher, at any speed or load without use of power factor correction capacitors.

**2.10 HARMONICS MITIGATION**

A. Provide output filters, as required, such that motor insulation will not be damaged.



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B. If additional equipment is necessary to meet IEEE 519 requirements, it shall be through use of one or more of following:

1. Input isolation transformer.
2. Input line reactor.
3. Input harmonic trap filter with series reactor.
4. Higher pulse rectifier.
5. Mirus filter.
6. Dc link reactor.

C. Drive manufacturer shall select and approve equipment provided.

**2.1.1 DRIVE CONTROL**

A. VFD shall use control strategy that maximizes efficiency, performance, and power factor while minimizing motor heating.

B. Drive regulator and control: Digital microprocessor design with following functions:

1. Speed regulation.
2. Current regulation.
3. Load angle regulation.
4. Drive protection.
5. Drive diagnostics.
6. System sequencing.

C. VFD regulator and control functions shall be stored on nonvolatile memory.

D. Drive shall have minimum of 3 programmable prohibited frequency ranges with adjustable span of 0 to 10 Hz.

E. Provide drive with local and remote controls:

1. Locate 2-position maintained switch on front of enclosure for selection of “Local” or “Remote” control.

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2. Individual momentary buttons for “Local,” “Start,” and “Stop.”
3. Speed reference potentiometer.

F. Operation:

1. Switch in “Local” position: Drive shall operate at speed set by potentiometer when local “Start” button is pushed. “Stop” button shall stop equipment without delay.
2. Switch in “Remote” position: Drive shall be remotely controlled. Local potentiometer, “Start” button, and “Stop” button shall have no effect on operation.
  - a. Speed control shall regulate motor speed corresponding to remote speed signal
  - b. When incoming signal is varying, rate of change of motor speed shall be limited by pre-selected acceleration/ deceleration rate.
  - c. Drive shall be programmable to either run at constant speed as determined by minimum speed setting, last signal, preset speed, or to shut down, upon loss of speed signal. Remote speed signal falling below lower limit of range shall also be considered as loss of speed signal. Loss of remote speed signal shall be alarmed.
  - d. If remote speed signal is above range upper limit, drive shall run at speed corresponding to upper limit.
  - e. Alarms and indication:
    - 1.) Loss of remote speed signal shall be alarmed.
    - 2.) Drive failure alarm.
    - 3.) Drive fault alarm.
    - 4.) Drive in remote and local control indication.
    - 5.) Drive running indication.

G. Following shall be available locally either on control panel display or by use of readouts and LEDs, and remotely through communication interface:

1. Drive ready.
2. Drive running.
3. Current, amps.

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4. Line-line voltage, volts.
5. Output horsepower, hp.
6. Speed, rpm.
7. Frequency, Hz: Digital readout.
8. Drive alarm conditions.
  - a. Missing run or start permissive.
  - b. Low control voltage.
  - c. Microprocessor problem.
  - d. I/O addressing problem.
  - e. Loss of speed reference.
  - f. Common trouble alarm.
9. Drive fault conditions requiring immediate attention, and may indicate impending shutdown of drive.
  - a. Source undervoltage.
  - b. Source overvoltage.
  - c. Source loss of phase.
  - d. Source reverse phase sequence.
  - e. Load overcurrent.
  - f. Overspeed.
  - g. Ground fault.
  - h. Dc Link overvoltage.
10. Provide communications interface for remote monitoring and control of VFD using DeviceNet communications protocol.

**2.12 DRIVE DIAGNOSTICS**

- A. Provide comprehensive diagnostics for maintenance and troubleshooting including:

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1. Self-test of microprocessor drive control system.
2. LED indicators for status indication on control boards.
3. Convenient maintenance test points.

2.13 COOLING

- A. Provide integral filtered ambient air cooling by natural convection or forced air cooling system as required to maintain drive equipment at its full current rating.

2.14 IDENTIFICATION AND TAGGING

- A. Securely attach nameplates with self-tapping stainless steel screws. Adhesive nameplates not acceptable.
- B. Lettering shall be black on white background.

3. EXECUTION

3.1 PREPARATION

- A. Clean interior and exterior of equipment prior to placing into service. Debris shall be removed and appropriately discarded.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Perform manufacturer's recommended start-up and commissioning tests prior to placing into service.
- C. Correct deficiencies with VFD and other furnished equipment until system operates as required for installed equipment, at no cost to User.
- D. Refinish marred spots to match original finish.

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DATA SHEETS LOW VOLTAGE VFD		Equipment Name: Blower 1,2,3,4	
		Tag No.:	REV. #
DESCRIPTION	UNITS/ OPTIONS	SPEC DATA	VENDOR DATA
Manufacturer	N/a		
Catalog/Serial No.	N/a		
<b>General:</b>			
Driven Equipment	-	Blower	
Motor NEMA Design	NEMA	Design B	
Nominal Operating Voltage	V	480	
System Operating Frequency	Hz	60	
Motor Nameplate Voltage	V	460	
Motor Nameplate Horsepower	Hp	50	
<b>Cable information:</b>			
Power Cable Incoming Location	Top/Bottom	Top	
Power Cable Exit Location	Top/Bottom	Top	
Maximum Expected Cable Length	ft	See Drawings	
<b>Site information:</b>			
Maximum Ambient Temperature	°C	40	
Minimum Ambient Temperature	°C	0	
<b>Design:</b>			
Rectifier Type	-	PWM	
No of Pulses, Minimum	12, 18, or 24	18	
THD at Point of Common Coupling (PCC)	%	5%	
Available Short Circuit Current at PCC	kA	65	
Mean Time Between Failure (MTFB), Minimum	Hrs	50,000	
Maximum Input Voltage Variation	%	+/- 10	
Maximum Input Frequency Variation	%	+/- 5	
Drive Efficiency, Minimum	%	95	
Displacement Power Factor, minimum	pu	0.9	
Programmable Output Voltage Range	V -V	320 – 480	
Overvoltage Capability of System Voltage, Min.	%	110	
Speed Range	Hz -Hz	6 – 60	
Minimum Programmable Prohibited Freq. Ranges	Qty	3	
Prohibited Freq. Range Span	Hz - Hz	0 – 10	
<b>Enclosure:</b>			
NEMA Rating	NEMA	1	
Dimensions	L x W x H	By Manufacturer	
Weight	lbs	By Manufacturer	
Cooling Method	Air/Water	By Manufacturer	
<b>Controls:</b>			
Local /Remote Switch	Y/N	Y	
Start and Stop Push Buttons	Y/N	Y	
Local Speed Reference Potentiometer/Adjustment	Y/N	Y	
Programmable Speed Setting	Y/N	Y	
Local LCD or LED Readout Panel	Y/N	Y	
Local and Remote Alarm Indication	Y/N	Y	

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<b>DATA SHEETS LOW VOLTAGE VFD</b>		<b>Equipment Name: Blower 1,2,3,4</b>	
		<b>Tag No.:</b>	<b>REV. #</b>
<b>DESCRIPTION</b>	<b>UNITS/ OPTIONS</b>	<b>SPEC DATA</b>	<b>VENDOR DATA</b>
Monitoring of VFD Fault Conditions	Y/N	Y	
Communication Interface	-	DeviceNet	
<b>Accessories:</b>			
Input Isolation Transformer	Y/N	By Manufacturer	
Input Line Reactor	Y/N	By Manufacturer	
Input Harmonic Filter Trap with Series Reactor	Y/N	By Manufacturer	
Output Filter	Y/N	By Manufacturer	
Mirus Filter	Y/N	By Manufacturer	
DC Link Reactor	Y/N	By Manufacturer	
Special Accessories Required:	Y/N	By Manufacturer	

END 26 29 23.

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1. GENERAL

1.1 SECTION INCLUDES

A. Base Bid:

1. Design Bid Contractor shall provide:

- a. Standby power diesel generator set, including all accessories, protections and controls.

1.2 WORK BY OTHERS

- A. Generator set foundations and supports.
- B. Receiving, unloading and storing.
- C. Final placement and assembly.
- D. Connection to external fuel source.
- E. Filling lube oil system if shipped dry.
- F. Filling cooling system if shipped dry.
- G. External power, control, and grounding connections.

1.3 INFORMATIONAL SUBMITTALS

A. Product Data:

- 1. List of instruments and accessories by manufacturer, model number, and operating ranges.
- 2. Nameplate information.
- 3. Complete list of manufacturer recommended spare parts, with unit pricing for each spare part including special equipment, tools and accessories required for installation or maintenance.
- 4. Recommended long term and short term storage requirements and procedures, submitted at least 30 days prior to shipment.

B. Quality assurance data:

- 1. Engineering, procurement, manufacturing, testing and shipping schedule.
- 2. Notice of any cancellation, delay, material change, or schedule impact upon knowledge of information.



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3. Time overcurrent characteristic curves and thermal damage curve for alternator, demonstrating effectiveness of protection provided.
4. Generator capability curves.
5. Certified production test reports.
6. Test reports for previous design, and documentation showing previous design ratings and configurations.
7. Warranty data.
8. Notification of inspection and test schedule 30 days prior to testing.

**1.4 ACTION SUBMITTALS**

**A. Shop Drawings:**

1. Dimensioned equipment arrangement plan view and elevation drawings that include, weight, lifting points, center of gravity, and layout accessories.
2. Piping and instrumentation layout and interfaces.
3. Interconnection wiring drawings with terminal points clearly labeled.
4. Interface coordination details, including foundation attachments or anchors, cable termination limitations, conduit penetration recommendations and access limitations.
5. Complete dimensional drawings for sliding bases, if required.

**B. Quality assurance data:**

1. Complete and accurate Data Sheets.
2. Master submittal drawing index.
3. Bill of Materials.
4. List of operating loads to be powered from external sources.
5. List of external cable connections and maximum power requirements.

**1.5 CLOSEOUT SUBMITTALS**

**A. Operation and maintenance manuals. Provide, at a minimum:**

1. General description and technical data.

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2. Receiving, storage, installation, and testing instructions.
3. Operating and maintenance procedures.
4. Complete set of final drawings, Product data, and quality assurance data as listed above.
5. Complete documentation of inspections and tests performed, including any logs, curves, and certificates. Documentation shall note any replacement of equipment or components that failed during testing.
6. Spare parts lists.
7. Installation field reports.
8. Data sheets updated to reflect field installation conditions.

**1.6 MAINTENANCE MATERIALS**

- A. Ship with unit spare parts required for complete start-up, field commissioning and testing including special tools required for same purpose. Special tools shall become property of User as part of final acceptance.
- B. Provide spare parts during warranty period at no cost to User including, but not be limited to, freight and shipping charges.
- C. It will be User's option to purchase additional spare parts at unit pricing for one year after end of warranty period.
- D. Spare parts shall be clearly identified with unique equipment identification numbers that can be easily cross referenced to manufacturer's drawings furnished for review.

**1.7 QUALITY ASSURANCE**

- A. Manufacturer's qualifications:
  1. Manufacturer shall be manufacturer of major components and shall be ISO certified.
- B. Manufacturer shall have produced similar equipment for minimum period of 5 years.
- C. When requested by Engineer, provide acceptable list of similar equipment installations complying with requirements of this Section.
- D. Regulatory requirements:

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1. Primary standards covering this equipment are ANSI C50.13, IEEE 115, IEEE 446, IEEE519, NEMA MG 1, NFPA 110, CSA 282, and NFPA 70.
2. Certifications: UL 2200
3. Standards of foreign organizations shall not be used without written approval from Engineer.

**1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Coordinate transportation with requirements of pertinent authorities.
- B. Prepare detailed packing lists and shipping notification.
- C. Fill lube oil and cooling systems, if shipped dry.
- D. Ship equipment to job site as completely assembled as practical.
- E. Equipment and accessories shall be covered and protected from damage during shipment.
- F. During delivery and storage, handle equipment to prevent damage, denting, or scoring.
- G. Store equipment and components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.
- H. Space heaters shall be connected to temporary source of power and shall be monitored.

**1.9 WARRANTY**

- A. Manufacturer shall provide 2-year minimum standard warranty on major components from date of final acceptance of User.
- B. Maintenance contract:
  1. In addition to required warranty, at User's option, provide 5-year maintenance contract to cover routine and major overhaul operations. Submit maintenance requirements in relation to operating hours.
  2. Include labor, equipment, tools and any other special requirements in cost of maintenance contract.

**2. PRODUCTS**

**2.1 MANUFACTURERS**

- A. Caterpillar.
- B. Kohler.
- C. Cummins.

## 2.2 SYSTEM DESCRIPTION

- A. Provide completely assembled, wired, tested and operational skid-mounted unit, required accessories and protection including, but not limited to:
  - 1. Diesel engine prime mover directly coupled to synchronous generator (DEG).
  - 2. Solid-state controls and control devices.
  - 3. Permanent magnet generator design.
  - 4. Annunciator and control panel.
  - 5. Exhaust system.
  - 6. Cooling system using skid-mounted radiator.
  - 7. Batteries, battery rack, and battery charger.
  - 8. Skid-mounted fuel tank.
  - 9. Skid-mounted main disconnect with load bank connectors.
  - 10. Remote outlet for exhaust.
- B. Rating of engine-generator set shall be based on operation of set with auxiliary systems operational under specified ambient temperature, and elevation above sea level.
- C. Auxiliary systems shall include, but not be limited to; radiator(s), fan(s), air cleaner, lube oil pump, fuel transfer pump, fuel injection pump, jacket water pump, governor, regulator, charging alternator, alternating current generator, space heaters, lube oil heaters, and all fluids.
- D. Arrange so standby loads are automatically transferred to engine generator upon loss of normal power, after engine generator has reached normal running speed and voltage.
- E. Upon return of normal power, systems return to normal operation, and reset for next operation.
- F. When indicated on Data Sheets, provide on-site start-up, testing, and training.

2.3 ENVIRONMENTAL REQUIREMENTS

- A. Generator set shall be capable of operating and providing full power output in accordance with Data Sheet for installed location, including ambient temperature, altitude and seismic conditions.

2.4 ENCLOSURE SYSTEM

- A. The generator will be installed indoor.
- B. Cooling system shall be sufficient to provide full protection over life of generator set at site conditions.
- C. Steel base shall incorporate vibration isolation system mounting for engine generator set.
- D. Manufacturer shall provide required hardware and shims to permanently mount unit to concrete pad.
- E. Grounding pads or lugs shall be provided inside termination boxes. A minimum of 2 NEMA 2-hole ground pads shall also be provided to ground skid to grounding grid.
- F. Sound attenuation such that operating decibel level shall not exceed sound regulatory requirements at site location.
- G. Provide lifting lugs on major components.

2.5 ENGINE

- A. Engine break horsepower shall be sufficient to deliver full rated generator set kVA at site conditions when operated at rated rpm and equipped with required mounted parasitic and external loads.
- B. Torque and horsepower shall be sufficient to carry alternator load with all dynamic parameters.
- C. Crankshafts shall be forged in 1 piece from steel, heat treated, and dynamically balanced.
- D. Main and connecting rod bearings shall be of precision insert type, steel or bronze backed, babbit or other such alloy linings.
- E. Power pistons shall be heavy section contour ground, oil-cooled with floating piston pins.

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- F. Camshafts shall be made of heat-treated steel, accurately machined, ground to size and fitted for forced-feed lubrication.
1. Connecting rods shall be made of forged steel with I-beam design.
  2. Valves shall be of forged alloy steel with 4 valves per cylinder. Valves shall be accessible for adjusting and grinding. Valve seats shall be replaceable.
  3. Cylinder block shall have replaceable wet liners. Cylinder heads shall be interchangeable. Provide base-type oil pan with access opening that provides sufficient area to permit inspection of main and connecting rod bearings.
  4. Engine speed shall not exceed rated rpm at normal full-load operation.
- G. Accessories:
1. Fuel strainer and filter one each, mounted between engine fuel pump and base tank along with water separator and clear sight glass indicator. Provide indicating pressure gauges on both upstream and downstream side of strainer and filter.
  2. Lube oil filter shall be conveniently located for servicing; equipped with a spring loaded bypass valve to ensure oil circulation if filters are clogged. Provide an oil drain extension line positioned to permit most convenient possible servicing of unit as installed. Provide oil drip pan for mounting underneath engine. Provide bayonet-type oil level dip stick.
  3. Intake air filter shall be one or more heavy-duty, dry-type, replaceable element type rated for normal service with restriction indicators that indicate service life of element.
  4. Fuel transfer pump shall be positive-displacement, engine-driven type. Relief valve shall be provided to prevent build up of excessive pressures if discharge line becomes clogged.
  5. Water pump shall be engine-driven, centrifugal type with thermostatic valve to maintain engine at recommended temperature level. Provide spin-on type engine water filters to treat coolant and prevent corrosion and scale deposits within cooling system.
  6. Pre-lube oil pump shall be electric-driven, continuously operating type for continuous circulation to ensure proper lubrication for automatic engine starts.

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7. Lube oil pump shall be gear type for supplying oil under predetermined constant pressure to main bearings, pistons, piston pins, timing gears, camshaft bearings and valve mechanism.
8. Turbocharger lubrication shall be accomplished downstream of lube oil filtration assembly.
9. Lube oil heater shall be pad-type with thermostatic control installed in crankcase. Size heater in accordance with manufacturer's recommendations to maintain engine lube oil to preset temperature for warm starts. Size to prevent charring of lube oil. Furnish pre-wired lockout to disconnect lube oil heater when engine starts.

**2.6 GOVERNOR**

- A. Provide isochronous type to maintain engine speed within  $\pm 0.5\%$ , steady state, and 5% during no load to full load application with recovery within 2 seconds after sudden load changes, with provisions for manual operation and adjustment.
- B. Governor shall be integrated into engine-generator control panel by engine generator manufacturer, and include, but not be limited to:
  1. Actuator.
  2. Governor control module.
  3. Separate magnetic pickup not to be used to operate any other device but governor.
  4. Idle/run switch for warm-up after maintenance.
  5. 3-phase isochronous load sharing module.
  6. Auto synchronizer.
- C. Speed sensor and decoupling system for start up motor shall prevent coupling of flywheel while in motion.

**2.7 ENGINE START-UP SYSTEM**

- A. Include pre-charged, heavy-duty, gel-cell, maintenance free diesel starting storage battery, of adequate capacity to accommodate not less than six 10-sec starting attempts for specified Site ambient range.
- B. Provide with required cables, cell interconnection ties, rack, and battery heater blanket.
- C. Battery tray shall be plastic-coated metal or wooden tray treated for electrolyte resistance, constructed to contain spillage of electrolyte.

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- D. Battery charger shall be constant potential, solid-state, current-limiting type, dual rate, designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell.
  - 1. Full wave rectifier.
  - 2. Charge rate, float and equalizing charge potential to conform to battery manufacturer's recommendations.
  - 3. Provide low battery voltage alarm contacts for remote annunciation.
  - 4. Overload protection.
  - 5. Dc voltmeter and ammeter.
  - 6. Built-in adjustable equalizer charge timer.
  - 7. Provide enclosure to meet NEMA 250, Type 1 requirements.
  - 8. Breaker protection on input.
- E. Provide solenoid activated starter motor, and jacket water heater designed for quick engine starting.
- F. In event of false start, design start up system to restart starter only after restart motor has stopped.
- G. Protection for prolonged start-ups shall include circuit interrupter to stop cranking after 75 seconds.
- H. Provide separate red LEDs for loss of ac power, loss of battery voltage, and high battery voltage, and green LED for power "ON".

**2.8 COOLING SYSTEM**

- A. Furnish engine with cooling system having sufficient capacity for cooling engine when generator set is delivering full rated load in ambient conditions including air cleaner and inlet silencer.
- B. Equip engine with engine-driven, centrifugal-type water circulating pump and thermostatic valve to maintain engine at recommended temperature level.
- C. Engine shall be equipped with readily accessible cooling radiator and fan. Fan shall be of type to draw air across engine-generator set and exhaust it through radiator. Size fan to maintain safe operation when fully loaded, within ambient conditions.
- D. Provide ventilated rigid guard to enclose fan and belts and pulleys necessary to prevent personnel injury.



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- E. Design of radiator fan shall be for stationary power applications only. One-piece cast aluminum "truck type," stamped steel or riveted fans not acceptable.
- F. Fill engine cooling system with manufacturer's recommended solution. Incorporate rust inhibitor in solution.
- G. Furnish immersion-type jacket water heater to warm water in engine cooling system. Heater shall maintain water temperature at 120°F at site minimum ambient conditions by automatic thermostat control. In event more than 1 jacket water heater is required, no single unit shall require electrical circuit greater than 20-ampere ampacity.
- H. Engine shall shut down on high temperature cooling liquid, low coolant, low oil level, low oil pressure or over speed signal.
- I. Cooling system controls shall be factory set to allow for operation of generator assembly without load after transfer to normal load.
- J. Provisions shall be made for filling and draining radiator. Location shall be easily accessible.
- K. Provide expansion tank with pressure cap, level indicator, and low level alarm switch.
- L. Provide connecting pipes and hoses between motor and radiator.

**2.9 EXHAUST SYSTEM**

- A. Furnish horizontally-mounted, critical grade exhaust silencer (muffler) that will provide 25 dBA of reduction with companion bolted flanges including flexible, stainless steel, bolted flange fitting. Size according to engine manufacturer's recommendation.
- B. Mount exhaust silencer and mounting hardware, inlet and outlet piping.
- C. Furnish low-point drain plug or petcock in exhaust silencer to drain condensation.
- D. Furnish rain cap at exhaust outlet.

**2.10 FUEL SYSTEM**

- A. Separate external fuel storage and day tank will be provided by others.
- B. Pumps shall be variable displacement type to alter volume of fuel delivered to spray nozzles according to load. Nozzles shall inject fuel directly into cylinder in combustion.

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- C. Provide pipe, valves and fittings associated with external fuel storage and connections in accordance with requirements of NFPA 30 and NFPA 37.
- D. Furnish positive measuring fuel level assembly in primary containment volume. Furnish low and high/full level alarm annunciation contacts prewired to furnished junction box.
- E. Fuel lines from day tank to engine components for supply and return shall be wire reinforced, flexible, fuel grade lines with threaded swivel connections for all connection points. Neatly dress and secure flexible lines.
- F. Furnish diesel engine manufacturer's standard engine-mounted replaceable spin-on fuel filter conveniently located for servicing.
- G. Provide for remote shutdown of engine and remote shutdown of fuel supply as required by NFPA 37.
- H. Fuel transfer pump, injection pumps, and timing mechanism shall be maintenance and adjustment free for life of equipment.
- I. Fuel filter shall not require replacement more frequently than once a year or 250 hours of operation, whichever comes first.

**2.11 GENERATOR**

- A. Generator shall be capable of withstanding 3-phase load of 300% rated current for 10 seconds, and sustaining 150% of continuous load current for 2 minutes with field set for rated load excitation.
- B. Generator set design shall withstand full voltage phase to ground short circuit at generator terminals when generator neutral is a solid ground.
- C. Provide close-coupled, dripproof, and guarded design. Construct to NEMA 1 and IP 22 protection standards with single sealed bearing, salient pole, revolving field, synchronous generator directly connected to engine shaft through flexible drive coupling for permanent alignment. Secure using SAE Grade 8 hardware.
- D. Windings: Copper magnet wire coated with underlay of polyester resins and superimposed heavy coat of resin. Insulation shall be Class H.
- E. Rotor winding: Layer wound with thermosetting epoxy between each layer and final coat of epoxy for moisture and abrasion resistance.
  - 1. Amortisseur windings integral with rotor coil.
  - 2. Support shaft bearing shielded type with provisions for easy servicing through grease pipes which extend to exterior of generator frame.

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3. Single bearing type designed for minimum B-10 bearing life of 40,000 hours.
  4. Dynamically balanced for up to 25% overspeed.
- F. Stator winding: Nonintegral pitch design to eliminate third harmonic waveform distortion and minimize harmful neutral circulating current when operating in parallel (2/3 pitch).
1. Windings shall have 5 dips and bakes of varnish and final coating of epoxy for moisture and abrasion resistance.
  2. Waveform harmonic distortion not over 5% THD rms, measured line to line at rated load.
- G. Rotating brushless exciter shall incorporate a full wave, 3-phase rotating rectifier with hermetically sealed, metallic type, silicon diodes to supply main field excitation. Connect multi-plate selenium surge protectors across diode network to protect it against transient conditions.
1. Voltage regulation:  $\pm 0.5\%$  from no load to 100% full load.
  2. Size exciter to handle 125% of maximum alternator output.
  3. Mount exciter for vibration isolation.
  4. Enclosure shall meet NEMA MG 1 standards, self-ventilated, and drip-proof.
- H. Telephone influence factor shall not exceed limits of balanced TIF established by ANSI C50.13 and NEMA MG 1.
- I. Temperature rise shall not exceed 80°C during continuous operation and 105°C when operating at 10% overload in a 40°C ambient as measured by resistance.
- J. Equip with space heaters to keep internal windings dry when unit is not in use. Logic to control heaters shall be furnished completely installed.
- K. Provide surge arresters to protect from voltage spikes.

**2.12 MOUNTING**

- A. Assemble engine generator to common base by manufacturer. Design and construct base to resist deflection, maintain alignment, and minimize resonant linear vibration.
- B. Construct base of Form C section steel members. Incorporate flexible fuel lines, external oil and coolant drains, and external crankcase fumes disposal hose.

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- C. Support cross members shall add rigidity and allow installation of vibration isolators between fuel tank base and generator set.
- D. Isolators: High-resilient rubber compound resistant to weather, heat, and aging. Isolators shall be impervious to oil, water, and antifreeze. Incorporate dual-spring rate for nonabrupt displacement.
- E. Provide required space for ground stub-ups between members. Include bottom mounting holes.
- F. Furnish skid-mounted connection box with load-break switch, such that load conductors can enter bottom of junction box.

**2.13 VOLTAGE REGULATOR**

- A. Microprocessor design shall be suitable for handling shock and vibration associated with mounting within generator assembly.
- B. Provide volts/hertz regulator capable of sensing line-line phases of generator output voltage. Generator voltage shall be maintained within 1% of rated value for any load variation between no-load and full load.
- C. For addition of load up to 90% of rated load, dip shall not exceed 20% of rated voltage. Voltage shall recover to and remain within steady band in not more than 1.5 seconds.
- D. Isochronous frequency regulation from no load to full load shall be in line with engine governor performance. For any addition of load up to 90% of rated load, frequency shall recover to steady-state band within 5 seconds.
- E. Include manual controls to adjust voltage droop,  $\pm 10\%$  voltage level. Voltage droop during motor starting shall not exceed 15%.
- F. Provide capability for include voltage build-up, overcurrent protection, and remote voltage control.
- G. Voltage regulation from no load to rated load shall be less than  $\pm 1\%$  of rated voltage. Steady-state voltage stability shall remain within 0.5% band of rated voltage. Steady-state voltage modulation shall not exceed 1 Hz per second.
- H. Alternator system: Tropicalized; self-ventilated; drip-proof construction.
- I. Equip alternator housing with space heater to prevent moisture condensation.
- J. Provide protection against loss of voltage sensing and long-term overcurrent conditions. Overcurrent protection function shall automatically reset where regulator is de-energized. Regulator shall not be damaged or result in unsafe

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operation when subjected to power or shorted input due to sensing loss, or short to ground on adjacent conductor.

K. Electrical connections shall be through labeled screw terminals.

2.14 MAIN POWER CONNECTIONS

- A. Size main breaker in accordance with manufacturer's recommendations.
- B. Interrupting capacity shall be based on allowable fault duty available from generator.
- C. Breaker:
  - 1. Manual operation for isolation during maintenance.
  - 2. Provide electronic trip unit that operates to protect alternator under all overcurrent conditions, or thermal-magnetic trip with other overcurrent protection devices that positively protect alternator under overcurrent conditions.
- D. Generator phase conductors shall be brought out to isolated phase buses securely mounted within conductor termination box. Size phase bus bars for 100% of main breaker rated ampacity. Phase busses shall be tin or silver-plated copper, drilled, tapped, and furnished with lugs for copper conductors preinstalled with bolts and spring washers. Lugs shall be compression-type.
- E. Generator conductor termination box shall have 100% capacity ground bus mounted inside. Ground bus shall be solidly connected to engine-generator frame rails with a properly sized NEC bonding jumper, and solidly connected to grounding electrode(s) at generator pad in accordance with NEC requirements. Mount to inside cabinet in accessible location. Furnish predrilled and tapped holes to match NEMA standard copper lug terminations for NEC-sized ground conductors. Furnish compression-type lugs preinstalled with bolts and spring washers.
- F. Generator neutral conductors shall be grounded through low impedance.
- G. Neutral or grounded conductors shall not be bonded together at any location in emergency power distribution system.
- H. Grounding: Provide clamp-type terminal on end of generator base suitable for 4/0 AWG stranded copper wire.
- I. Torque terminations to final settings in accordance with manufacturer's recommended values.

2.15 CONTROL PANEL

- A. Controls shall be microprocessor-based with integrated control and protection. Design shall incorporate menu-driven digital display screen with membrane-style buttons and nonrotary style switches.
- B. Control panel enclosure shall be constructed with steel, mounted in an easily readable and accessible location on generator set. Mount on vibration isolators.
- C. Digital voltage regulation and engine speed governing, synchronizing, and load sharing. Include import/export controls for paralleling with infinite bus.
- D. Digital starting control shall provide functions for fuel ramping, failure to crank, temperature dynamic governing, digital excitation control and cycle cranking. Selectable number of cycles, cranking, and off time periods.
- E. Protection of alternator and power system shall be protected from overcurrent, over/under voltage, over/under frequency, and over load conditions.
- F. Comprehensive display of engine and alternator data
- G. Self diagnostics and circuit boards diagnostic LED's.
- H. Pushbuttons:
  - 1. Local-Off-Auto.
  - 2. Start.
  - 3. Stop.
  - 4. E-stop.
  - 5. Reset.
  - 6. Menu.
- I. 3-phase digital meters:
  - 1. Percent of current, amperes.
  - 2. Percent of load meter, kW.
  - 3. Frequency meter, ac.
  - 4. Voltage meter, volts ac.
- J. Network communications for future twisted, shielded pair connection to master paralleling control unit.

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K. Panel shall provide protective functions to prevent damage to generator.

2.16 ALARM MODULE

A. NFPA 110 requirements shall be satisfied by microprocessor alarm module mounted in panel. Provide auxiliary contacts for NFPA 110 panel alarms.

2.17 ISOLATORS

A. Clearly indicate complete assembled unit center of gravity (CG) on frame rails on both sides and provide CG information on Shop Drawings from datum points.

B. Mount engine and generator on common structural steel frame sufficiently rigid to prevent deflection between vibration isolators. Mount structural steel frame on minimum 4" (100 mm) deflection open-type spring vibration isolators and independent snubbers. Isolators shall be individually selected from each load bearing location to maintain equal deflection without compensation.

C. Spring isolators shall be adjustable, freestanding, stable, open spring mounting of specified minimum static deflection with combination leveling bolt and equipment fastening bolt. Spring shall be rigidly attached to spring mounting baseplate and compression plate. Spring element shall have a 50% overload capacity. The overall diameter of spring shall be not less than 0.8 times operating height of spring.

D. Fabricate snubbers of steel plate to limit horizontal and vertical motion of isolated equipment. Affix minimum 1/4" (6 mm) thick neoprene pad at point of contact. There shall be no contact between snubbers and inertia base or equipment support frame during normal operation. Provide minimum of 1 snubber per side, 4 total, on each base.

1. Do not install snubbers until vibration isolators are in place and adjusted with actual operating loads.

2. Design snubbers to provide seismic restraint as required. Provide seismic calculations to demonstrate compliance with code requirements for Seismic Zone compliance criteria.

2.18 WIRING

A. Manufacturer shall pre-install all equipment, internal wiring, wire markers, terminal blocks, raceways and accessories required for system ready for field installation and terminations.

B. Each interconnecting wire shall be identified at both ends with sleeve type wire markers.

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- C. Terminate control and monitoring circuits exiting generator set on terminal blocks specified for control circuits.

**2.19 IDENTIFICATION AND TAGGING**

- A. Securely attach nameplates with self-tapping stainless steel screws or rivets. Adhesive nameplates not acceptable.
- B. Lettering shall be black on white background.
- C. Terminal blocks shall be clearly identified for wiring.
- D. Boxes, enclosures, transfer switches, generators and power panels for emergency circuits shall be permanently marked and readily identified as emergency equipment.
- E. In addition to requirements of Section 26 05 00, nameplate shall contain standard information in accordance with IEEE/ANSI C57.12.01 and serial number and year of manufacture.

**2.20 SOURCE QUALITY CONTROL**

- A. Perform factory tests to confirm requirements of this specification and applicable authorities. Acceptance tests shall successfully demonstrate following:
  - 1. 100% resistive load carrying capability.
  - 2. 20% reactive and 80% resistive simultaneous load carrying capability.
- B. Acceptance test shall be documented by means of certified, calibrated test equipment on strip charts or other permanent recording means. Test results shall be included in complete factory acceptance test manual certified by factory engineer.
- C. Testing shall be manufacturer's standard, and following tests shall be added if not included in standard testing:
  - 1. Engine performance testing:
    - a. Load operation.
    - b. Continuous running.
    - c. Overload operation.
  - 2. Governor characteristics test.



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3. Starting test to verify proper startup of system when loss of normal system voltage is detected at Automatic Transfer Switch (ATS). Test to verify proper shutdown when normal system voltage is restored at ATS. ATS provided under this contract shall be for remote installation. Refer to Section 26 36 23.
  4. Functional factory operation test of assembled unit and test equipment. Perform test at 100% load rating for four hours at unity power factor.
  5. Dynamic response to step voltage changes.
  6. Insulation resistance test.
  7. Winding resistance test.
  8. IEEE 115 tests.
- D. Generator set speed shall be adjustable to within  $\pm 5\%$  of normal operating speed. Speed variation during load rejection shall not cause trip due to overspeed of unit.
- E. Provide certified test reports for complete generator set assembly and sub-assemblies.
- F. Manufacturer shall provide notice to User to permit witnessing of tests.
- G. Prior to shipment, correct defects and defective equipment revealed or noted during testing.

3. EXECUTION

3.1 INSTALLATION

- A. Verify generator space and arrangement and install system components within designated space. If space allocated does not meet installation requirements, notify Engineer immediately before proceeding.
- B. Provide structural pad as required for permanent installation.
- C. Install in accordance with manufacturer's recommendations.
- D. Connect to external fuel source.
- E. Provide external power, control, and grounding connections.

3.2 FIELD QUALITY CONTROL

A. Load bank test:

1. After installation is completed, perform break-in in accordance with manufacturer's recommendations.
2. Provide load bank to test engine(s) at 100% of full kilowatt resistive load.
3. **Completely fill tank with winter-blend diesel fuel.**
4. After break-in period, run entire unit as follows:
  - a. 50% load for 1 hour.
  - b. 75% load for 1 hour.
  - c. 100% load for 3 hours.
5. Provide log of test results indicating oil pressure, water temperature, voltage, amperes and frequency.
6. Record values every 15 minutes for one hour, every 30 minutes for remainder of test.
7. Record any abnormal readings or condition and outside air temperature at time of test.
8. Demonstrate operation of alarm functions and engine safety shutdown circuits.
9. Engine shall perform satisfactorily without excessive smoke, overheating, vibration, blowby, and piping leaks. Demonstrate proper operation of all engine and switchgear components, including cooling, exhaust and fuel systems.
10. Provide necessary load banks, meters, and personnel.
11. Demonstrate automatic operation of transfer switches and engine generator set by introducing loss of power at each transfer switch.
12. Provide photograph of oscilloscope trace of generator output 60-cycle sine wave. Demonstrate isochronous operation from 10% to 100% load. Demonstrate parallel speed droop operation from 10% to 100% load. Demonstrate both manual and automatic operation.

B. Final test:

1. Simulate power failure of normal supply, verify start up time of diesel generator and transfer to emergency mode within preset time delays specified.
2. Restore normal supply, verify transfer within preset time delays and operation of diesel generator under no load condition for a preset time period.
3. Test operation of automatic transfer switch to insure proper automatic and manual operation and with automatic transfer switch manufacturer's requirements and/or recommendations. Verify signals sent for load shed are operating devices correctly.
4. Test diesel generator main breaker and all other breakers associated with emergency power transfer to insure proper protection and operation of transfer systems.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Final connections, check-out, start-up, testing and instruction by shall be performed by factory-authorized and trained technician.
- B. Provide factory qualified erection engineer to personally supervise complete installation of diesel engine and generator including setting, alignment, assembly, connections, startup, testing, and instruction of User. Furnish manufacturer's written certification assuring that each item of equipment is complete, in good condition, free from damage, and properly installed, connected, and adjusted.
- C. Factory qualified engineer shall be present at job site during following activities:
  1. Pre-installation coordination meeting with Contractor, Engineer, and User to coordinate installation and interconnection of packaged engine-generator system with other engine-generator equipment.
  2. Post-installation startup and testing assistance prior to system turnover and initial instruction period for operating personnel.
  3. Maintain competent, factory service organization that is available for service on 24-hour call basis.

3.4 TRAINING

- A. Provide services of fully trained manufacturer's technician to instruct User's staff in care and operation of generating set. Period of instruction shall not be less than required to provide adequate training and instruction to staff.

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- B. Instruct User for a period of no less than 1 day in maintenance and operation of equipment.
- C. Instruction and training program shall include basic theory of engine operation, procedures of operating, preventative maintenance, troubleshooting and major component replacement.

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<b>DATA SHEETS ENGINE GENERATOR SET</b>		<b>Equipment Name: Standby Generator</b>	
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
Manufacturer	-		
Catalog/Serial No.	-		
<b>Ratings (based on site conditions):</b>			
Model No.	-	By Manufacturer	
Frame No.	-	By Manufacturer	
Prime Power	KVA/MVA	-	
Standby Power	KVA/MVA	1875 KVA	
Power Factor	PU	0.8	
Terminal Voltage	V	2400	
Voltage Regulation	%	± 0.5%	
Frequency	Hz	60	
Rated Full Load Amperes	A	By Manufacturer	
Ground Configuration	-	Low Impedance	
Efficiency / % Load	%	Per NEMA MG 1	
Insulation Class	-	H	
Temperature Rise Above Ambient	-	F	
Voltage Regulator Model		By Manufacturer	
Qty of generators in parallel	Ea	(3)	
<b>Site Requirements:</b>			
Installed Location	-	Outdoor	
Maximum Ambient Temperature	°F	100	
Minimum Ambient Temperature	°F	-30	
Altitude	Ft	1000	
Seismic Zone			
Operating noise limit	dBA		
<b>Package Features:</b>			
Application	-		
Special Protection	Y/N	N	
Dimensions (H x W x D)	in	By Manufacturer	
Weight Without Fuel	lb	By Manufacturer	
Total Weight with Fuel	lb	By Manufacturer	
Fuel Tank Location	-	N/A	
Manufacturer Tech. Rep on site	Y/N	3 days at Start-up	
<b>Enclosure:</b>			
Material	Steel	N/A	
Finish		N/A	
Enclosure Type		N/A	
Sound Attenuation Enclosure	Y/N	N	
<b>Engine:</b>			
Model number	-	By Manufacturer	
Cylinder Bank Configuration	-	By Manufacturer	
Speed	rpm	1800	
Cycle	stroke	Four stroke	

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DATA SHEETS ENGINE GENERATOR SET		Equipment Name: Standby Generator	
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
No. of Cylinders		By Manufacturer	
Fuel Type		Diesel	
Fuel Tank capacity	Gal	By Manufacturer	
Hours of operation without refueling Tank	hrs	See Note below	
Fuel Tank Warming Heater	Vac	See Note below	
Fuel consumption w/ Fan	gallons/hr	By Manufacturer	
Lube Oil, Volume	quarts	By Manufacturer	
Lube Oil Heater:	Y/N	Y	
Rating (Maximum 16 amps)	KW	BY Manufacturer	
Operating Voltage	Vac	120	
Alternator Space Heater:	Y/N	Y	
Rating (Maximum 16 amps)	KW	BY Manufacturer	
Operating Voltage	Vac	120	
Water Jacket, Volume	quarts	By Manufacturer	
Jacket Water Heater	Y/N	Y	
Jacket Water Heater Voltage	Vac	120	
Engine Block Heater	Y/N	Y	
Block Heater Voltage	Vac	120	
<b>Batteries and Charger:</b>			
Charger Manufacturer	-	By Manufacturer	
Charger Model No.	-	By Manufacturer	
Charger Input Voltage	Vac	120	
Battery Manufacturer		By Manufacturer	
Catalog/Serial No.		By Manufacturer	
Maintenance Free	Y/N	Y	
Battery Voltage	Vdc	12	
Battery Warranty	years	10	
Battery Blanket Heater	Y/N	Y	
Blanket Heater Voltage	Vac	120	
Duty Cycle Loading	minutes	By Manufacturer	
Battery breaker/disconnect	Y/N	Y	
Engine Generator Controls:			
Digital/Analog		By Manufacturer	
Off/Manual/Auto Switch with Indication	Y/N	Y	
Phase selector switch	Y/N	Y	
Phase Voltage	Y/N	Y	
Current	Y/N	Y	
Emergency Stop Button	Y/N	Y	
Temperature Indication and Alarm	Y/N	Y	
Water Level Indication and Alarm	Y/N	Y	
Oil Level Indication and Alarm	Y/N	Y	
Oil Pressure Indication and Alarm	Y/N	Y	
Over Speed Indication and Alarm	Y/N	Y	

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DATA SHEETS ENGINE GENERATOR SET		Equipment Name: Standby Generator	
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
Over Crank Indication and Alarm	Y/N	Y	
RPM Indication	Y/N	Y	
Fuel Level	Y/N	Y	
Remote Control / Monitoring	Y/N	Y	
Remote Fuel Shutdown	Y/N	N	
Main Disconnect:			
Main Type	-	E-Stop control mushroom pushbutton	
Manufacturer and Model Number	-	By Manufacturer	
Model Number	-	By Manufacturer	
Rated Continuous Current	A	N/A	
Rated Symmetrical Interrupt	kA	N/A	
Thermal-Magnetic Element	Y/N	N/A	
Fuse Type and Size	Type/A	Not used	
Special Requirements:  Battery charger shall be located at the generator  All 120V electrical equipment (battery charger, heaters, etc.) shall be factory wired to a load center within the generator allowing for a single-point 120V 30A field connection by contractor.  Generator fuel will be supplied from a separate outdoor tank and Day tank by others..	-		
Special Tools: Provide Paralleling Switchgear (PS) with additional controls to synchronize the parallel generators. See specification 26 13 13 for more information	-	By Manufacturer	

END OF SECTION

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**Section 26 32 13-16 – Natural Gas Engine Generator**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design Bid Contractor shall provide:
  - a. Power natural gas generator set, including accessories.

1.2 SYSTEM DESCRIPTION

- A. Provide completely assembled, wired, tested and operational skid-mounted unit, required accessories including, but not limited to:
  1. Natural gas engine prime mover directly coupled to synchronous generator.
  2. Solid-state controls and control devices.
  3. Permanent magnet generator design.
  4. Annunciator and control panel.
  5. Exhaust system.
  6. Cooling system using skid-mounted radiator.
  7. Batteries, battery rack, and battery charger.
- B. Rating of engine-generator set shall be based on operation of set with auxiliary systems operational under specified ambient temperature, and elevation above sea level.
- C. Auxiliary systems shall include, but not be limited to; radiator(s), fan(s), air cleaner, lube oil pump, fuel injection pump, jacket water pump, governor, regulator, charging alternator, alternating current generator, space heaters, lube oil heaters, and all fluids.
- D. Arrange so load is automatically transferred to engine generator upon loss of normal power, after engine generator has reached normal running speed and voltage.
- E. Upon return of normal power and after adjustable delay, systems return to normal operation, and reset for next operation.
- F. When indicated on Data Sheets, provide on-site start-up, testing, and training.

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1.3 ACTION SUBMITTALS

A. Documents to submit:

1. Completed Data Sheets.
2. List of recommended start-up parts, spare parts and maintenance tools.
3. List of items requiring field installation and required special equipment.
4. Guaranteed sound levels and fuel consumption at rated load.
5. Drawings with proposed overall estimated dimensions, weight, enclosure construction, and general layout of equipment and accessories.
6. List of equipment shipped loose requiring field installation.

B. Product Data:

1. List of instruments and accessories by manufacturer, model number, and operating ranges.
2. Nameplate information.
3. Special equipment, tools and accessories required for installation or maintenance.
4. Recommended long term and short term storage requirements and procedures, submitted at least 30 days prior to shipment.

C. Submit for review after award of Contract.

1. Complete and accurate Data Sheets.
2. Master submittal drawing index.
3. Bill of Materials.
4. Dimensioned equipment arrangement plan view and elevation drawings that include, weight, lifting points, center of gravity, enclosure construction, and layout of accessories.
5. Piping and instrumentation layout and interfaces.
6. Interconnection wiring drawings with terminal points clearly labeled.
7. Interface coordination details, including foundation attachments or anchors, cable termination limitations, conduit penetration recommendations and access limitations.

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8. List of operating loads to be powered from external sources.
9. List of external cable connections and maximum power requirements.
10. Complete dimensional drawings for sliding bases, if required.

**D. Quality assurance data:**

1. Engineering, procurement, manufacturing, testing and shipping schedule.
2. Notice of any cancellation, delay, material change, or schedule impact upon knowledge of information.
3. Time overcurrent characteristic curves and thermal damage curve for alternator, demonstrating effectiveness of protection provided.
4. Generator capability curves.
5. Certified production test reports.
6. Test reports for previous design, and documentation showing previous design ratings and configurations.
7. Warranty data.
8. Notification of inspection and test schedule 30 days prior to testing.

**E. Operation and maintenance manuals. Provide, at a minimum:**

1. General description and technical data.
2. Receiving, storage, installation, and testing instructions.
3. Operating and maintenance procedures.
4. Complete set of final drawings, Product data, and quality assurance data as listed above.
5. Complete documentation of inspections and tests performed, including any logs, curves, and certificates. Documentation shall note any replacement of equipment or components that failed during testing.
6. Spare parts lists.
7. Installation field reports.
8. Data sheets updated to reflect field installation conditions.

#### 1.4 QUALITY ASSURANCE

A. Manufacturer's qualifications:

1. Manufacturer shall be manufacturer of major components and shall be ISO certified.
2. Manufacturer shall have produced similar equipment for minimum period of 5 years.
3. When requested by Engineer, provide acceptable list of similar equipment installations complying with requirements of this Section.

B. Regulatory requirements: Primary standards covering this equipment are ANSI C50.13, IEEE 115, IEEE 446, IEEE 519, NEMA MG 1, NFPA 110, CSA 282, and NFPA 70.

C. Certifications: UL 2200

D. Standards of foreign organizations shall not be used without written approval from Engineer.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Coordinate transportation with requirements of pertinent authorities.

B. Prepare detailed packing lists and shipping notification.

C. Fill lube oil and cooling systems, if shipped dry.

D. Ship equipment to job site as completely assembled as practical.

E. Equipment and accessories shall be covered and protected from damage during shipment.

F. During delivery and storage, handle equipment to prevent damage, denting, or scoring.

G. Store equipment and components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

H. Space heaters shall be connected to temporary source of power and shall be monitored.

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1.6 ENVIRONMENTAL REQUIREMENTS

- A. Generator shall comply with US and Illinois EPA regulations for natural gas generators manufactured.
- B. Generator set shall be capable of operating and providing full power output in accordance with Data Sheet for installed location, including ambient temperature, altitude and seismic conditions.

1.7 WARRANTY

- A. Manufacturer shall provide 5-year warranty on major components from date of final acceptance of User. See Section 1.09 B.

1.8 USER INSTRUCTION

- A. Provide services of fully trained manufacturer's technician to instruct User's staff in care and operation of generating set. Period of instruction shall not be less than required to provide adequate training and instruction to staff.
- B. Instruct User for a period of no less than 1 day in maintenance and operation of equipment.
- C. instruction and training program shall include basic theory of engine operation, procedures of operating, preventative maintenance, troubleshooting and major component replacement.

1.9 MAINTENANCE

- A. Extra materials:
  - 1. Ship with unit spare parts required for complete start-up, field commissioning and testing including special tools required for same purpose. Special tools shall become property of User as part of final acceptance.
  - 2. Provide spare parts during warranty period at no cost to User including, but not be limited to, freight and shipping charges.
  - 3. Submit complete list of manufacturer recommended spare parts, with unit pricing for each spare part. It will be User's option to purchase additional spare parts at unit pricing for one year after end of warranty period.
  - 4. Spare parts shall be clearly identified with unique equipment identification numbers that can be easily cross referenced to manufacturer's drawings furnished for review.

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B. Maintenance contract:

1. In addition to required warranty, at User's option, provide 5-year maintenance contract to cover routine and major overhaul operations. Submit maintenance requirements in relation to operating hours.
2. A minimum of 4 PM's visit per year shall be required and shall include at least one oil change per year and batteries as necessary.
3. Include labor, equipment, tools and any other special requirements in cost of maintenance contract.
4. Once a year, Contactor shall perform a simulated loss of power test on live system - coordinate with User to confirm that simulated power outage does not occur while pumps are active, and that pumps are manually started and brought to full load while under generator power, reverse process once test is complete.

2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Caterpillar.
- B. Cummins/Onan.
- C. Generac.
- D. Kohler.

2.2 ENGINE

- A. Engine break horsepower shall be sufficient to deliver full rated generator set kVA when operated at rated rpm and equipped with required mounted parasitic and external loads.
- B. Torque and horsepower shall be sufficient to carry alternator load with all dynamic parameters.
- C. Crankshafts shall be forged in 1 piece from steel, heat treated, and dynamically balanced.
- D. Main and connecting rod bearings shall be of precision insert type, steel or bronze backed, babbitt or other such alloy linings.

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- E. Power pistons shall be heavy section contour ground, oil-cooled with floating piston pins.
- F. Camshafts shall be made of heat-treated steel, accurately machined, ground to size and fitted for forced-feed lubrication.
  - 1. Connecting rods shall be made of forged steel with I-beam design.
  - 2. Valves shall be of forged alloy steel with 4 valves per cylinder. Valves shall be accessible for adjusting and grinding. Valve seats shall be replaceable.
  - 3. Cylinder block shall have replaceable wet liners. Cylinder heads shall be interchangeable. Provide base-type oil pan with access opening that provides sufficient area to permit inspection of main and connecting rod bearings.
  - 4. Engine speed shall not exceed rated rpm at normal full-load operation.
- G. Accessories:
  - 1. Fuel strainer and filter one each. Provide indicating pressure gauges on both upstream and downstream side of strainer and filter.
  - 2. Lube oil filter shall be conveniently located for servicing; equipped with a spring loaded bypass valve to ensure oil circulation if filters are clogged. Provide an oil drain extension line positioned to permit most convenient possible servicing of unit as installed. Provide oil drip pan for mounting underneath engine. Provide bayonet-type oil level dip stick.
  - 3. Intake air filter shall be one or more heavy-duty, dry-type, replaceable element type rated for normal service with restriction indicators that indicate service life of element.
  - 4. Water pump shall be engine-driven, centrifugal type with thermostatic valve to maintain engine at recommended temperature level. Provide spin-on type engine water filters to treat coolant and prevent corrosion and scale deposits within cooling system.
  - 5. Pre-lube oil pump shall be electric-driven, continuously operating type for continuous circulation to ensure proper lubrication for automatic engine starts.
  - 6. Lube oil pump shall be gear type for supplying oil under predetermined constant pressure to main bearings, pistons, piston pins, timing gears, camshaft bearings and valve mechanism.

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7. Turbocharger lubrication shall be accomplished downstream of lube oil filtration assembly.
8. Lube oil heater shall be an immersion-type with thermostatic control installed in crankcase. Size heater in accordance with manufacturer's recommendations to maintain engine lube oil to preset temperature for warm starts. Size to prevent charring of lube oil. Furnish pre-wired lockout to disconnect lube oil heater when engine starts.

**2.3 GOVERNOR**

- A. Provide isochronous type to maintain engine speed within  $\pm 0.5\%$ , steady state, and 5% during no load to full load application with recovery within 2 seconds after sudden load changes, with provisions for manual operation and adjustment.
- B. Governor shall be integrated into engine-generator control panel by engine generator manufacturer, and include, but not be limited to:
  1. Actuator.
  2. Governor control module.
  3. Separate magnetic pickup not to be used to operate any other device but governor.
  4. Idle/run switch for warm-up after maintenance.
- C. Speed sensor and decoupling system for start up motor shall prevent coupling of flywheel while in motion.

**2.4 ENGINE START-UP SYSTEM**

- A. Include pre-charged, heavy-duty, gel-cell, maintenance-free gas starting storage battery, of adequate capacity to accommodate not less than six 10-sec starting attempts for specified Site ambient range.
- B. Provide with required cables, cell interconnection ties, rack, and battery heater blanket.
- C. Battery tray shall be plastic-coated metal or wooden tray treated for electrolyte resistance, constructed to contain spillage of electrolyte.
- D. Battery charger shall be constant potential, solid-state, current-limiting type, dual rate, designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell.
  1. Full wave rectifier.
  2. Charge rate, float and equalizing charge potential to conform to battery manufacturer's recommendations.



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3. Provide low battery voltage alarm contacts for remote annunciation.
  4. Overload protection.
  5. Dc voltmeter and ammeter.
  6. Built-in adjustable equalizer charge timer.
  7. Provide enclosure to meet NEMA 250, Type 1 requirements.
  8. Breaker protection on input.
- E. Provide solenoid activated starter motor, and jacket water heater designed for quick engine starting.
- F. In event of false start, design start up system to restart starter only after restart motor has stopped.
- G. Protection for prolonged start-ups shall include circuit interrupter to stop cranking after 75 seconds.
- H. Provide separate red LEDs for loss of ac power, loss of battery voltage, and high battery voltage, and green LED for power “ON”.

**2.5 COOLING SYSTEM**

- A. Furnish engine with cooling system having sufficient capacity for cooling engine when generator set is delivering full rated load in ambient conditions including air cleaner and inlet silencer.
- B. Equip engine with engine-driven, centrifugal-type water circulating pump and thermostatic valve to maintain engine at recommended temperature level.
- C. Engine shall be equipped with readily accessible cooling radiator and fan. Fan shall be of type to draw air across engine-generator set and exhaust it through radiator. Size fan to maintain safe operation when fully loaded, within ambient conditions.
- D. Provide ventilated rigid guard to enclose fan and belts and pulleys necessary to prevent personnel injury.
- E. Design of radiator fan shall be for stationary power applications only. One-piece cast aluminum “truck type,” stamped steel or riveted fans not acceptable.
- F. Fill engine cooling system with manufacturer’s recommended solution. Incorporate rust inhibitor in solution.

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- G. Furnish immersion-type jacket water heater to warm water in engine cooling system. Heater shall maintain water temperature at 120°F at site minimum ambient conditions by automatic thermostat control. Provide shutoff valves to isolate heater for replacement without having to drain coolant from unit. In event more than 1 jacket water heater is required, no single unit shall require electrical circuit greater than 20-ampere ampacity.
- H. Engine shall shut down on high temperature cooling liquid, low coolant, low oil level, low oil pressure or over speed signal.
- I. Cooling system controls shall be factory set to allow for operation of generator assembly without load after transfer to normal load.
- J. Provisions shall be made for filling and draining radiator. Location shall be easily accessible.
- K. Provide connecting pipes and hoses between motor and radiator.

**2.6 EXHAUST SYSTEM**

- A. Furnish horizontally-mounted, critical grade exhaust silencer (muffler) with companion bolted flanges including flexible, stainless steel, bolted flange fitting. Size according to engine manufacturer's recommendation.
- B. Mount exhaust silencer and mounting hardware, inlet and outlet piping.
- C. Furnish low-point drain plug or petcock in exhaust silencer to drain condensation.
- D. Furnish rain cap and bird screen at exhaust outlet.

**2.7 NATURAL GAS FUEL SYSTEM**

- A. Fuel system: Integral with engine, including filters, strainers, regulators, control valves, injection pumps, lines, nozzles, and solenoids.
- B. Injection pumps shall be driven from camshaft. Pumps shall be of a variable displacement type to alter volume of fuel delivered to spray nozzles according to load demand.
- C. Nozzles shall inject fuel directly into cylinder in combustion.
- D. Flexible fuel lines between engine and fuel supply shall be installed to isolate vibration.
- E. Generator shall be capable of delivering rated load with 10" WC supply pressure.

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**2.8 GENERATOR**

- A. Generator shall be capable of withstanding 3-phase load of 300% rated current for 10 seconds, and sustaining 150% of continuous load current for 2 minutes with field set for rated load excitation.
- B. Generator set design shall withstand full voltage phase to ground short circuit at generator terminals when generator neutral is a solid ground.
- C. Provide close-coupled, dripproof, and guarded design. Construct to NEMA 1 and IP 22 protection standards with single sealed bearing, salient pole, revolving field, synchronous generator directly connected to engine shaft through flexible drive coupling for permanent alignment. Secure using SAE Grade 8 hardware.
- D. Windings shall be copper magnet wire coated with underlay of polyester resins and superimposed heavy coat of resin. Insulation shall be Class H.
- E. Rotor winding shall be layer wound with thermosetting epoxy between each layer and final coat of epoxy for moisture and abrasion resistance.
  - 1. Amortisseur windings integral with rotor coil.
  - 2. Support shaft bearing shielded type with provisions for easy servicing through grease pipes which extend to exterior of generator frame.
  - 3. Single bearing type designed for minimum B-10 bearing life of 40,000 hours.
  - 4. Dynamically balanced for up to 25% overspeed.
- F. Stator winding shall be nonintegral pitch design to eliminate third harmonic waveform distortion and minimize harmful neutral circulating current when operating in parallel (2/3 pitch).
  - 1. Windings shall have 5 dips and bakes of varnish and final coating of epoxy for moisture and abrasion resistance.
  - 2. Waveform harmonic distortion not over 5% THD rms, measured line to line at rated load.
- G. PMG exciter shall incorporate a full wave, 3-phase rotating rectifier with hermetically sealed, metallic type, silicon diodes to supply main field excitation. Connect multi-plate selenium surge protectors across diode network to protect it against transient conditions.

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1. Voltage regulation:  $\pm 0.5\%$  from no load to 100% full load.
  2. Size exciter to handle 125% of maximum alternator output.
  3. Mount exciter for vibration isolation.
  4. Enclosure shall meet NEMA MG 1 standards, self-ventilated, and drip-proof.
- H. Telephone influence factor shall not exceed limits of balanced TIF established by ANSI C50.13 and NEMA MG 1.
- I. Temperature rise shall not exceed 80°C during continuous operation and 105°C when operating at 10% overload in a 40°C ambient as measured by resistance.
- J. Equip with space heaters to keep internal windings dry when unit is not in use. Logic to control heaters shall be furnished completely installed.
- K. Provide surge arresters to protect from voltage spikes.

**2.9 MOUNTING**

- A. Engine generator shall be assembled to a common base by manufacturer. Base shall be designed and built to resist deflection, maintain alignment, and minimize resonant linear vibration.
- B. Construct base of Form C section steel members. Incorporate flexible fuel lines, external oil and coolant drains, and external crankcase fumes disposal hose.
- C. Support cross members shall add rigidity and allow installation of vibration isolators between fuel tank base and generator set.
- D. Isolators shall be high-resilient rubber compound resistant to weather, heat, and aging. Isolators shall be impervious to oil, water, and antifreeze. Incorporate dual-spring rate for non-abrupt displacement.
- E. Provide required space for ground stub-ups between members. Include bottom mounting holes.
- F. Furnish skid-mounted connection box with load-break switch, such that load conductors can enter bottom of junction box.

**2.10 VOLTAGE REGULATOR**

- A. Microprocessor design suitable for handling shock and vibration associated with mounting within generator assembly.

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- B. Provide volts/hertz regulator capable of sensing line-line phases of generator output voltage. Generator voltage shall be maintained within 1% of rated value for any load variation between no-load and full load.
- C. For addition of load up to 90% of rated load, dip shall not exceed 20% of rated voltage. Voltage shall recover to and remain within steady band in not more than 1.5 seconds.
- D. Isochronous frequency regulation from no load to full load shall be in line with engine governor performance. For any addition of load up to 90% of rated load, frequency shall recover to steady-state band within 5 seconds.
- E. Include manual controls to adjust voltage droop,  $\pm 10\%$  voltage level. Voltage droop during motor starting shall not exceed 15%.
- F. Provide capability for include voltage build-up, overcurrent protection, and remote voltage control.
- G. Voltage regulation from no load to rated load shall be less than  $\pm 1\%$  of rated voltage. Steady-state voltage stability shall remain within 0.5% band of rated voltage. Steady-state voltage modulation shall not exceed 1 Hz per second.
- H. Alternator system: Tropicalized; self-ventilated; drip-proof construction.
- I. Equip alternator housing with space heater to prevent moisture condensation.
- J. Provide protection against loss of voltage sensing and long-term overcurrent conditions. Overcurrent protection function shall automatically reset where regulator is de-energized. Regulator shall not be damaged or result in unsafe operation when subjected to power or shorted input due to sensing loss, or short to ground on adjacent conductor.
- K. Electrical connections shall be through labeled screw terminals.

**2.11 MAIN POWER CONNECTIONS**

- A. Size load-break, molded-case main breaker in accordance with manufacturer's recommendations. Locate switch in NEMA 1 termination box attached to connection enclosure on engine-generator assembly.
- B. Interrupting capacity shall be based on allowable fault duty available from generator.
- C. Breaker:
  - 1. Manual operation for isolation during maintenance.

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2. Thermal-magnetic, protective, quick-make, quick-break, trip-free from handle, and trip indicating.
  3. Provide electronic trip unit that operates to protect alternator under all overcurrent conditions, or thermal-magnetic trip with other overcurrent protection devices that positively protect alternator under overcurrent conditions.
- D. Generator phase conductors shall be brought out to isolated phase buses securely mounted within conductor termination box. Size phase bus bars for 100% of main breaker rated ampacity. Phase busses shall be tin or silver-plated copper, drilled, tapped, and furnished with lugs for copper conductors preinstalled with bolts and spring washers. Lugs shall be compression-type.
- E. Generator conductor termination box shall have 100% capacity ground bus mounted inside. Ground bus shall be solidly connected to engine-generator frame rails with a properly sized NEC bonding jumper, and solidly connected to grounding electrode(s) at generator pad in accordance with NEC requirements. Mount to inside cabinet in accessible location. Furnish predrilled and tapped holes to match NEMA standard copper lug terminations for NEC-sized ground conductors. Furnish compression-type lugs preinstalled with bolts and spring washers.
- F. Generator neutral conductors shall be brought out to isolated neutral bus mounted securely within conductor termination box. Neutral bus shall be tin or silver-plated copper, drilled, tapped, and furnished with lugs for copper conductors preinstalled with bolts and spring washers. Lugs shall be compression-type.
- G. Neutral or grounded conductors shall not be bonded together at any location in emergency power distribution system except at service disconnecting means from which automatic transfer switch receives its normal source of power.
- H. Grounding: Provide clamp-type terminal on end of generator base suitable for 4/0 AWG stranded copper wire.
- I. Torque terminations to final settings in accordance with manufacturer's recommended values.

**2.12 CONTROL PANEL**

- A. Controls shall be microprocessor-based with integrated control and protection. Design shall incorporate menu-driven digital display screen with membrane-style buttons and nonrotary style switches.
- B. Control panel enclosure shall be constructed with steel, mounted in an easily readable and accessible location on generator set. Mount on vibration isolators.

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- C. Digital voltage regulation and engine speed governing, synchronizing, and load sharing. Include import/export controls for paralleling with infinite bus.
- D. Digital starting control shall provide functions for fuel ramping, failure to crank, temperature dynamic governing, digital excitation control and cycle cranking. Selectable number of cycles, cranking, and off time periods.
- E. Protection of alternator and power system shall be protected from overcurrent, over/under voltage, over/under frequency, and over load conditions.
- F. Comprehensive display of engine and alternator data
- G. Self diagnostics and circuit boards diagnostic LED's.
- H. Pushbuttons:
  - 1. Local-Off-Auto.
  - 2. Start.
  - 3. Stop.
  - 4. Reset.
  - 5. Menu.
- I. 3-phase digital meters:
  - 1. Percent of current, amperes.
  - 2. Percent of load meter, kW.
  - 3. Frequency meter, ac.
  - 4. Voltage meter, volts ac.
- J. Network communications for future twisted, shielded pair connection to master paralleling control unit. Modbus RTU.
- K. Provide dry contacts for following alarms:
  - 1. Generator Fail to Start.
  - 2. Generator Common Trouble Alarm.
- L. Panel shall provide protective functions to prevent damage to generator.

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**2.13 ALARM MODULE**

- A. NFPA 110 requirements shall be satisfied by microprocessor alarm module mounted in panel. Provide auxiliary contacts for NFPA 110 panel alarms.

**2.14 ISOLATORS**

- A. Clearly indicate complete assembled unit center of gravity (CG) on frame rails on both sides and provide CG information on Shop Drawings from datum points.
- B. Mount engine and generator on common structural steel frame sufficiently rigid to prevent deflection between vibration isolators. Mount structural steel frame on minimum 4" (100 mm) deflection open-type spring vibration isolators and independent snubbers. Isolators shall be individually selected from each load bearing location to maintain equal deflection without compensation.
- C. External spring isolators are required if not integral to the genset. Spring isolators shall be adjustable, freestanding, stable, open spring mounting of specified minimum static deflection with combination leveling bolt and equipment fastening bolt. Spring shall be rigidly attached to spring mounting baseplate and compression plate. Spring element shall have a 50% overload capacity. The overall diameter of spring shall be not less than 0.8 times operating height of spring.
- D. Fabricate snubbers of steel plate to limit horizontal and vertical motion of isolated equipment. Affix minimum 1/4" (6 mm) thick neoprene pad at point of contact. There shall be no contact between snubbers and inertia base or equipment support frame during normal operation. Provide minimum of 1 snubber per side, 4 total, on each base.
  - 1. Do not install snubbers until vibration isolators are in place and adjusted with actual operating loads.
  - 2. Design snubbers to provide seismic restraint as required. Provide seismic calculations to demonstrate compliance with code requirements for Seismic Zone compliance criteria.

**2.15 WIRING**

- A. Manufacturer shall pre-install all equipment, enclosures, internal wiring, wire markers, terminal blocks, raceways and accessories required for system ready for field installation and terminations.
- B. Each interconnecting wire shall be identified at both ends with sleeve type wire markers.



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- C. Terminate control and monitoring circuits exiting generator set on terminal blocks specified for control circuits.

**2.16 IDENTIFICATION AND TAGGING**

- A. Securely attach nameplates with self-tapping stainless steel screws or rivets. Adhesive nameplates not acceptable.
- B. Lettering shall be black on white background.
- C. Terminal blocks shall be clearly identified for wiring.
- D. At a minimum, nameplate shall contain standard information in accordance with IEEE/ANSI C57.12.01 and serial number and year of manufacture.

**2.17 SOURCE QUALITY CONTROL**

- A. Perform factory tests to confirm requirements of this specification and applicable authorities. Acceptance tests shall successfully demonstrate following:
  - 1. 100% resistive load carrying capability.
  - 2. 20% reactive and 80% resistive simultaneous load carrying capability.
  - 3. Provide photograph of oscilloscope trace of generator output 60-cycle sine wave. Demonstrate isochronous operation from 10% to 100% load. Demonstrate parallel speed droop operation from 10% to 100% load. Demonstrate both manual and automatic operation.
- B. Acceptance test shall be documented by means of certified, calibrated test equipment on strip charts or other permanent recording means. Test results shall be included in complete factory acceptance test manual certified by factory engineer.
- C. Testing shall be manufacturer's standard, and following tests shall be added if not included in standard testing:
  - 1. Engine performance testing:
    - a. Load operation.
    - b. Continuous running.
    - c. Overload operation.
  - 2. Governor characteristics test.

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3. Starting test to verify proper startup of system when loss of normal system voltage is detected at Automatic Transfer Switch (ATS). Test to verify proper shutdown when normal system voltage is restored at ATS.
  4. Functional factory operation test of assembled unit and test equipment. Perform test at 100% load rating for four hours at unity power factor.
  5. Dynamic response to step voltage changes.
  6. Insulation resistance test.
  7. Winding resistance test.
  8. IEEE 115 tests.
  9. 10% overload for 1 hour.
- D. Generator set speed shall be adjustable to within  $\pm 5\%$  of normal operating speed. Speed variation during load rejection shall not cause trip due to overspeed of unit.
- E. Provide certified test reports for complete generator set assembly and sub-assemblies.
- F. Manufacturer shall provide notice to User to permit witnessing of tests.
- G. Prior to shipment, correct defects and defective equipment revealed or noted during testing.

3. EXECUTION

3.1 INSTALLATION

- A. Verify generator space and arrangement and install system components within designated space. If space allocated does not meet installation requirements, notify Engineer immediately before proceeding.
- B. structural pad as required for permanent installation.
- C. Install in accordance with manufacturer's recommendations.
- D. Connect to external fuel source.
- E. Provide external power, control, and grounding connections.

3.2 FIELD QUALITY CONTROL

- A. Load bank test:

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1. After installation is completed, perform break-in in accordance with manufacturer's recommendations.
  2. Provide load bank to test engine(s) at 100% of full kilowatt resistive load.
  3. After break-in period, run entire unit as follows:
    - a. 50% load for 1 hour.
    - b. 75% load for 1 hour.
    - c. 100% load for 3 hours.
  4. Provide log of test results indicating oil pressure, water temperature, voltage, amperes and frequency.
  5. Record values every 15 minutes for one hour, every 30 minutes for remainder of test.
  6. Record any abnormal readings or condition and outside air temperature at time of test.
  7. Demonstrate operation of alarm functions and engine safety shutdown circuits.
  8. Engine shall perform satisfactorily without excessive smoke, overheating, vibration, blowby, and piping leaks. Demonstrate proper operation of all engine and switchgear components, including cooling, exhaust and fuel systems.
  9. Provide necessary load banks, meters, and personnel.
  10. Demonstrate automatic operation of transfer switches and engine generator set by introducing loss of power at each transfer switch.
- B. Final test:
1. Simulate power failure of normal supply, verify start up time of diesel generator and transfer to emergency mode within preset time delays specified.
  2. Restore normal supply, verify transfer within preset time delays and operation of diesel generator under no load condition for a preset time period.
  3. Test operation of automatic transfer switch to insure proper automatic and manual operation and with automatic transfer switch manufacturer's

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requirements and/or recommendations. Verify signals sent for load shed are operating devices correctly.

4. Test diesel generator main breaker and all other breakers associated with emergency power transfer to insure proper protection and operation of transfer systems.
5. Following satisfactory completion of tests, replace fuel oil in storage tank consumed during testing.

**3.3 MANUFACTURER'S FIELD SERVICES**

- A. Final connections, check-out, start-up, testing and instruction by shall be performed by factory-authorized and trained technician.
- B. Provide factory qualified erection engineer to personally supervise complete installation of diesel engine and generator including setting, alignment, assembly, connections, startup, testing, and instruction of User. Furnish manufacturer's written certification assuring that each item of equipment is complete, in good condition, free from damage, and properly installed, connected, and adjusted.
- C. Factory qualified engineer shall be present at job site during following activities:
  1. Pre-installation coordination meeting with Contractor, Engineer, and User to coordinate installation and interconnection of packaged engine-generator system with other engine-generator equipment.
  2. Post-installation startup and testing assistance prior to system turnover and initial instruction period for operating personnel.
  3. Maintain competent, factory service organization that is available for service on 24-hour call basis.

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DATA SHEETS ENGINE GENERATOR SET			
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
Manufacturer	-		
Catalog/Serial No.	-		
<b>RATINGS</b>			
Model No.	-	By Manufacturer	
Frame No.	-	By Manufacturer	
Prime Power	kVA	n/a	
Standby Power	kVA	150	
Power Factor	pu	.8	
Terminal Voltage	V	208	
Voltage Regulation	%	± 0.5%	
Frequency	Hz	60	
Rated Full Load Amperes	A	By Manufacturer	
Ground Configuration	-		
Efficiency / % Load	%	Per NEMA MG 1	
Insulation Class	-	H	
Temperature Rise Above Ambient	-	F	
Voltage Regulator Model		By Manufacturer	
Qty of generators in parallel	Ea	n/a	
<b>SITE REQUIREMENTS</b>			
Installed Location	-	Indoors	
Maximum Ambient Temperature	°C	40	
Minimum Ambient Temperature	°C	-30	
Altitude	Ft	650	
Seismic Zone			
Maximum operating noise limit at 23 ft.	dBA	75	
<b>PACKAGE FEATURES</b>			
Application	-	Standby	
Special Protection	Y/N	N	
Dimensions (H x W x D)	in	By Manufacturer	
Weight Without Fuel	lb	By Manufacturer	
Total Weight with Fuel	lb	By Manufacturer	
Fuel Tank Location	-	n/a	
Manufacturer Tech. Rep on site	Y/N	Y	
<b>ENCLOSURE</b>			
Material	Steel	Steel	
Finish		Manufacturer Std.	
Enclosure Type			
Sound Attenuation Enclosure	Y/N	Y	
<b>ENGINE</b>			
Model number	-	By Manufacturer	
Cylinder Bank Configuration	-	By Manufacturer	
Speed	rpm	1800	

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DATA SHEETS ENGINE GENERATOR SET			
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
Cycle	stroke	Four stroke	
No. of Cylinders		By Manufacturer	
Fuel Type		Natural gas	
Fuel Tank capacity	Gal	n/a	
Hours of operation without refueling Tank	hrs	See Note Below	
Fuel Tank Warming Heater	Vac	n/a	
Fuel consumption w/ Fan	BTU/min	By Manufacturer	
Lube Oil, Volume	quarts	By Manufacturer	
Lube Oil Heater:	Y/N	Y	
Rating (Maximum 16 amps)	KW	BY Manufacturer	
Operating Voltage	Vac	120	
Alternator Space Heater:	Y/N	Y	
Rating (Maximum 16 amps)	KW	BY Manufacturer	
Operating Voltage	Vac	120	
Water Jacket, Volume	quarts	By Manufacturer	
Jacket Water Heater	Y/N	Y	
Jacket Water Heater Voltage	Vac	120	
Engine Block Heater	Y/N	Y	
Block Heater Voltage	Vac	120	
<b>BATTERIES/CHARGER</b>			
Charger Manufacturer	-	By Manufacturer	
Charger Model No.	-	By Manufacturer	
Charger Input Voltage	Vac	120	
Battery Manufacturer		By Manufacturer	
Catalog/Serial No.		By Manufacturer	
Maintenance Free	Y/N	Y	
Battery Voltage	Vdc	12	
Battery Warranty	years	10	
Battery Blanket Heater	Y/N	Y	
Blanket Heater Voltage	Vac	120	
Duty Cycle Loading	minutes	By Manufacturer	
Battery breaker/disconnect	Y/N	Y	
Engine Generator Controls:			
Digital/Analog		Digital	
Off/Manual/Auto Switch with Indication	Y/N	Y	
Phase selector switch	Y/N	Y	
Phase Voltage	Y/N	Y	
Current	Y/N	Y	
Emergency Stop Button	Y/N	Y	
Temperature Indication and Alarm	Y/N	Y	
Water Level Indication and Alarm	Y/N	Y	
Oil Level Indication and Alarm	Y/N	Y	
Oil Pressure Indication and Alarm	Y/N	Y	

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DATA SHEETS ENGINE GENERATOR SET			
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
Over Speed Indication and Alarm	Y/N	Y	
Over Crank Indication and Alarm	Y/N	Y	
RPM Indication	Y/N	Y	
Fuel Level	Y/N	n/a	
Remote Control / Monitoring	Y/N	Y	
Remote Fuel Shutdown	Y/N	N	
<b>MAIN DISCONNECT</b>			
Main Type	-	Breaker	
Manufacturer and Model Number	-	By Manufacturer	
Model Number	-	By Manufacturer	
Rated Continuous Current	A	By Manufacturer	
Rated Symmetrical Interrupt	kA	By Manufacturer	
Thermal-Magnetic Element	Y/N	Y	
Fuse Type and Size	Type/A	Not used	
<p>Special Requirements:  Generator shall be running and able to accept full load in less than 10 seconds.</p> <p>Aux power single point connection: 120V, 30A</p> <p>Generator controller shall accept start commands from any of 3 independent automatic transfer switches. Coordinate whetting voltage source between generator and automatic transfer switch manufacturers.</p> <p>Battery charger shall be of a compact size and installed inside the generator enclosure. Remote mounting of the battery charger from the enclosure shall not be accepted.</p> <p>Generator fuel will be supplied from a separate outdoor tank by others. Day tank required by the generator manufacturer.</p>	-		
Special Tools:	-	By Manufacturer	

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1. GENERAL

1.1 SECTION INCLUDES

A. Base Bid:

1. Design Bid Contractor shall provide:
  - a. Microprocessor-based logic bypass isolation automatic transfer switches (ATS).

1.2 WORK BY OTHERS

- A. Receiving, unloading, and storage.
- B. Final placement.

1.3 INFORMATIONAL SUBMITTALS

A. Submit with Bid:

1. Completed Data Sheets.
2. Ratings and nameplate information.
3. Elevation and outline drawings with dimensions.
4. Component and accessories list.

B. Quality assurance data: Certified test reports.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Nameplate schedule.
2. Component list.

B. Shop Drawings:

1. Certified complete and accurate Data Sheets.
2. Master drawing index
3. Front view and plan view of assembly.
4. Schematic diagrams.

5. Conduit space locations within assembly.
6. Assembly ratings including:
  - a. Short-circuit rating.
  - b. Voltage.
  - c. Continuous current rating.
5. Major component ratings including:
  - a. Voltage.
  - b. Continuous current rating.
  - c. Interrupting ratings.
6. Cable terminal sizes.
7. Where applicable, submit following additional information:
  - a. Busway connection.
  - b. Connection details between close-coupled assemblies.
  - c. Composite front view and plan view of close-coupled assemblies.
  - d. Key interlock schematic drawing and sequence of operations.
  - e. Mimic bus.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Record Documents:
  1. Final Record Drawings and information for items submitted for review.
  2. Internal wiring diagrams.
  3. Certified production test reports.
  4. Installation information.
  5. Seismic certification.
  6. Component and accessories list.
  7. Receiving, storage, installation, and testing instructions.

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8. Warranty data.
9. Operation and maintenance manuals:
  - a. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for complete assembly and each major component.

**1.6 QUALITY ASSURANCE**

**A. Manufacturer's qualifications:**

1. Manufacturer of major components within assembly.
2. ISO 9001 certified.
3. Manufacturer of equipment shall have produced similar electrical equipment for a minimum period of 5 years.
4. When requested by Engineer, provide acceptable list of similar equipment installations complying with requirements of this specification.

**B. Regulatory requirements: Design, manufacture, and test in accordance with:**

1. ANSI C37.90.
2. CISPR 11.
3. FCC Part 15, Subpart B, Class A.
4. IEC 801-2, 3, 4, and 5.
5. IEEE 446.
6. NEMA ICS10.
7. NFPA 70, 99, 110.
8. UL 991.
9. UL 1008.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Handle and store in accordance with manufacturer's instructions. Provide 1 copy of instructions with equipment at time of shipment.
- B. During delivery, handle equipment to prevent damage, denting, or scoring.

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- C. Store equipment and components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.
- D. Space heaters shall be connected to temporary source of power and shall be monitored.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Ambient Conditions: See Data Sheets
- B. Design equipment in accordance with the relevant sections of the most recent local Building Code.

2. PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Provide automatic transfer switch that will initiate signal on power failure and automatically detect secondary power source, transferring load to secondary source.
- B. On restoration of primary power, switch shall automatically transfer back to primary power.
- C. Signal shall be available to shut down secondary source.

2.2 RATINGS

- A. 100% equipment rated for continuous duty conforming to applicable requirements of UL 1008 for emergency system total load.
- B. Refer to Data Sheets.
- C. Transfer switches rated 800 amperes and above shall have minimum 60-cycle withstand rating of 51 kA.
- D. Switch shall be rated for application with upstream power circuit breakers and insulated case circuit breakers having short-time delay settings of up to 30 cycles.
- E. Voltage rating: No less than system voltage rating.
- F. Continuous current rating: No less than maximum continuous current requirements of system.
- G. Fully rated to protect all types of loads, inductive and resistive, from loss of continuity of power, without derating, either open or enclosed.

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- H. Contacts shall not weld when used with upstream overcurrent protective devices that do not incorporate instantaneous trip units.

**2.3 CONSTRUCTION**

- A. Switching panel shall consist of completely enclosed contact assemblies and separate control logic panel.
- B. Control power for transfer operations shall be derived from line-side of source to which load is being transferred.
- C. Each transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation.
- D. Main contacts shall be mechanically locked in position in both normal and emergency positions.
- E. Neutral position shall not be possible under normal electrical operation unless delayed transition accessory is required for switching highly inductive loads.
- F. Operations:
  - 1. Transfer switches shall be capable of being operated manually under full rated load conditions.
  - 2. Manual operation shall be accomplished by a permanently attached manual operator, or by integrally mounted pushbuttons.
  - 3. Removable manual operating handles and handles that may move in event of electrical operation during manual operation not acceptable.
  - 4. Manual operators requiring source or load disconnection prior to manual operation not acceptable.
- G. Neutral:
  - 1. On transfer switches requiring fourth pole for switching neutral:
    - a. Neutral shall be fully rated with equal withstand, closing and interrupting ratings to power poles.
    - b. Switched neutral poles which are add-on or overlap, or that are not capable of breaking full rated load current not acceptable.
  - 2. Provide neutral disconnect link for 3-pole solid neutral switches, and neutral-to-ground main bonding jumper for switches to meet UL service entrance requirements.

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- H. Transfer switch shall have multitap voltage selection plug for ease of voltage adjustment in field.
- I. Provide transfer switches applied as service entrance switches with overcurrent trip units and service entrance label.
- J. Provide external key-operated selector switch to disconnect power supplies.
- K. Indicators shall be provided to show availability of each source as well as breakers in a tripped or disconnected position.
- L. Provide ground fault protection for switches rated 1.000 amperes or more applied on 480Y/277V ac systems in accordance with NEC Article 230.

**2.4 MICROPROCESSOR-BASED CONTROLLER**

- A. Transfer switch shall be controlled by a UL 1008-listed microprocessor-based controller.
- B. Controller shall be hardened against potential problems from transients and surges.
- C. Operation of transfer switch and monitoring of both sources shall be managed by controller.
- D. Microprocessor-based logic controller shall be door mounted and shall provide operator with overview of transfer switch status, parameters, and diagnostic data.
- E. Voltage range: 0-790 volts (50/60 Hz); accuracy,  $\pm 2\%$  of nominal input voltage.
- F. Frequency range: 40-70 Hz; accuracy,  $\pm 0.1$  Hz.
- G. Control power input range: From 65 volts ac to 160 volts ac rms 50/60 Hz.
- H. Provide LED display indicating:
  - 1. Line-to-line voltages for each source and load.
  - 2. Line frequency for each source.
  - 3. Timer countdown for each timer while functioning.
  - 4. Real-time clock.
  - 5. Set points.

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I. Individual LEDs shall indicate:

1. Source 1 available.
2. Source 1 connected.
3. Source 2 available.
4. Source 2 connected.
5. Source 1 preferred.
6. Source 2 preferred.
7. Load energized.
8. Automatic mode.
9. Test mode.
10. Program mode.

J. Voltage and frequency features:

1. Monitor voltage of each phase of normal source and alternate source with undervoltage dropout adjustable from 50% to 97% of nominal and pickup adjustable from dropout setting  $\pm 2\%$  to 99% of nominal.
2. Monitor voltage of each phase of normal source and alternate source with overvoltage dropout adjustable from 105% to 120% of nominal and pickup adjustable from dropout setting  $+2\%$  to 103% of nominal.
3. Frequency of normal source and alternate source shall be monitored with underfrequency dropout adjustable from 90% to 97% of nominal and pickup adjustable from dropout setting  $+1$  Hz to 99% of nominal.
4. Frequency of normal source and alternate source shall be monitored with overfrequency dropout adjustable from 100% to 120% of nominal and pickup adjustable from dropout setting  $+1$  Hz to 101% of nominal.

K. Time delay features, provide:

1. To override momentary power outage or voltage fluctuation, adjustable from 0 to 120 seconds.
2. On transfer to alternate source, adjustable from 0 to 1,800 seconds.



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3. On retransfer from alternate source to normal source, adjustable from 0 to 1800 seconds. Time delay shall be bypassed if emergency source fails and normal source is available.
4. After retransfer that allows generator to run unloaded prior to shutdown, adjustable from 0 to 1800 seconds.
5. For neutral position, adjustable from 0 to 120 seconds.
6. For engine failure to start, adjustable from 0 to 6 seconds.
7. Delays shall be field-adjustable from microprocessor-based controller without use of special tools.

L. Features:

1. Password programming protection.
2. Setpoints shall be stored in nonvolatile memory. Use of external battery source to maintain operation during “dead” periods not required.
3. Capable of communication to monitor all set points and operational characteristics.
4. Program/run switch.
5. Pre-transfer signal, range 0-120 seconds.
6. Plant exerciser, selectable: Disabled or 7-day interval, 0-600 minutes load or no load.
7. Retransfer mode: Manual or automatic.
8. Preferred source selection.
9. Test pushbutton mode: Disabled, load or no load.

M. Input/output contacts:

1. 2 SPST contacts for generator start, rated 5-ampere, 250 volts ac.
2. 4 SPST contacts for control functions, rated 10-ampere, 250 volts ac.
3. 3 SPDT contacts for control functions, rated 10-ampere, 250 volts ac.

2.5 WIRING/TERMINATIONS

- A. Terminal blocks shall conform to NEMA ICS 4.

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- B. Arrange terminal facilities for entrance of external conductors from top or bottom of enclosure.
- C. Main transfer switch terminals shall be suitable for termination of conductors.

**2.6 POWER SWITCHING DEVICE**

- A. Insulated case circuit breakers
- B. Frame ratings: 400,600, 800, 1200, 1600, 2000, 2500, 3000, 4000 or 5000 (fixed only) amperes.
- C. Breakers:
  - 4. Breakers shall be UL-listed for application in their intended enclosures for 100% of their continuous ampere rating.
  - 5. Breakers shall be electrically operated.
  - 6. Provide selective override circuit on breakers having short-time adjustments but without instantaneous adjustments that will allow selectively up to its rms symmetrical short-time rating.
  - 7. Selective override circuit shall allow breaker to ride through a fully offset (asymmetrical) fault equal to its rms symmetrical short-time rating in a system having an X/R ratio of 6.6 with a maximum single-phase peak current of 2.3 times rms symmetrical short-time ranging. No deviations.
  - 8. Provide breakers with true, 2-step stored energy mechanism providing maximum of 5-cycle closing.
  - 9. Energy required for closing breakers shall be completely stored and held in readiness pending release to close action.
  - 10. Insulated case breakers shall have high-endurance characteristics being capable of no-load and full-load interruptions at rated current equal to or exceeding UL endurance ratings for molded case breakers without maintenance.

**2.7 CUSTOMER METERING**

- A. Where indicated, provide separate customer metering compartment with front hinged door and include:
  - 1. Current transformers wired to shorting-type terminal blocks.
  - 2. Voltage transformers including primary fuses and secondary DIN rail mounted miniature circuit breakers with alarm contacts and disconnecting means or fused potential taps as potential source for metering.

2.8 ENCLOSURE

- A. Provide each transfer switch in enclosure suitable for use in environments where installed. Enclosure options include NEMA 1, NEMA 12, NEMA 3R, NEMA 4, and NEMA 4X.
- B. NEMA 1, 12 or 3R enclosures: Painted with manufacturer's standard ANSI 61 light gray.
- C. NEMA 4 or 4X enclosures: Stainless steel, unpainted.

2.9 PAINTS AND FINISHES

- A. Surface preparation and paint shall be in accordance with manufacturer's standard paint specification.

2.10 IDENTIFICATION AND TAGGING

- A. Securely attach nameplates with self-tapping stainless steel screws. Adhesive nameplates not acceptable.
- B. Lettering: Black on white background.
- C. Terminal blocks shall be clearly identified for wiring.

2.11 SOURCE QUALITY CONTROL

- A. Perform manufacturer's standard factory tests on assemblies.
- B. Perform standard factory tests equipment provided.
- C. Tests shall be in accordance with UL and NEMA standards.
  - 1. Insulation check to verify integrity of insulation and continuity of entire system
  - 2. Visual inspection to verify switch matches specification requirements and to verify that fit and finish meet quality standards.
  - 3. Mechanical tests to verify that switch power sections are free of mechanical hindrances.
  - 4. Electrical tests to verify complete electrical operation of switch and to set up time delays and voltage sensing settings of logic.

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3. EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations.

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DATA SHEETS AUTOMATIC TRANSFER SWITCH		Equipment Name: ATS	
		Tag No.: ATS-###	REV. #1
DESCRIPTION	UNITS / OPTIONS	SPEC DATA	VENDOR DATA
Manufacturer	N/A	By Manufacturer	
Catalog/Serial No.	N/A	By Manufacturer	
<b>Environmental Conditions:</b>			
Ambient Temperature Range	°C	-20 to 40	
Specific local Building Code and specific relevant sections used in equipment design.	---	By Manufacturer	
<b>Enclosure:</b>			
Location	Indoor/Outdoor	Indoor	
NEMA Rating	-	1	
Enclosure Dimensions	LxWxD	By Manufacturer	
Mounting	Wall/free standing	Wall	
<b>Ratings:</b>			
Voltage Class	V	600	
Operating Voltage	V	208	
Continuous Current Rating	A	600	
Phases	1 or 3	3	
Frequency	Hz	60	
Interrupting Current	kA	65	
Closing Current Rating	A	65	
Withstand Current Rating	A	65	
<b>Main Bus:</b>			
Material	Copper or Aluminum	Mfgr. Standard	
Fault Current Rating	kA Braced For		
<b>Incoming Supply – Normal And Alternate:</b>			
Cable Entry Point	Top/Bottom	Bottom	
Conductor Type	Material, Insulation, Size	Cu, See Drawings	
Phase Conductor Size	-	See Drawings	
Number of Conductor Sets/Phase	Qty.	See Drawings	
Ground Conductor Size	-	See Drawings	
Neutral Conductor Size	-	See Drawings	
Lug Material	Cu/Al	CU	
<b>Operating Characteristics:</b>			
Open Transition with Adjustable Time Delay	Y/N	Y	
Closed Transition	Y/N	Y	
3-Phase Sensing of Emergency Source	Y/N	Required	
Toggle Switches for Selecting Auto or Manual Transfer and Retransfer	Y/N	Required	
Neutral Transfer	Y/N	N	
Auxiliary Contacts	Y/N	N	
Switch Position	NO/NC Sets	0/0	

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<b>DATA SHEETS AUTOMATIC TRANSFER SWITCH</b>		<b>Equipment Name: ATS</b>	
		<b>Tag No.: ATS-###</b>	<b>REV. #1</b>
DESCRIPTION	UNITS / OPTIONS	SPEC DATA	VENDOR DATA
Normal Power Available	NO/NC Sets	0/0	
Alternate Power Available	NO/NC Sets	0/0	
Trouble Alarm	NO/NC Sets	0/0	
Selector Switch Manual/Auto	NO/NC Sets	0/0	
<b>Tests and inspections:</b>			
User Inspection	Required/Witness	W	
Routine Shop Tests	Required/Witness	W	
Functional Shop Tests	Required/Witness	R	
<b>Accessories:</b>			
Operation and Maintenance Tools	Yes/No	Y	
Enclosure Space Heaters	Yes/No, Voltage	Y	
Thermostat	Yes/No, Voltage	Y	
Indicating Lights	Qty	5; Normal Power Available Alternate Source Available Switch in "Auto" Switch in "Manual" Trouble	
UL Label	Yes/No	Y	
<b>Miscellaneous:</b>			
Nameplate Details	Material, Text Language	English	

END 26 36 23.

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1. GENERAL

1.1 WORK INCLUDES:

A. Base Bid:

1. Design-Build Contractor shall provide:

- a. Integrated lightning protection system including, but not be limited to:
  - 1.) Air terminals.
  - 2.) Conductor and connections.
  - 3.) Hardware.
  - 4.) Interconnections of structure and other metal objects.
  - 5.) Overhead shield wires.
  - 6.) Electrodes.

1.2 RELATED WORK

A. Section 26 05 00 Common Work Results for Electrical

1.3 Furnished, but installed by others

A. NOT USED.

1.4 QUALITY ASSURANCE

A. Qualifications:

- 1. Manufacturer regularly engaged in production of lightning protection systems for a minimum of 5 years.
- 2. Lightning protection system installer shall be a UL Listed Master Label Installer and shall offer a Master Label, UL certified installation when requested.

B. Lightning protection system, design, and installation shall conform to applicable requirements of: NFPA 70, NFPA 780, UL 96, UL 96A, UL 467, LPI 175, and UL Electrical Construction Equipment Directory.

- 1. Where specification requirements are more stringent, specification shall take precedence.



- C. System furnished shall consist of standard products of manufacturer regularly engaged in production of lightning protection systems and shall be manufacturer's latest NRTL-approved design.
- D. System components shall be furnished by a company that has been engaged in manufacturing of lightning protection systems and equipment for a minimum of 5 years.
- E. Certifications:
  - 1. Where material or equipment is specified to comply with requirements of a NRTL, provide proof of such compliance. Label of or listing in Electrical Construction Equipment Directory will be acceptable evidence.
  - 2. Instead of label or listing, written certificate from approved, nationally recognized testing organization equipped to perform such services, stating that items have been tested and conform to NRTL requirements and testing methods may be submitted.
  - 3. When requested, provide UL Listed Master Label or other NRTL certification for completed and certified lightning protection system installation.

#### 1.5 SUBMITTALS

##### A. Submit with Bid:

- 1. Product Data with complete list of material, including manufacturer's descriptive and technical literature, catalog cuts sheets for each type of system components.
- 2. Certificate of qualifications for performing design and installation of lightning protection system.
- 3. Unit adjustment labor and material pricing for system components.

##### B. Product Data

- 1. Complete list of material, including manufacturer's descriptive and technical literature, catalog cuts sheets for each type of system components.
- 2. Installation information.

C. Shop Drawings:

1. Master drawing index.
2. Design calculations and methods.
3. Certified plan and elevation drawings indicating dimensions and zones of protection.
4. Detail drawings consisting of system components layout drawings, and installation instructions. Detail drawings shall demonstrate that system has been coordinated and will function as a unit. Drawings shall show proposed layout and mounting and relationship to other parts of work.

D. Operation and maintenance data.

2. PRODUCTS

2.1 MANUFACTURERS

- A. Harger Lightning Protection Grounding Equipment.
- B. Thompson Lightning Protection, Inc.
- C. ALT Advanced Lightning Technology.

2.2 LIGHTNING PROTECTION - GENERAL

- A. Components shall be provided that will not be adversely affected by environmental conditions encountered.
- B. Provide oversized conductors where unusual conditions exist which would cause corrosion of conductors.
- C. Provide protective conduit for conductors exposed to mechanical hazard. When metallic conduit is used, conductor shall be electrically connected at upper and lower ends.
- D. Design requirements:
  1. Design to provide shortest distance and most direct current path to ground for structure and other metal objects.
  2. Design shall produce drawings indicating zone of protection from lightning to prevent personal injury, structural damage, and equipment downtime, with calculations supporting design.

3. Do not use combination of materials that form electrolytic couple of such nature that corrosion is accelerated in presence of moisture unless moisture is permanently excluded from junction of such metals.
4. Fabricate, assemble, erect, and place in proper operating condition in full conformity with Contract Documents.

### 2.3 CONDUCTORS

- A. Main and secondary conductors shall be copper unless required otherwise due to galvanized or aluminum mounting surface, or corrosive environment.
- B. Conductors shall be in accordance with applicable parts of NFPA 780 and UL 96 for Class I or Class II materials.

### 2.4 AIR TERMINALS

- A. Air terminals shall be copper or bronze. Terminals shall be in accordance with UL 96 and NFPA 780.
- B. Tip of air terminals on buildings used for manufacturing, processing, handling, or storing explosives, ammunition, or explosive ingredients shall be at least of 2' (600 mm) above ridge parapet, ventilator, or perimeter.
- C. Tip of air terminals on open or hooded vents emitting explosive dusts or vapors under natural draft shall be minimum of 5' (1.5 m) above opening.
- D. On open stacks emitting explosive dusts, gases, or vapor under forced draft, air terminals shall extend minimum of 15' (4.5 m) above vent opening. Air terminals more than 2' (600 mm) in length shall be supported by suitable brace, with guides not less than one-half height of terminal.

### 2.5 GROUND RODS

- A. Type: Copper-clad steel, stainless steel, or solid copper; UL 467.
- B. Size: Not less than 3/4" (19 mm) in diameter and 10' (3 m) in length.
- C. Do not mix ground rods of copper-clad steel, stainless steel, galvanized, ferrous, and solid copper on Project Site.

2.6 CONNECTORS

- A. In general, connections, bonds, and splices shall be done by exothermic welds or by use of high-compression fittings.
- B. Exothermic welds and high compression fittings shall be listed for purpose.
- C. High compression fittings shall be type that requires hydraulically operated mechanism to apply minimum of 10,000 psi.
- D. Clamp-type connectors may be used for connection of roof conductor to air terminal and to guttering. Conform to UL 96, class as applicable, and style and size as required for installation.

2.7 ACCESSORIES

- A. Lightning protection components, such as, but not limited to bonding plates, air terminal supports, chimney bands, clips, and fasteners shall conform to UL 96, classes as applicable.

2.8 IDENTIFICATION AND TAGGING

- A. Materials furnished for lightning protection system shall be NRTL certified.

3. EXECUTION

3.1 INSTALLATION - GENERAL

- A. Install in accordance with manufacturer's recommendations.
- B. Install in neat and inconspicuous manner so components will blend in with appearance of structures.

3.2 CONDUCTORS

- A. Main and secondary conductors shall preserve downward or horizontal course. Rigidly fasten at least every 3' (900 mm) along roof and down building to ground.
- B. Connect roof conductors directly to roof or ridge roll along contours of flat roofs, ridges, parapets, and edges; and where necessary, over flat surfaces, in such a way as to connect all air terminals together forming a closed loop.
- C. Bends less than 8" (203 mm) radius and angles less than 90° in conductors not acceptable.

- D. If lightning protection system relies on structural steel frame of building for path to ground, structural steel shall be made electrically continuous.
- E. Down conductors shall be electrically continuous from air terminals and roof conductors to grounding electrodes.
  - 1. Each building or structure shall have not less than 2 down conductors located as widely separated as practicable, at diagonally opposite corners.
  - 2. On irregularly shaped structures, total number of down conductors shall be sufficient to make average distance between them along perimeter not greater than 100' (30 meters).
  - 3. Structures exceeding 50' (15 m) in height, there shall be at least one additional down conductor for each additional 60' (18 m) of height or fraction thereof, except that this application shall not cause down conductors to be placed about perimeter of structure at intervals of less than 50' (15 m).
- F. Extend down conductors directly to ground connection. Others shall be connected to lightning protection system of building structure that is an adjunct of building, near or touching perimeter.
- G. Protect down conductors by placing in nonmetallic conduit for minimum distance of 72" (1800 mm) above finished grade level.
- H. Metal doors, windows, and gutters shall be connected directly to grounds or down conductors using not smaller than No. 6 AWG (10 mm<sup>2</sup>) copper conductor, or equivalent when located within flashover distance.
- I. Interconnections made within side-flash distances shall be at or above level of grounded metallic parts.
- J. Secondary conductors shall interconnect with grounded metallic parts within building.
- K. Conductors placed where there is probability of unusual wear, mechanical injury, or corrosion shall be of greater electrical capacity than would normally be used, or shall be protected.

### 3.3 AIR TERMINALS

- A. Design base supports for surface on which installed; securely anchored, rigidly connected to, and made electrically continuous with roof conductors by means of pressure connectors or crimped joints of

T-shaped malleable metal and connected to air terminal by a dowel or threaded fitting.

- B. Set air terminals at ends of structure not more than 2' (600 mm) from ends of ridge or edges and corners of roofs. Spacing of air terminals 2' (600 mm) in height on ridges, parapets, and around perimeter of buildings with flat roofs shall not exceed 20' (6.1 m).
- C. Metal projections and metal parts of buildings, smokestacks, and other metal objects 3/16" (5 mm) thick or greater that do not contain hazardous materials and that may be struck but not appreciably damaged by lightning, need not be provided with air terminals. Bond metal objects at structure base to lightning conductor.
- D. On large, flat or gently sloping roofs, as defined in NFPA 780, air terminals shall be placed at points of intersection of imaginary lines dividing surface into rectangles having sides not exceeding 50' (15 m) in length.

#### 3.4 GROUNDING

- A. Ground connection to metal doors and windows shall be by means of crimped mechanical connections or equivalent.
- B. Metal roofs in form of sections insulated from each other shall be made electrically continuous by bonding. Metal roof, metal walls, and steel framework shall be bonded and made electrically continuous and considered as one unit.
- C. Connect air terminals to and make electrically continuous with metal roof as well as roof and down conductors.
- D. Exposed metal eave troughs, roof vents, guy wires, antennas, and mechanical equipment shall be bonded to lightning protection system in such a way that two paths to ground are provided.
- E. Metal guy wires for tanks, towers, and stacks shall be grounded.
- F. Metal guy wires or cables attached to anchor rods set in concrete or attached to buildings or non-conducting supports shall be grounded to a ground rod driven full length into ground.
- G. Grounding electrode shall be provided for each down conductor located as shown.
- H. Driven ground shall extend into earth for a distance of not less than 10' (3.0 m).

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- I. Ground rods shall be set not less than 3' (900 mm), nor more than 8' (2.5 m) from structures foundation.
- J. Connections to pipes shall be by means of ground clamps with lugs. Connections to structural framework shall be by means of nut and bolt or welding. Connections between columns and ground connections shall be made at bottom of steel columns.
- K. Connections between ground connectors and grounds or counterpoise and between counterpoise and grounds shall be electrically continuous.
- L. Test ground rods individually prior to connection to system. Test system as a whole not less than 24 hours after rainfall.
- M. Store equipment and their components in a clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

END 26 41 00

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor shall provide:

- a. Interior lighting fixtures and accessories.
- b. Exterior lighting fixtures and accessories.
- c. LED drivers.
- d. Light control systems.
- e. Emergency lighting systems.

1.2 RELATED WORK

A. Section 26 05 00 Common Work Results for Electrical

1.3 Furnished, but installed by others:

A. NOT USED.

1.4 QUALITY ASSURANCE

A. Manufacturer qualifications:

- 1. Manufacturer of major components within assembly.
- 2. ISO 9001 certified.
- 3. Manufacturer shall have produced similar electrical equipment for a minimum period of 5 years.
- 4. When requested by Engineer, provide acceptable list of similar equipment installations complying with requirements of this specification.

1.5 REGULATORY REQUIREMENTS

A. American National Standards Institute (ANSI)

- 1. ANSI C2 - National Electrical Safety Code.
- 2. ANSI C81.10-76 - Electric Lamp Bases and Holders - Screw-Shell Types (Revised and Consolidated into ANSI C81.61-90).



3. ANSI H35.1-88 - Alloy and Temper Designation Systems for Aluminum.
- B. Federal Communications Commission (FCC) Part 15 - Rules and Regulations:  
Radio Frequency Devices
- C. National Electrical Manufacturers Association (NEMA)
  1. FA 1 - Outdoor Floodlighting Equipment.
  2. OD 3 - Physical and Electrical Interchangeability of Photo Control Devices and Mating Receptacles.
- D. ASTM B429, "Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube."
- E. Military Standards (MIL-STD):
  1. 461A - Electromagnetic Interference Characteristics Requirements for Equipment.
  2. 462 - Electromagnetic Interference Characteristics, Measurement.
  3. 463 - Definition and System of Units Electromagnetic Interference Technology.
- F. National Fire Protection Association (NFPA):
  1. 70 - National Electrical Code (NEC)
  2. 90A - Installation of Air Conditioning and Ventilation Systems.
  3. 101 - Code for Safety to life from fire in Buildings and Structures.
- G. Underwriters Laboratories (UL):
  1. UL 57 - Electric Fixture.
  2. UL 496 - Edison-Base Lamp holders.
  3. UL 773 - Plug-in, Locking Type Photo controls, for Use with Area Lighting.
  4. UL 773A – Non-industrial Photoelectric Switches for Lighting Control.
  5. UL 884 - Lighting fixtures used in hazardous locations.
  6. UL 1449 - Standard for protective devices

H. Code of Federal Regulations (CFR):

1. CFR 21 Part 1040 - Performance Standards for Light-Emitting Products.
2. CFR 40 Part 761 - Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.

I. Illuminating Engineering Society of North America (IES)

1. LHBK - Lighting Handbook, References and Application Volumes.
2. LM 79 - Electrical and Photometric Measurements of Solid-State Lighting Products
3. LM 80 - Measuring Lumen Maintenance of LED Light Sources
4. TM 21 – Projecting Long Term Lumen Maintenance of LED Light Sources

J. IEEE

1. C 62.41.2 – Recommended practice on characterization of surges in low-voltage ac power circuits

1.6 SUBMITTALS

A. Product Data:

1. Lamp ANSI designation, initial and mean lumen output, average rated hours of lamp life and lamp mortality curve, and color temperature and color rendering index.
2. LED driver ANSI designation; electrical characteristics, including volts, lamp, and line operating and starting amperes, watts and watt losses, percent of allowable line voltage variation range and lamp crest factor; total current harmonic distortion; minimum lamp starting temperature; and normal and maximum driver operating temperature.

B. Shop Drawings: Dimensioned and detailed drawings in booklet form with separate sheet or sheets for each fixture, assembled in luminaire "type" alphabetical order and showing:

1. Materials of construction.
2. Arrangement of components and wiring.
3. Gasket sealed for weather tightness.
4. Means of mounting luminaire and adjusting aspect.

5. Finish; photometric data with lamp or lamps specified.
6. Electrical data including volts, amperes and watts; and for roadway type lighting fixtures.
7. Distribution data according to IES roadway classification type.

## 1.7 WARRANTIES

- A. Provide a written two year on-site replacement warranty for material, fixture finish, and workmanship and five year warranty for LED drivers. On-site replacement includes transportation, removal, and installation of new products. See section 01 78 36 for warranty requirements.
  1. Finish warranty shall include warranty against failure and against substantial deterioration such as blistering, cracking, peeling, chalking, or fading.
  2. Material warranty shall include:
    - a. All power supply units (drivers).
    - b. Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.
  3. Warranty period must begin on date of substantial completion. Contractor shall provide the CDB and Using Agency signed warranty certificates prior to final payment.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. During delivery and storage, handle equipment to prevent damage, denting, or scoring.
- B. Store equipment and components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

## 2. PRODUCTS

### 2.1 MANUFACTURERS

- A. Eaton/Cooper Lighting
- B. Lithonia
- C. GE Lighting

## 2.2 LIGHTING FIXTURES

- A. Types: As designated by Contractors. .
- B. Lighting fixtures shall be furnished completely assembled with wiring and mounting devices, ready for installation in their intended location.
- C. Design fixtures with supports independent of ceiling supports.
- D. Equip with required lamps.
- E. Fixtures used as air handling registers shall meet requirements for intended use.
- F. Recessed fixtures mounted in insulated or fire rated ceiling shall be listed for use in insulated or fire rated ceilings.
- G. Lenses, diffusers, covers, and globes: 100% virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
  - 1. Plastic: High-resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
  - 2. Lens thickness: 0.125" (3 mm) minimum, unless greater thickness is indicated.

## 2.3 LAMPS

- A. Comply with standard of ANSI C78 series that is applicable to each type of lamp. Provide luminaires with indicated lamps of designated type, characteristics, and wattage. Where a lamp is not indicated for a luminaire, provide medium wattage lamp recommended by manufacturer for luminaire.

## 2.4 LED Light Sources

- A. Lighting design and photometric calculation should account for LLF which is based on LDD (Luminaire Dirt Depreciation) and Lamp Lumen Depreciation (LLD) as well as ambient temperature and similar factors. L70 should be used while calculating LLD.
- B. Manufacturer's testing should be done per IES LM-79, LM-80 and TM-21. Testing per IES LM-79 should be performed by one of the DOE's LED Lighting Facts approved labs.
- C. Some LED light sources have high in-rush currents that may break a circuit breaker depending on its type. Specify in-rush timing devices. The LED driver and the dimmer should be paired to avoid high in rush currents.

- D. Surge Protective Devices (SPD) s should be added at each outside luminaire. SPDs should be UL1449 recognized for all phases.

## 2.5 LED Drivers

### A. Luminaire wiring:

1. Conductors: Stranded copper.
2. Insulation: 600-volt class, type in accordance with manufacturer's standards for ambient and environmental conditions.
3. Other requirements in accordance with NEC Article 410F.

### B. 0-10V dimming driver (10% - 100%).

## 2.6 RECESS- AND FLUSH-MOUNTED FIXTURES

- A. Provide fixture type that can be re-lamped from bottom. Access to driver shall be from bottom.
- B. Trim for exposed surface of flush-mounted fixtures shall be as indicated.

## 2.7 SUSPENDED FIXTURES

### A. Hangers:

1. Provide hangers capable of supporting twice combined weight of fixtures supported by hangers.
2. Type: Cadmium-plated steel with swivel-ball tapped for conduit size indicated.
3. Hangers shall allow fixtures to swing within an angle of 0.79 rad 45°.
4. Brace pendants 4' (1.2 m) or longer, provided in shops or hangers, to limit swinging.

### B. Single-unit suspended fixtures shall have twin-stem hangers.

### C. Multiple-unit or continuous row LED fixtures shall have a tubing or stem for wiring at one point and tubing or rod suspension provided for each unit length of chassis, including one at each end.

### D. Rods shall be a minimum 0.18" (4.57 mm) diameter.

2.8 FIXTURES FOR HAZARDOUS LOCATIONS

- A. Type: LED fixtures conforming to UL 844, or FM-certified for class and division indicated.

2.9 EMERGENCY LIGHTING UNITS

- A. Provide emergency fixtures as shown on Drawings and Fixture Schedules.

2.10 LIGHTING CONTROLS

A. General Requirements

- 1. Commissioning of lighting controls is mandatory per energy codes & LEED certification. Functional testing of lightning controls & system are also required for ASHRAE 90.1-2010.

B. Contactor, electrically-held, non-latching type:

1. Ratings:

- a. Continuous current: By Manufacturer.
- b. Contacts: 277 volts.
- c. Coil: 277 volts.
- d. Frequency: 60 Hz.

2. Accessories:

- a. Control transformer rated 277 volts.
- b. "Hand-Off-Auto" selector switch on contactor cover.

Enclosures: NEMA 1.

Control: Photocell.

C. Photocell controls :

- 1. Type: Locking; approved sealed cadmium-sulfide cell.
- 2. Ratings: 277 volts, 60 Hz, 1,800 VA.
- 3. Contacts: Single-pole for control of mechanically held contactors arranged to fail in on position
- 4. Switching range:

- a. On: 1 footcandle.
- b. Off: 4.5 to 10 footcandle with 15-second minimum time delay
- 5. Minimum time delay on turn-off: 15 seconds.
- 6. Temperature range: -10°C to 50°C.
- 7. Enclosure: Weatherproof (integral to fixture).
- 8. Mounting: Locking-type receptacle.

**D. Photocell switch:**

- 1. UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated 240 volts ac, 60 Hz with single-pole, double-throw (SPDT) contacts for control of mechanically held contactors, rated 1000 W.
- 2. Switch shall turn on at or below 3 footcandles and off at 2 to 10 footcandles.
- 3. Time delay shall prevent accidental switching from transient light sources.
- 4. Integral to luminaire. rated 1000W minimum. Provide a directional lens in front of cell to prevent fixed light sources from creating a turnoff condition.

**E. Dimmers**

- 1. Specify dimming controls that are compatible with the specified LED light sources and corresponding drivers. Some of the dimmers may require a minimum wattage to operate. Since NEC-2011, it is required to include a neutral conductor to be installed with all dimming controls.
- 2. Even with dimmable controls, the LED drivers should be capable of dimming without LED strobing or flicker across the full dimming range.

**F. Occupancy Sensors**

- 1. Specify Passive Infrared occupancy sensors that are compatible with the specified LED light sources and corresponding drivers. Provide wall switch sensors, ceiling sensors, high bay sensors, as noted on Plans. Provide associated power or relay packs as required by manufacturer.
  - a. Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
  - b. Sensors shall have time delays from 10 to 30 minutes.

- c. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
- d. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
- e. Provide all necessary mounting hardware and instructions.

### 3. EXECUTION

#### 3.1 EXAMINATION

- A. Examine each piece of equipment to ensure there are no defects and that equipment conforms to these specifications.

#### 3.2 PREPARATION

- A. Interior and exterior of equipment shall be cleaned prior to placing into service. Debris shall be removed and appropriately discarded.

#### 3.3 INSTALLATION

- A. Install equipment in strict accordance with manufacturer's recommendations.
- B. Determine locations and arrangement of equipment from Drawings. Locations shown on Drawings are approximate unless dimensioned. Choose precise location to clear obstructions and to provide sufficient space for operation and maintenance.
- C. Coordinate timing of installation and location of equipment with other trades.
- D. Make permanent lighting system, or selected portions thereof, operable as soon as possible.
- E. Perform construction in accordance with NEC.
- F. Repair factory finishes where they become damaged during construction.
- G. Install equipment level and plumb.
- H. Coordinate with Division 1 for temporary lighting during construction.
- I. Grounding:
  - 1. Ground noncurrent carrying parts of equipment including metal poles, luminaires, mounting arms, brackets, and metallic enclosures.



2. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

J. Lighting fixtures:

1. Support lighting fixtures from building framing or floor slabs, independent of conduit system and suspended ceilings.
2. To minimize equipment breakage, delay installation of lighting fixtures in locations near heavy piping and equipment until such equipment is in place.
3. When permanent lighting system becomes operable, re-lamp lighting fixtures, as directed by User.
4. Replace defective or damaged lighting fixtures and lamps at conclusion of job.

K. Wall-mounted equipment:

1. Concrete or masonry walls: Use expansion anchors and bolts; install collars around mounting bolts, or use other means to provide air space between wall and equipment enclosure.
2. Structural steel mounting: Bolt to steel or brackets attached to steel; provide air space between steel and equipment enclosure.

L. Floor-mounted equipment: Secure to concrete floor or foundation with expansion anchors.

M. Emergency lighting system: Install raceway and wiring for emergency lighting system in accordance with NEC Article 700.

N. Lighting controls:

1. Mount photocells facing north or upward and adjust to render insensitive to artificial lighting units.
2. Install occupancy sensors and ambient light sensor in accordance with manufacturer's installation procedures. Final adjustments of sensors shall be coordinated with User for proper settings.

O. Outdoor lighting system:

1. Wiring: Install in underground conduits.
2. Provide excavation for and underground wiring.

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- a. Excavate to depths indicated.
- b. Excavate by hand in areas near existing foundations and utilities.
- c. Backfill with materials from excavation, but exclude large stones, organic material, rubbish, and frozen material.
- d. Dispose of excess excavated material off Site.

END 26 50 00

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**Section 26 50 00 - Lighting**

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1. GENERAL

1.1 WORK INCLUDES

A. Base bid:

1. Electrical Fire Alarm Contractor
  - a. Manual fire-alarm boxes.
  - b. System smoke detectors.
  - c. Heat detectors.
  - d. Notification appliances.

1.2 RELATED DOCUMENTS

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

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

- A. Scope is limited to renovated areas only; scope includes removal, relocation and new devices installation (notification and initiation), interconnected to existing system.

1.5 INFORMATIONAL SUBMITTALS

A. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
  3. Trained and certified by manufacturer in fire-alarm system design.

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4. Licensed or certified by authorities having jurisdiction.

B. Product Data: For each type of product indicated.

1. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
2. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
  - a. Include voltage drop calculations for notification appliance circuits.
  - b. Include battery-size calculations.
  - c. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
  - d. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. Delegated-Design Submittal

1. For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - a. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
  - b. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

1.6 QUALIFICATIONS DATA: For qualified Installer.

A. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

B. Dimensioned Outline Drawings of Equipment Unit.

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1. Identify center of gravity and locate and describe mounting and anchorage provisions.
- C. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control reports.

1.7 OPERATION AND MAINTENANCE DATA:

- A. For fire-alarm systems and components 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. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
  2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
  3. Record copy of site-specific software.
  4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
    - a. Frequency of testing of installed components.
    - b. Frequency of inspection of installed components.
    - c. Requirements and recommendations related to results of maintenance.
    - d. Manufacturer's user training manuals.
    - e. Manufacturer's required maintenance related to system warranty requirements.
    - f. Abbreviated operating instructions for mounting at fire-alarm control unit.
    - g. Copy of NFPA 25.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

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- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm technician.
- C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
- D. 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. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.
  - 2. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.
  - 3. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FMG-approved alarm company.
  - 4. NFPA Certification: Obtain certification according to NFPA 72

**1.9 PROJECT CONDITIONS**

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
  - 1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
  - 2. Do not proceed with interruption of fire-alarm service without Architect's Construction Manager's and Owner's written permission.

**1.10 SEQUENCING AND SCHEDULING**

- A. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

**1.11 EXTRA MATERIALS**

N/A

2. PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices:
  - 1. Manual stations.
  - 2. Heat detectors.
  - 3. Smoke detectors.

2.3 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
- B. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit. Match existing.
- C. Station Reset: Key- or wrench-operated switch.

2.4 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
  - 1. Comply with UL 268; operating at 24-V dc, nominal.
  - 2. Detectors shall be four or two-wire type. Match existing system.
  - 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
  - 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.



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5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
8. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
9. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
10. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - a. Primary status.
  - b. Device type.
  - c. Present average value.
  - d. Present sensitivity selected.
  - e. Sensor range (normal, dirty, etc.).

2.5 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.

- C. Mounting: Adapter plate for outlet box mounting.
- D. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

## 2.6 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
- B. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
- C. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
- D. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.
- E. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
- F. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
- G. Rated Light Output:
  - 1. 15/30/75/110 cd, selectable in the field.
  - 2. Mounting: Wall mounted unless otherwise indicated.
  - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
  - 4. Flashing shall be in a temporal pattern, synchronized with other units.
  - 5. Strobe Leads: Factory connected to screw terminals.
  - 6. Mounting Faceplate: Factory finished, red.

3. EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
  - 1. Connect new equipment to existing control panel in existing part of the building.
  - 2. Connect new equipment to existing monitoring equipment at the supervising station.
  - 3. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
  - 4. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
  - 5. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

3.2 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Visual Inspection: Conduct visual inspection prior to testing.

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2. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
3. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
4. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
5. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
6. Test visible appliances for the public operating mode according to manufacturer's written instructions.
7. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
8. Fire-alarm system will be considered defective if it does not pass tests and inspections.
9. Prepare test and inspection reports.

3.4 DEMONSTRATION

N/A

END 28 31 11

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build Contractor.

1. Remove existing trees and other vegetation that are called out to be removed.
2. Protect of all other existing trees and other vegetation on and adjacent to the site.
3. Clearing and grubbing of obstructions, trees, shrubs, and other vegetation, including tree stump grinding, removal of roots and other debris.
  - a. Any chipping of removed tree branches to be stockpiled in areas approved by the User.
4. Stripping and stockpiling of topsoil or surplus topsoil.
5. Stripping and stockpiling of rock or surplus rock.
6. Remove existing above and below grade site improvements within the limits of the site.
7. Disconnecting, capping and/or sealing, and removing existing site utilities.
8. Furnish and install all required temporary soil erosion and sedimentation control (SESC) measures.

B. Alternate Bids: Alternate 1 (Remote Salt Storage) Design-Build Contractor.

1. Clearing and grubbing of obstructions, trees, shrubs, and other vegetation, including tree stump grinding, removal of roots and other debris.
  - a. Any chipping of removed tree branches to be stockpiled in areas approved by the User.
2. Furnish and install all required temporary soil erosion and sedimentation control (SESC) measures.

1.2 REFERENCES

- A. Standard Specifications for Road and Bridge Construction in Illinois (SSRBC) 2016 Edition, with Supplemental Specifications and Recurring Special Provisions adopted January 1, 2021 (Illinois Department of Transportation)

1.3 SUBMITTALS

A. SESC plan drawing(s).

2. PRODUCTS

2.1 Temporary Soil Erosion and Sedimentation Control (SESC) devices shall meet the requirements of IDOT SSRBC Article 1081.15.

3. EXECUTION

3.1 INSTALLATION

A. All work shall be performed in accordance with Division 200 of the IDOT SSRBC.

3.2 FIELD QUALITY CONTROL

A. Inspection Agency: Contractor engaged.

END 31 10 00

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build Contractor.

1. Rough grading of the site.
2. Preparing subgrades for slabs-on-grade, curb and gutter, sidewalks, pavements, and grasses.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Base course for concrete sidewalks.
6. Subbase course for asphalt paving.
7. Subsurface drainage backfill for walls and trenches.
8. Excavating and backfilling for utilities.

B. Alternate Bids: Alternate 1 (Remote Salt Storage) Design-Build Contractor.

1. Rough grading of the site.
2. Preparing subgrades for slabs-on-grade, curb and gutter, sidewalks, pavements, and grasses.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for asphalt paving.

1.2 REFERENCES

- A. Standard Specifications for Road and Bridge Construction in Illinois (SSRBC) 2016 Edition, with Supplemental Specifications and Recurring Special Provisions adopted January 1, 2021 (Illinois Department of Transportation)

2. PRODUCTS

- 2.1 Coarse aggregates permanently incorporated into the project shall come from an IDOT approved source and shall be in accordance with SSRBC Section 1004.

3. EXECUTION

3.1 INSTALLATION

- A. Subgrades, subbases, and base courses shall be installed per SSRBC Division 300.
- B. Coarse aggregates shall be installed per SSRBC Section 351.

END 31 12 00



1. GENERAL

1.1 PERFORMANCE REQUIREMENTS

A. Base Bid

1. Design-Build Contractor to design dewatering system(s).

B. Alternate Bids: Alternate 1 (Remote Salt Storage)

1. Design-Build Contractor to design dewatering system(s).

1.2 REFERENCES

- A. 00 31 32 – Geotechnical Data: Geotechnical report and soil boring data.

2. EQUIPMENT

- 2.1 All required pumping equipment shall be furnished by the Contractor.

3. EXECUTION

3.1 INSTALLATION

- A. Maintain groundwater level at a depth of 2 feet below bottom of excavation.

END 31 23 19

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DIVISION 31 – EARTHWORK  
**Section 31 50 00 – Excavation Support and Protection**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. Design-Build Contractor to design excavation support and protection.

1.2 REFERENCES

- A. Standards 29 CFR 1926.651 and 1926.652, US Department of Labor (DOL) - Occupational Safety and Health Administration (OSHA)

2. PRODUCTS

2.1 Structural steel.

2.2 Steel sheet piling.

2.3 Wood lagging: 3-inch nominal rough thickness.

2.4 Shotcrete.

2.5 Cast-in-place concrete.

2.6 Tiebacks.

3. EXECUTION

3.1 INSTALLATION

- A. All excavation support and protection systems shall be installed to meet OSHA requirements.

3.2 REMOVAL

- A. Remove all excavation support and protection systems before backfilling operations.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Contractor engaged.

END 31 50 00

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DIVISION 32 – EXTERIOR IMPROVEMENTS  
**Section 32 12 16 – Asphalt Paving**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build Contractor.

1. Furnishing, placing and proper compaction of hot-mix asphalt for roadway, parking lot, and driveway pavement.

B. Alternate Bids: Alternate 1 (Remote Salt Storage) Design-Build Contractor.

1. Furnishing, placing and proper compaction of hot-mix asphalt for parking lot pavement.

1.2 REFERENCES

A. Standard Specifications for Road and Bridge Construction in Illinois (SSRBC) 2016 Edition, with Supplemental Specifications and Recurring Special Provisions adopted January 1, 2021 (Illinois Department of Transportation)

2. PRODUCTS

2.1 Asphalt paving materials furnished shall be in accordance with SSRBC Section 1030.

A. Binder Course: IL-19.0, N50.

B. Surface Course: IL-9.5, N50.

3. EXECUTION

3.1 INSTALLATION

A. Asphalt paving shall be performed in accordance with SSRBC Section 406.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Contractor engaged.

END 32 12 16

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DIVISION 32 – EXTERIOR IMPROVEMENTS  
**Section 32 16 00 – Curbs, Gutters, Sidewalks, and Driveways**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build Contractor.

1. Furnishing and placing of Portland cement concrete (PCC) for curbs, gutters, sidewalks, and driveways.

1.2 REFERENCES

- A. Standard Specifications for Road and Bridge Construction in Illinois (SSRBC) 2016 Edition, with Supplemental Specifications and Recurring Special Provisions adopted January 1, 2021 (Illinois Department of Transportation)

2. PRODUCTS

2.1 All materials furnished shall be in accordance with the following:

- A. Portland cement concrete: SSRBC Section 1020.
- B. Steel Reinforcement: SSRBC Section 1006.

3. EXECUTION

3.1 INSTALLATION

- A. Curb and Gutter: Type B-6.12 combination curb and gutter, per SSRBC Section 606 and IDOT Highway Standard 606001-07.
- B. Sidewalk: per SSRBC Section 424.
- C. Driveways: per SSRBC Section 423.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor engaged.

END 32 16 00

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DIVISION 32 – EXTERIOR IMPROVEMENTS  
**Section 32 17 23 – Pavement Markings**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build Contractor.

1. Layout and painting of acrylic pavement markings.

1.2 REFERENCES

A. Standard Specifications for Road and Bridge Construction in Illinois (SSRBC) 2016 Edition, with Supplemental Specifications and Recurring Special Provisions adopted January 1, 2021 (Illinois Department of Transportation)

2. PRODUCTS

A. Pavement Marking Paint: Acrylic Type per SSRBC Section 1095.

3. EXECUTION

3.1 INSTALLATION

A. Pavement markings shall be painted per SSRBC Section 780.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Contractor engaged.

END 32 17 23

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DIVISION 32 – EXTERIOR IMPROVEMENTS  
**Section 32 39 13 – Manufactured Metal Bollards**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build Contractor.

1. Furnishing and installation of manufactured steel bollards.

B. Alternate Bids: Alternate 1 (Remote Salt Storage) Design-Build Contractor.

1. Furnishing and installation of manufactured steel bollards.

1.2 REFERENCES

A. ASTM A 36 – Standard Specification for Carbon Structural Steel

B. ASTM A500 – Standard Specifications for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

1.3 SUBMITTALS

A. Submit product data for each type of bollard, component, finish, and accessory specified.

2. PRODUCTS

2.1 Bollards:

A. Bollard shall be steel meeting the requirements of ASTM A36 with black powder coat over epoxy primer.

2.2 Bollard Covers:

A. Plastic bollard covers shall be high density polyethylene (HDPE) with a minimum tensile strength of 4,000 psi.

3. EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's installation instructions and setting drawings.

END 32 39 13

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DIVISION 32 – EXTERIOR IMPROVEMENTS  
**Section 32 92 00 – Turf & Grasses**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build Contractor.

1. Furnishing and installation of seeding with erosion control blanket or sodding.

1.2 REFERENCES

A. Standard Specifications for Road and Bridge Construction in Illinois (SSRBC) 2016 Edition, with Supplemental Specifications and Recurring Special Provisions adopted January 1, 2021 (Illinois Department of Transportation)

2. PRODUCTS

2.1 Seeding: IDOT Class 1 or 1A, per SSRBC Section 250 and Article 1081.04.

2.2 Sodding: Native or Salt Tolerant, per SSRBC Section 252 and Article 1081.03.

2.3 Erosion Control Blanket: Excelsior or knitted straw blanket per SSRBC Articles 251.04 and 1081.10.

3. EXECUTION

3.1 INSTALLATION

A. Seeding: per SSRBC Section 250.

B. Sodding: per SSRBC Section 252.

C. Erosion Control Blanket: per SSRBC Section 251.04.

END 32 92 00

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1. GENERAL

1.1 WORK INCLUDES

A. Base Bid: Design-Build Contractor responsible for furnishing, installation, and testing of the following items:

1. Underground domestic and fire protection water pipes and fittings.
2. Pressure connection.
3. Valve box.

1.2 REFERENCES

A. Standard Specifications for Water and Sewer Construction in Illinois (SSWSC), 8<sup>th</sup> Edition / 2020 (Standard Specifications Committee)

1.3 SUBMITTALS

- A. General: Contractor shall submit product specifications, technical data, standard detail drawings, and installation instructions from the manufacturer of each component.
- B. Fire Protection: Contractor shall submit product specifications, technical data, standard detail drawings, and installation instructions from the manufacturer of each component. Make simultaneous submittal directly to insurance underwriter of User and authorities having jurisdiction over the Work.
- C. Test Reports: Submit reports for all required testing performed per the SSWSC and IEPA requirements.

2. PRODUCTS

2.1 Domestic Water Main Piping:

A. Ductile Iron, Class 52.

2.2 Pressure Connection:

- A. Tapping Sleeve.
- B. Resilient Wedge Gate Valve.
- C. Valve Box.

3. EXECUTION

3.1 INSTALLATION

- A. All water utility work shall be performed in accordance with SSWSC Division IV.

3.2 FIELD QUALITY CONTROL

- A. Inspection Agency: Contractor engaged.

END 33 10 00



1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design-Build Contractor responsible for furnishing, installation, and testing sanitary sewerage piping.

1.2 REFERENCES

- A. Standard Specifications for Water and Sewer Construction in Illinois (SSWSC), 8<sup>th</sup> Edition / 2020 (Standard Specifications Committee)

1.3 SUBMITTALS

- A. General: Contractor shall submit product specifications, technical data, standard detail drawings, and installation instructions from the manufacturer of each component.
- B. Test Reports: Submit reports for all required testing performed per SSWSC Division III.

2. PRODUCTS

2.1 Sanitary Sewerage Piping

- A. Polyvinyl Chloride (PVC), SDR26 with elastomeric seals per ASTM D3212.

3. EXECUTION

3.1 INSTALLATION

- A. All sanitary sewerage piping work shall be performed in accordance with SSWSC Division III.

3.2 FIELD QUALITY CONTROL

- A. Inspection Agency: Contractor engaged.

END 33 31 00

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1. GENERAL

1.1 WORK INCLUDES

- A. Base Bid: Design-Build Contractor responsible for furnishing, installation, and testing stormwater piping, structures, frames, and grates.

1.2 REFERENCES

- A. Standard Specifications for Water and Sewer Construction in Illinois (SSWSC), 8<sup>th</sup> Edition / 2020 (Standard Specifications Committee)

1.3 SUBMITTALS

- A. General: Contractor shall submit product specifications, technical data, standard detail drawings, and installation instructions from the manufacturer of each component.

2. PRODUCTS

2.1 Storm Sewer Piping

- A. Reinforced concrete pipe (RCP) per ASTM C76, Class IV with flexible gaskets per ASTM C443 .

3. EXECUTION

3.1 INSTALLATION

- A. All storm sewerage piping work shall be performed in accordance with SSWSC Division III and SSRBC Section 550.

3.2 FIELD QUALITY CONTROL

- A. Inspection Agency: Contractor engaged.

END 33 42 00

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DIVISION 33 – UTILITIES  
**Section 33 71 49 – Medium Voltage Cable and Accessories**

1. GENERAL

1.1 SECTION INCLUDES

- A. Base Bid: Design-Build Contractor to provide medium-voltage cable and related splices, terminations, and accessories for cables rated at or above 2001 volts and at or below 35 kV.

1.2 WORK BY OTHERS

- A. Receiving, unloading and storing of cable.
- B. Installation and termination of cable.
- C. Quality assurance data:
  - 1. Certified manufacturer test reports in accordance with AEIC and ICEA.
  - 2. Cable test data report in accordance with AEIC and ICEA for each lot and type of cable.
  - 3. Pulling tension and side wall pressure calculations if requested by Engineer.
  - 4. Submit documented installer experience if requested by Engineer.

1.3 INFORMATIONAL SUBMITTALS

- A. Submit with Bid for each cable type supplied:
  - 1. Completed Data Sheets.
  - 2. Cable damage curves.
  - 3. List of recommended cable pulling lubricants.

1.4 ACTION SUBMITTALS

- A. Shop Drawings:
  - 1. Completed and updated Data Sheets.
  - 2. Detailed drawings and manufacturer information for accessories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance manuals. Provide at a minimum:

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**Section 33 71 49 – Medium Voltage Cable and Accessories**

1. General description and technical data.
2. List accessories supplied, listing manufacturer, model number and operating ranges.
3. Receiving, storage, installation, and testing instructions.
4. Complete documentation of inspections and tests performed, including logs, curves, and certificates.

**1.6 QUALITY ASSURANCE**

- A. Installer qualifications: Installer shall have minimum of 10 years documented experience as an installer of medium-voltage electrical systems, medium-voltage cable, and medium-voltage terminations and splices.
- B. Manufacturer's qualifications:
  1. Manufacturer of cable and any accessories shall be ISO certified.
  2. Manufacturer shall have produced similar equipment for a minimum period of 5 years.
  3. When requested by Engineer, provide acceptable list of similar equipment installations complying with requirements of this Section.
- C. Regulatory requirements:
  1. Cables and accessories shall be in accordance with applicable standards.
    - a. Armored and unarmored shielded power cable ICEA S-93-639 and NEMA WC74.
    - b. IEEE 383, ASTM B3 and B8, UL 1072.
    - c. NETA Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
    - d. AIEC CS6.
    - e. IEEE 48 and IEEE 386.
  2. Standards of foreign organizations shall not be used without written approval from Engineer.
- D. Cable shall not have had more than 1 year elapse from date of manufacture to date of delivery to job Site.

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**Section 33 71 49 – Medium Voltage Cable and Accessories**

- E. Testing services: Employ and pay for services of qualified independent testing agency to perform field quality control testing. Test equipment shall be calibrated within 3 months prior to cable test date. Certified test reports shall be furnished to User. Interpretation of test results with regards to compliance to this specification shall accompany test reports.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Coordinate transportation with requirements of pertinent authorities.
- B. Cover and protect cable and accessories from damage during shipment.
- C. Dispose of nonreturnable reels. Return recyclable reels to cable manufacturer.
- D. Ensure reel lengths accommodate continuous pull lengths required. Splicing not allowed unless specifically shown on Drawings.
- E. Cable ends on cable reels shall be available for testing. Cable ends, whether exposed or concealed, shall be sealed with heat shrinkable caps. Cap sizes shall be as recommended by cap manufacturer for cable OD and insulation. Caps shall contain sufficient adhesive so shrinkage of cap during application result in formation of positive water seal capable of withstanding complete immersion or totally exposed storage over a period of several months without permitting entrance of moisture.
- F. Prepare detailed packing lists and shipping notification for items shipped.

**2. PRODUCTS**

**2.1 SYSTEM DESCRIPTION**

- A. Components may include, but are not limited to:
  - 1. Tape.
  - 2. Break out boots.
  - 3. Lugs and termination kits.
  - 4. Strain relief devices.
  - 5. Splices.
- B. Asbestos in any form is prohibited from cable, including fillers and binding tapes even if encapsulated or if asbestos fibers are impregnated with binder material.

**2.2 POWER CABLE**

**A. Single-conductor and multi-conductor, unarmored:**

1. Conductor material: In accordance with Data Sheet.
2. Stranding: Class B.
3. Cable sizes and types: In accordance with Data Sheet.
4. Insulation levels and voltage classes: in accordance with Data Sheet.
5. Temperature: 105°C continuous; 140°C emergency; and 250°C short circuit.
6. Conductor semi-conductor shield: Extruded semi-conducting, thermosetting polymeric layer over conductor applied in tandem with and firmly bonded to insulation, and shall be free stripping from conductor.
7. Conductor insulation: in accordance with Data Sheets. If specified on Data Sheets, provide ethylene propylene rubber (EPR) with minimum dielectric strength of 3.2 and minimum impulse strength of 1,500 V/mil.
8. Insulation semi-conductor shield: Cover insulation with extruded semi-conducting thermosetting material.
9. Metallic shield: In accordance with Data Sheet. Tape shields shall be helically applied, minimum 5-mil, nonmagnetic, uncoated copper tape over insulation with minimum lap of 12.5%. Apply binder tape and jacket to meet NEC Article 318, on sizes No. 1/0 AWG and larger.
10. Jacket: Provide in accordance with Data Sheet.
11. Multiconductor cable shall be rounded with nonhygroscopic fillers. Solid, extruded fillers not permitted. Install grounding conductor in one outer filler interstice and cover with binder tape.
12. Cable shall be rated for use in cable tray, aerial, direct burial, conduit, and underground duct installations. Cables smaller than No. 1/0 AWG (70 mm<sup>2</sup>) shall be provided in multiconductor cable either 3/C or 4/C with ground.
13. Cable assemblies shall be tested and shall pass ICEA 70,000 Btu/hr and 210,000 Btu/hr vertical tray flame tests.

**B. Multiconductor, armored:**

1. Conductor material: In accordance with Data Sheet.
2. Stranding: Compact, Class B.



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3. Cable size and type: In accordance with Data Sheets.
4. Ground conductor: Class B compressed concentric stranded bare copper.
5. Insulation level and voltage class: In accordance with Data Sheets.
6. Temperature: 105°C continuous, 140°C emergency and 250°C short circuit.
7. Conductor shield: Extruded semi-conducting, thermosetting polymeric layer over conductor applied in tandem with and firmly bonded to insulation, and shall be free stripping from conductor.
8. Conductor insulation: In accordance with Data Sheets. If specified on Data Sheets, provide ethylene propylene rubber (EPR) with minimum dielectric strength of 3.2 and minimum impulse strength of 1,500 V/mil.
9. Insulation shield: Cover insulation with extruded semi-conducting thermosetting material.
10. Armor: Single strip of interlocked or continuously welded and corrugated aluminum armor applied over cable assembly.
11. Armor jacket: Sunlight-resistant, red or yellow PVC conforming to IEEE 1202 and ICEA T-29-520 vertical cable tray flame tests.
12. Multiconductor cable shall be rounded with nonhygroscopic fillers. Solid, extruded fillers not permitted. Install grounding conductor in one outer filler interstice and cover with binder tape.
13. Cable shall be rated for installation in cable tray.

**2.3 CABLE MARKING**

- A. Surface print each length of conductor or cable at least every 3' (1 m) with:
  1. Voltage rating.
  2. Conductor size.
  3. Conductor quantity.
  4. Conductor material.
  5. Insulation type.
  6. Manufacturer's identification.
  7. Running length of cable.

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**Section 33 71 49 – Medium Voltage Cable and Accessories**

B. Permanently attach metal tags to both sides of each cable reel displaying:

1. Manufacturer.
2. Date of manufacture.
3. Job order number.
4. Unique reel identification number.
5. Purchaser's name.
6. Voltage rating.
7. Conductor size.
8. Conductor quantity.
9. Feet on reel.
10. As shipped weight of cable and reel.

**2.4 SPLICING**

- A. Splices not allowed unless specifically shown on Drawings.
- B. Splice kits: 3M “Cold Shrink” for shielded cable or as recommended by manufacturer for specific application.
- C. Use compression-type, 2-hole lugs with corrosion-resistant bolting material or compression barrel connectors.
- D. Shield shall be appropriately connected at splice to provide continuous shield for complete cable installation.

**2.5 TERMINATIONS**

- A. Design terminations for shielded cables and include shield ground strap. Only Class 1 terminations acceptable.
- B. Termination kits: 3M “Cold Shrink” silicon rubber; compression-type connectors and lugs. Field-verify lug type and arrangement with equipment configurations.

**2.6 UNDERGROUND WARNING TAPE**

- A. Use: Underground installation including direct-buried cable, direct-buried conduit and concrete-encased duct banks.
- B. Type and size: Permanent, vinyl; not less than 6” wide x 4 mils thick (150 mm wide x 0.102 mm thick).

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- C. Compounded for permanent direct-burial service.
- D. Embedded continuous metallic strip or core.
- E. Printed legend shall indicate type of underground line.

**2.7 SOURCE QUALITY CONTROL**

- A. Factory-test cables in accordance with AEIC CS6.
- B. Submit certificate of compliance and manufacturer's test reports showing results of tests required by AEIC CS6. Reports shall include reel numbers for tests performed on each length of completed cable.
- C. Include manufacturer's flame test data in test reports. Prototype data is acceptable instead of flame testing, as long as conductor size, insulating and jacketing materials, and insulation and jacket thickness are same as worst-case flame test configuration being provided.

**3. EXECUTION**

**3.1 INSTALLATION**

- A. Install in accordance with manufacturer's recommendations, IEEE 576 and Section 26 05 00.
- B. Perform pulling tension and side wall pressure calculations for each pull. If requested by Engineer, submit data verifying compliance with manufacturer's recommendations.
- C. Support cables in accordance with requirements of NEC.
- D. Install direct-buried cables in minimum 3" (80 mm) thick bed of clean sand. Separate multiple sets of 3-phase cables by minimum of 4" (105 mm).
- E. Place underground warning tape 6" to 12" (150 mm to 300 mm) above electrical lines.
- F. Install underground cables with minimum earth cover to final grade in accordance with NEC requirements.
- G. Cable installed underground in cable vaults, manholes, and hand holes shall have arc-proof taping installed for additional protection. Clean cable sheath and apply half-lap layer of tape. Secure with electrical tape in accordance with manufacturer's instructions.
- H. Unarmored cable installed in cable tray shall transition out of cable tray by use of conduit or wireway, or as allowed by the NEC. Armored cable may transition

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out of cable tray without use of conduit or wireway as long as it is supported by approved methods. Cable glands shall be used where conduit or wireway is not provided.

I. Cable in cable tray:

1. Install single conductor cables in triplexed or quadriplexed configuration. Maintain free air space minimum  $2.15 \times$  cable OD of largest conductor in group and adjacent conductor configurations or cable. Refer to corresponding sections of NEC for acceptable ampacity tables.
2. Install multiconductor cables with maintained spacing of not less than one cable diameter of largest cable, between cables.

J. Terminations and shields.

1. Install terminations at ends of conductors with standard kits. Comply with kit manufacturer's written instructions and with classes of terminations indicated.
2. Provide break out boots for multiconductor cables.
3. Connect shield ground strap to cable shield after cable passes through ground sensors. Route ground shield strap back through ground sensor to cancel effect of circulating currents.
4. Connect shields to ground on both ends of cable. Connection of shield to a shield ground strap shall be with solder and mechanical clamp.

K. Provide cable tagging including phase indication and cable number identification in accordance with Section 26 05 00.

L. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cable through walls by longest route from entry and exit. Support cables at intervals adequate to prevent sag.

M. Install cable accessories in accordance with manufacturer's recommendations and as shown on Drawings.

N. Use heat shrinkable caps for storing unused cable.

3.2 FIELD QUALITY CONTROL

A. Cable insulation test: Conductors with insulation rated 5,000 volts and above shall be given high-voltage dc insulation test (Hi-Pot).

1. Ampacity of direct current testing equipment shall be at least 2,500 microamperes.

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2. Final test voltages and duration of test shall be in accordance with cable manufacturer's recommendations.
  3. Test procedures shall conform to IEEE STD 400.
  4. Competent personnel specializing in electrical cable testing shall perform tests.
  5. Perform test on completed cable installation. Perform test done after installation of termination kits and splice kits. Cable shall be isolated from equipment.
- B. If equipment or system fails to function properly, make necessary corrections, including replacement, at no cost to User, and after such corrections are completed, demonstrate to Engineer that equipment or system functions properly.

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**Section 33 71 49 – Medium Voltage Cable and Accessories**

<b>DATA SHEETS MEDIUM-VOLTAGE CABLE</b>		<b>Equipment Name:</b>	
		<b>Tag No.:</b>	<b>Ref. No.:</b>
<b>DESCRIPTION</b>	<b>UNITS</b>	<b>SPEC DATA</b>	<b>VENDOR DATA</b>
Cable Manufacturer	-	By Manufacturer	
Cable Catalog No.	-	By Manufacturer	
Location of Manufacturer	-	By Manufacturer	
Voltage Class (5, 8, 15, 25, 35)	kV	5	
Temperature: MV-90 or MV-105	-	MV-105	
Voltage Insulation Level: 100% or 133%	%	133	
Conductor			
Conductor Size	kcmil or AWG	See Drawings	
Conductor Material	Cu/Al/Tinned Cu	Cu	
Conductors per Cable: (1/C, 3/C or 4/C)	#/C	1/C	
Ground Conductor			
Conductor Size	kcmil or AWG		
Conductor material	Cu/Al/Tinned Cu	Cu	
Shield			
Shield material	Cu/Al/Tinned Cu	Cu	
Tape or wires	-	Tape	
Size	-	5 mil	
Insulation type	-	EPR	
Jacket type	-	CSPE	
Armored	Y/N	N	
Rated for Installation in Cable Tray (CT Rated)	Y/N	Y	
Cable O.D.	in.	By Manufacturer	
Weight	lb/1000'	By Manufacturer	
Insulation thickness	in.	By Manufacturer	
Jacket thickness	in.	By Manufacturer	
Maximum pulling tension per cable	lb.	By Manufacturer	
Maximum sidewall bearing pressure	lb.	By Manufacturer	
Minimum bending radius	in.	By Manufacturer	
Maximum reel length available	ft.	By Manufacturer	
<b>Accessories:</b>			
Splice Kits			
Required	Y/N	N	
Manufacturer and Model Number	-		
Lugs			
Required	Y/N	Y	
Manufacturer and Model Number	-	By Manufacturer	
Termination Kits			
Required	Y/N	Y	
Manufacturer and Model Number	-	By Manufacturer	

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**Section 33 71 49 – Medium Voltage Cable and Accessories**

<b>DATA SHEETS</b> <b>MEDIUM-VOLTAGE CABLE</b>	Equipment Name: Tag No.:                      Ref. No.:		
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
Special Requirements:			

END 33 71 49

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1. GENERAL

1.1 SECTION INCLUDES

- A. Base Bid: Design-Build Contractor provide 3-phase, liquid-filled, pad-mounted, compartmental, power distribution transformers up to 2,500 kVA.

1.2 INFORMATIONAL SUBMITTALS

A. Submit with Bid:

- 1. Completed Data Sheets.
- 2. Product data sheets for each transformer, components, and accessories.

B. Product Data:

- 1. List of special equipment required for installation, operation, and maintenance of transformer.
- 2. List of recommended “start-up” and “running” spare parts and prices, as well as maintenance tools for each type of transformer.
- 3. Recommended long term and short term storage requirements and procedures.
- 4. Complete Bill of Material.
- 5. List of items requiring field installation.

C. Quality assurance data:

- 1. Certified shop test reports.
- 2. Copies of warranties.

1.3 ACTION SUBMITTALS

A. Shop Drawings:

- 1. Updated, complete, and accurate Data Sheets.
- 2. Certified drawings with dimensional data, outlines, elevations, general arrangement, centerline dimensions to bushings, anchor details, and foundation arrangement. Drawings shall provide complete and accurate information for design of transformer pad and anchoring details.

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**Section 33 73 29 – Pad Mounted Transformer**

3. Location of control cabinets and conduit exit/entrance locations, and locations of external connections shall be provided, dimensioned from equipment centerlines and bottom of base.
4. Schematic and wiring diagrams showing tap arrangements and wiring of accessories, including cable terminal sizes or dead-front elbow information.
5. Nameplate diagram.
6. Complete list of equipment proposed, including model numbers and description for bushings, fuses, switches, etc. Specific model number and technical information for proposed bushings.
7. Information as defined in ANSI C57.12.00, Section 10.
8. Guaranteed loss data including load, no-load and cooling losses.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance manuals. Provide as a minimum:

1. General description and technical data, including actual weights and dimensions.
2. Complete Bill of Material.
3. Receiving, storage, installation, handling and testing instructions.
4. Operating and maintenance procedures.
5. Complete set of reviewed drawings that require no further action.
6. Updated Data Sheets modified to include field installation conditions.
7. Complete documentation of inspections and tests performed, including logs, curves, and certificates. Documentation shall note any replacement of equipment or components that failed during testing.
8. Recommended spare parts list. Bushings shall be included on spare parts list with breakout price.
9. Nameplate information and shop order numbers for each item of equipment furnished.

1.5 MAINTENANCE MATERIALS

- A. Provide complete set of special tools required for installation and maintenance for each piece of equipment furnished. Tools and their intended use shall be identified in assembly instructions.

1.6 QUALITY ASSURANCE

- A. Manufacturer qualifications: Manufacture major components of transformer, ISO compliant, and shall have produced similar equipment for a minimum period of 5 years.
- B. Regulatory requirements:
  - 1. Transformers shall be in accordance with applicable requirements of ANSI C57.12.00, C57.12.26, C57.12.22, C57.12.28, C57.12.90, and C57.91.
  - 2. Transformers with a kVA rating smaller than 167 kVA, IEEE/ANSI C57.12.25 shall apply.
  - 3. Standards of foreign organizations shall not be used without written approval from Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate transportation with requirements of pertinent authorities.
- B. Ship equipment completely assembled including bushings. Contractor shall detail field assemblies, as required.
- C. Oil or liquid shall be shipped in transformer tank.
- D. During delivery and storage, handle equipment carefully to prevent damage, denting, or scoring.
- E. Store transformers and components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

1.8 WARRANTY

- A. Unless requested otherwise, provide manufacturer's standard warranty. Warranty shall be no less than 1 year from date of energization.

2. PRODUCTS

2.1 MANUFACTURERS

- A. ABB.
- B. Cooper Power Systems.
- C. Waukesha.
- D. Cutler Hammer.
- E. Virginia Transformers.

## 2.2 ENCLOSURE

- A. Locate full height, high-voltage and low-voltage cable terminating compartments side-by-side. Grounded steel barrier shall separate compartments.
- B. Each terminating compartment shall have a separate door designed such that access to high-voltage compartment is available only after low-voltage compartment has been opened. Provide an additional fastening device accessible only after low-voltage door has been opened, which must be removed to open high-voltage door. Mount doors flush with cabinet frame.
  - 1. Low-voltage door shall have handle-operated, 3-point latching mechanism secured with single padlock. Hex-head bolt shall be used on low-voltage compartment door.
  - 2. Equip high- and low-voltage doors with lift-off type stainless steel hinges and doorstops to secure in open position.
  - 3. Compartment sills, doors, and covers shall be removable to facilitate cable pulling and installation.
- C. Cabinet security shall meet NEMA Standards Publication for Transformers, Regulators and Reactors, NEMA TR-1 and ANSI C57.12.28.
- D. Size compartments, at minimum, to dimensions of ANSI C58.12.25 or C57.12.26. Compartments shall be large enough to accommodate cable terminations and cable terminating devices including stress cones and elbows.
- E. Tank and compartments shall be an integral unit suitable for flush mounting on a pad and capable of anchoring to bolts, or welding to embedded steel channel. Four lifting lugs shall be integral to entire assembly.
- F. Furnish grounding provisions in both compartments.

## 2.3 TANK

- A. Main tank shall be of sealed-tank construction designed to withstand a pressure of 7 psig without permanent deformation. Where high molecular

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**Section 33 73 29 – Pad Mounted Transformer**

weight hydrocarbon or silicone fluids are used shall be manufactured to withstand 12 psig without rupture.

B. Tank covers:

1. Transformers rated 45-1,000 kVA: Bolted cover for tank access, bolts shall be concealed by cover-guards accessible only from inside of cabinet and be supplied with tamper-resistant access handholes sized to allow access to internal bushing and switch connections.
  2. Transformer rated 1,500 – 7,500 kVA: Welded cover with handholes.
- C. Construction shall be of cold-rolled or carbon steel plate with seams and joints continuously welded on inside and outside of joints.
- D. Construct base to permit rolling or sliding in any direction perpendicular to a tank wall.
- F. E. Tank cover shall be domed to facilitate moisture run-off.
- G. Transformer shall remain effectively sealed for a top oil temperature of -5°C thru 105°C.
- H. Transformer tank shall meet requirements outlined in ANSI C57.12.25 or C57.12.26.

2.4 INSULATING FLUID

- A. Conform to requirements of ASTM D3487 and test in accordance with ASTM D117.
- B. Certify that transformer is nonPCB containing no detectable PCBs.
- C. Transformer shall be vacuum-filled with appropriate fluid. Process shall be of sufficient vacuum and duration so core and coil assembly is free of moisture prior to filling tank.

2.5 RADIATORS

- A. Each radiator assembly shall be individually welded and receive a quality control pressurized check for leaks. Entire tank assembly shall receive similar leak test before tanking. Final 6-hour leak test shall be performed.
- B. Provide lifting eyes on each radiator to facilitate removal of radiators. Drain valves shall be provided.

**2.6 CORE AND COIL**

- A. Coil windings shall be 2-winding type, designed to reduce losses. High-voltage and low-voltage conductor shall be copper.
- B. Percent impedance voltage, as measured on rated voltage connection, shall be in accordance with ANSI C57.12.26, with tolerances as specified in ANSI C57.12.00.
- C. Core material shall be high-grade, grain-oriented, nonaging silicon core steel with high magnetic permeability, low hysteresis, and eddy current losses. Keep magnetic flux densities well below saturation to allow for minimum of 10% overvoltage excitation.
- D. Core and coils shall withstand normal moving and handling without use of special shipping braces.
- E. Design and manufacturer core and coil assembly to meet short-circuit requirements of ANSI C57.12.90. Brace to withstand short-circuit forces without damage or displacement of coil on core limited only by transformer impedance.
- F. Maximum loading capabilities shall be in accordance with ANSI C57.
  - 1. Tap changers, terminals, leads, and other ancillary equipment shall not restrict loading.
  - 2. Transformer windings shall be limiting part during overload.
- G. Grounded wye to grounded wye transformers shall be designed with a 5 legged, distributed gap, wound core designed with low flux density to reduce noise.

**2.7 SOUND LEVEL**

- A. Meet sound level standards for liquid filled transformers as defined by NEMA and ANSI.
- B. Audible sound level for transformers shall not exceed values given in NEMA TR 1 when measured in factory in accordance with NEMA TR 1 test code.

**2.8 CONNECTORS AND TERMINALS**

- A. High-voltage line and neutral bushings shall be externally removable and clamped, suitable for cable sizes and quantities as required. Dead front: Epoxy bushing wells with load-break inserts and elbows.

- B. Low-voltage line and neutral bushings shall be molded epoxy with NEMA standard spade terminals.
- C. Electrical characteristics of completely assembled, high-voltage connectors shall be as indicated in ANSI C57.12.25 or C57.12.26.
- D. Insulation class shall not be less than that of winding to which connected.
- E. Quantity, location, and arrangement of high-voltage and neutral connectors and low-voltage and neutral terminals shall conform to ANSI C57.12.25 or C57.12.26.

## 2.9 TAPS

- A. Furnish high-voltage full-capacity taps with a de-energized tap changing mechanism. Tap changer shall be externally operable from tank and located within one of lockable compartments.

## 2.10 HIGH-VOLTAGE SWITCHING

- A. Where radial or loop feed system switch is specified on Data Sheets, provide oil-immersed, 3-phase, gang-operated, switch with spring-loaded mechanism for load break and latch operation. Switch shall be mounted near core and coil assembly.
  - 1. Radial feed: 2-position.
  - 2. Loop feed: 4-position.

## 2.11 HIGH-VOLTAGE FUSING

- A. When specified on Data Sheets, provide overcurrent protection as follows:
  - 1. Protective fuse link: Internal, oil-immersed, expulsion-type. Sized to operate only in event of an winding failure and isolate transformer high voltage side from source.
  - 2. Expulsion type fuse: Bayonet type, oil immersed, and drawout for replacement. Hookstick operable load-break design available for either overload or fault sensing as specified.
  - 3. Current-limiting fuses: Air-immersed in drywell canisters, dead-break drawout for replacement and hookstick operable. Limits both current magnitude and energy associated with low impedance faults. Effective for minimizing probability of tank rupture.

4. Partial range current limiting fuses: Oil-immersed, internally block mounted. Applied in series with expulsion-type fuse. Protects against tank rupture.

## 2.12 IDENTIFICATION AND TAGGING

- A. Transformer shall be furnished with stainless steel nameplates attached with stainless steel screws or pins in locations clearly visible and readable without requiring unsafe condition. Where nameplate is mounted on removable part, manufacturer's name and transformer serial number shall be permanently affixed to nonremovable part of transformer.
- B. Nameplate shall contain standard information in accordance with IEEE/ANSI C57.12.01 and additional information as specified below:
  1. Year of manufacture.
  2. Certification that transformer is nonPCB as defined in ASTM D4059.
  3. Job site temperature.
- C. Affix nonPCB decal adjacent to each drain valve.
- D. Each internal interconnecting wire shall be identified at both ends with sleeve type wire markers. Markers shall be labeled with from and to information.

## 2.13 ARRESTERS

- A. Live front designs shall have mounting nuts welded on tank wall for arrester mounting.
- B. Dead front arresters shall not hinder dead front construction in cabinet and usable wherever a load-break elbow can be used.
- C. Furnish distribution class surge arresters when specified.

## 2.14 SOURCE QUALITY CONTROL

- A. Perform standard factory tests as indicated in ANSI/IEEE C57.12.00. Tests shall be in accordance with latest applicable ANSI and NEMA standards and performed at rated frequency specified in Data Sheets.
- B. Test results shall be tabulated, submitted, and approved by User prior to shipment.
- C. Defects and defective equipment revealed or noted during testing shall be corrected prior to shipment.



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- D. Jacking points shall be at minimum dimension of 18" (450 mm) from floor line.

3. EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Provide 4" (100 mm) high housekeeping pad under each indoor transformer, unless indicated otherwise. Level pad such that transformer can be installed directly on top of pad without additional leveling. Provide anchors and other required hardware. Follow manufacturer's instructions for anchoring in place.
- C. Make connections to ground grid using fittings designed and rated for intended use.

3.2 FIELD QUALITY CONTROL

- A. Testing of transformer shall be performed by a qualified testing agency. Tests shall include:
  - 1. Measure primary and secondary voltages for proper tap settings.
  - 2. Megger primary and secondary windings.
  - 3. Test insulating liquid for proper di-electric strength.

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<b>DATA SHEETS</b>		<b>Equipment Name:</b>	
<b>PAD-MOUNTED TRANSFORMER</b>		<b>Tag No.:</b>	
<b>Description:</b>	<b>UNITS</b>	<b>SPEC DATA</b>	<b>VENDOR DATA</b>
Manufacturer	N/A	By Manufacturer	
Catalog/Serial No.	N/A	By Manufacturer	
<b>Site Information:</b>			
Installation Location (Indoor or Outdoor)	-	Outdoor	
Maximum Ambient Temperature	Deg. C	40	
Minimum Ambient Temperature	Deg. C	-35	
Elevation Above Sea Level (Installed)	Ft	<3300	
Corrosive Environment	Y/N	N	
Seismic Zone	-		
<b>Ratings:</b>			
Design Temperature Rise Above Ambient	Deg. C	By Manufacturer	
Base Rating (ONAN)	kVA	750	
Frequency	Hz	60	
Winding Material	Cu	Cu	
<b>HV Terminals:</b>			
Rated Voltage (Nominal)	kV	2.4	
Basic Impulse Level	kVBIL	60	
Connection	Delta/wye	Delta	
<b>LV Terminals:</b>			
Rated Voltage (Nominal)	V	0.480	
Basic Impulse Level	kVBIL	N/A	
Connection	Delta/wye	Wye, solid ground	
Design Impedance at Rated Nominal Voltage	Z%	ANSI Standard	
X/R Ratio	-	By Manufacturer	
Angular displacement	-	ANSI Standard	
Tap Location	HV/LV	By Manufacturer	
Steps Above Nominal	Qty x +%	2 x +2.5%	
Steps Below Nominal	Qty x -%	2 x -2.5%	
Sound Level at 100% of Max. 65 deg C kVA Rating	dBA	By Manufacturer	
<b>Design:</b>			
<b>HV Design:</b>		See one-line Diagrams	
Loop or Radial Feed	-		
Dead Front	Y/N		
Cable Entry Location	-	See one-line Diagrams	
Cable Size and Qty	-	See one-line Diagrams	
HV Neutral Terminal	Y/N		
<b>LV Design:</b>		See One-line Diagrams	
Cable Entry Location	-	See one-line Diagrams	
Cable Size and Qty	-	See one-line Diagrams	
LV Neutral Terminal	Y/N		
<b>Guaranteed Efficiency At 65°C :</b>			
At 100% of Maximum kVA	%	By Manufacturer	
At 75% of Maximum kVA	%	By Manufacturer	
At 50% of Maximum kVA	%	By Manufacturer	
Voltage Regulation at 100% of kVA Rating:			
Guaranteed Losses at 100% Rated Voltage:			

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<b>DATA SHEETS</b>		<b>Equipment Name:</b>	
<b>PAD-MOUNTED TRANSFORMER</b>		<b>Tag No.:</b>	
<b>Description:</b>	<b>UNITS</b>	<b>SPEC DATA</b>	<b>VENDOR DATA</b>
No Load Losses	kW	By Manufacturer	
Load Losses	kW	By Manufacturer	
Transformer Fluid:			
Type	-	FR3	
Quantity Gallons	gal	By Manufacturer	
Color Preference	-	Standard	
<b>Oil:</b>			
Total Gallons in System	gal	By Manufacturer	
Qty Shipped Separately	gal	By Manufacturer	
Weight of Oil as Shipped	lbs.	By Manufacturer	
Proposed Method of Oil Shipment	-	By Manufacturer	
<b>Shipping:</b>			
Dimensions ( L x W x H)	in.	By Manufacturer	
Weight:		By Manufacturer	
Fluid	lbs.	By Manufacturer	
Transformer Without Fluid	lbs.	By Manufacturer	
Total Shipping Weight	lbs.	By Manufacturer	
Method of Shipment	-	By Manufacturer	
<b>Accessories:</b>			
Stainless Steel Nameplate	Y/N	Y	
Dial-Type Thermometer	Y/N	Y	
Liquid Level Gage	Y/N	Y	
Pressure-Vacuum Gage	Y/N	Y	
1" Drain Valve w/ Sampling Device	Y/N	Y	
Pressure relief Device	Y/N	Y	
NonPCB labels	Y/N	Y	
1" Upper Fill Connection	Y/N	Y	
<b>Options:</b>			
HV Surge Arresters	Y/N	N	
High Voltage Switch	Y/N	N	
Amp Rating	A		
Switch Configuration (2 or 4 position)	Ea		
HV Fusing:			
Integral Fusing: (Select One)			
Fuse Links	Y/N	N	
Expulsion Type	Y/N	N	
Current Limiting	Y/N	N	
Partial Range/Expulsion Type	Y/N	N	
External Fuses	Y/N	N	
External LV Molded Case Circuit Breaker	Y/N	N	
Current Transformers:			
HV External CTs:	Y/N	N	
Quantity Per Phase	No.		
Ratio	A/A		
Accuracy	Class		
LV External CTs:	Y/N	N	

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<b>DATA SHEETS</b>		<b>Equipment Name:</b>	
<b>PAD-MOUNTED TRANSFORMER</b>		<b>Tag No.:</b>	
<b>Description:</b>	<b>UNITS</b>	<b>SPEC DATA</b>	<b>VENDOR DATA</b>
Quantity Per Phase	No.		
Ratio	A/A		
Accuracy	Class		
Fault Indicators	Y/N	N	
Revenue Metering	Y/N	N	
Revenue Meter Manufacturer	-		
Revenue Meter Model Number	-		
<b>Installation:</b>			
Manufacturer Furnished and Installed	Y/N	N	
User Furnished / User Installed	Y/N	N	
User Furnished / Contractor Installed	Y/N	N	
Contractor Furnished / Contractor Installed	Y/N	Y	
Contractor Furnished / User Installed	Y/N	N	
<b>Special Requirements:</b>			
Miscellaneous Work Required:	-	By Manufacturer	
List parts Requiring Field Assembly	-	By Manufacturer	
List of Required Maintenance Tools Furnished with Equipment	-	By Manufacturer	

END 33 73 29

DIVISION 40 – PROCESS INTEGRATION  
**Section 40 80 00 – Commissioning of Process Systems**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Provide supervision, labor, coordination, tools, material, equipment, and services required to perform commissioning and start-up of each respective item of equipment and systems furnished and/or installed as a part of this contract.
- b. Provide supervision, labor, and assistance to manufacturer's field representative and technical directors of installation for equipment installed as a part of this Contract. Follow specified procedures and instructions provided by these representatives. Representatives will not be present at all times. User or User's Representative will determine when representatives are required.
- c. Provide construction labor required for commissioning process necessary to support schedule as determined by User or User's Representative, including initial total plant startup.
  - 1.) Plant startup will proceed on a schedule determined by User or User's Representative and will likely entail 24-hour a day activity until startup is complete.
  - 2.) User will provide operators for commissioning process. User or User's Representative will determine when startup has been completed.
  - 3.) Startup refers not only to startup of total plant but also to individual systems requiring checkout prior to total plant startup.
- d. Verify operation performance of equipment and associated accessories for compliance, as described in Contract Documents.
- e. Document test inspections.
- f. Verify application of operation and maintenance manuals, record documents, spare parts listings, and other items as may be specified for supporting of piping systems and equipment.

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**Section 40 80 00 – Commissioning of Process Systems**

1.2 ACTION SUBMITTALS

A. Quality assurance data:

1. Commissioning responsibilities list including breakdown of each trades responsibilities during commissioning activities.
2. Sample documentation for tests and inspections required by Code Authorities.

1.3 CLOSEOUT SUBMITTALS

A. Record documents:

1. Provide alignment and vibration tolerances and readings after adjustments for devices and systems defined below.
2. Provide instrument calibration reports for each field and panel device furnished and/or installed as part of this contract. Sample calibration reports for each type of instrument supplied. Completed calibration reports shall include, but not be limited to:
  - a. Equipment: Instrument tag number, manufacturer, model number and serial number. For valves, include fail position, model number of actuator, model number of positioner (if included) and power requirements.
  - b. Service: Application, building, floor, and area.
  - c. Test data: Test equipment used, test performance data for instrument in "As Found" and "As Left" conditions.
  - d. Date of calibration and name of individual performing calibration.

1.4 QUALITY ASSURANCE

- A. Assure participation and cooperation of specialty contractors under its jurisdiction as required for commissioning process.
- B. Check-out each piece of equipment and each system with approved checklist to ensure Contract Document conformance prior to start-up.

2. PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide test equipment required for commissioning and startup of equipment.

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**Section 40 80 00 – Commissioning of Process Systems**

- B. Provide and maintain tools and test equipment in first-class condition and quantities sufficient to assure timely, successful performance and completion of required Work.
- C. Test equipment shall have recent calibration checks by equipment manufacturer or authorized facility to assure accuracy of commissioning process.

3. EXECUTION

3.1 SITE VERIFICATION OF CONDITIONS

A. Installation verification:

- 1. Prior to system start-up, the Contractor, User, and User's Representative shall conduct final installation verification audit. Contractor shall be responsible for completeness of work to User's satisfaction including change orders and punch list items. Audit shall include checking of:
  - a. Piping specialties including balancing, control, and isolation valves.
  - b. Control sensor types and locations.
  - c. Identification of piping, valves, equipment, controls, etc.
  - d. Major equipment, fans, valves, starters, gages, thermometers, etc.
  - e. Documentation of prestart-up tests performed, including manufacturer's factory tests.
- 2. If Work is found to be incomplete, incorrect, or nonfunctional, Contractor shall take corrective action before system start-up work proceeds. If during system start-up additional items are found, Contractor shall take corrective action before system start-up is completed.

B. Operation verification:

- 1. After system equipment, wiring, piping, and component installation has been verified, system start-up and calibration shall commence.
- 2. Contractor shall be responsible for operation and control of installed systems.

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3. During system checkout, operation checklist shall be filled out to verify system operation.
4. User and/or User's Representative shall verify system operation with responsible Contractor.

**3.2 ACCEPTANCE FOR OPERATION**

- A. Each piece of equipment installed by this contract shall carry "Acceptance for Operation Checklist." Each checklist shall be signed by the Contractor's Representative and User, or User's Representative. Each list shall have applicable blanks filled in and attached to items indicating that it is prepared for operation.
- B. User will accept equipment and systems for operation when construction has been substantially completed by Contractor. "Acceptance for Operation" shall mean User will assume operational and routine maintenance duties. "Acceptance for Operation" does not relieve Contractor from responsibilities related to defective materials and workmanship; neither does it constitute final acceptance of materials and equipment.
- C. After User has accepted a system for operation, Contractor shall continue to perform following as requested and scheduled by User at no additional cost to User until final acceptance:
  1. Troubleshooting, adjustments, and repairs until system operation and performance is acceptable.
  2. Assist instrument and control personnel with instrument calibration.
- D. After User has accepted a system for operation, Contractor shall continue to supply technical services when needed until final acceptance.

**3.3 TRAINING**

- A. Coordinate and direct training of personnel for operation and maintenance of systems and equipment specified.
- B. Provide User's selected staff with adequate training to fully operate and maintain the individual systems. Training shall be in accordance with the Contract Documents.

END 40 80 00



DIVISION 40 – PROCESS INTEGRATION  
**Section 40 91 00 – Primary Process Measuring Devices**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Instrument mounting stands.
- b. Instruments and control equipment:
  - 1.) Pressure sensing devices.
  - 2.) Flow sensing devices.
  - 3.) Level sensing devices.
  - 4.) Temperature sensing devices.
  - 5.) Analytical devices.
  - 6.) Control valves.
  - 7.) Safety relief valves.
- c. Installation of instrumentation and control equipment including field transmitters, sensing elements, control valves, analyzers, and miscellaneous devices.

1.2 INFORMATIONAL SUBMITTALS

- A. Submitted information relating to instrumentation and control devices shall be referenced by instrument tag number.
- B. Complete part or catalog number including material selections, design parameters, equipment catalog designations, calibration range, device options and accessories to be provided.
- C. Product Data: Spare parts lists including maintenance, special tools, test equipment, and name with address of manufacturer's local supplier for spare parts.

1.3 ACTION SUBMITTALS

A. Product Data:

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**Section 40 91 00 – Primary Process Measuring Devices**

1. Manufacturer's data or specification sheets for instrumentation and control devices showing design parameters, equipment catalog designations, calibration range, and clearly identifying options provided.
2. Instrument listing: Listing shall be oriented by instrument tag number and include manufacturer, model number, calibrated range, and setpoint values.
3. Certified calculation sheets:
  - a. Flow meter sizing.
  - b. Thermowell stress analysis.
  - c. Control valve sizing and aerodynamic noise predictions.
  - d. Pressure relieving device sizing.

**B. Shop Drawings:**

1. Certified outline drawings.
2. Installation drawings including mounting and grounding requirements.
3. Wiring interconnection drawings for equipment and accessories provided. Wiring interconnection drawings shall define terminal numbers and functions for interface with other instruments and equipment.

**1.4 CLOSEOUT SUBMITTALS**

**A. Operation and maintenance manuals:**

1. Complete instruction manuals and parts lists covering installation, operation, wiring interconnections, and maintenance of equipment.
2. Control loop diagrams for instrument and control devices wired or tubed to control system enclosures. Diagrams shall be in accordance with minimum requirements of ANSI/ISA S5.4. Control loop diagrams shall also include manufacturer, model number, and calibrated range; setpoint values for alarm and shutdown devices; equipment numbers for racks, panels, and junction boxes; exact location of device including column, row, and elevation; and control of solenoid valve fail-safe operation. Assign tag number oriented cable, wire, and tube numbers.

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**Section 40 91 00 – Primary Process Measuring Devices**

3. Schematic drawings for motor or relay-based control logic. Show color of wire, all termination points, terminal numbers, cable and wire numbers. Assign cable and wire numbers for external panel wiring. Cable and wire numbers shall be tag number oriented.

B. Record Documents:

1. “As-built” control loop diagrams and schematic drawings as defined above.
2. Instrumentation calibration reports.

1.5 QUALITY ASSURANCE

- A. Provide instruments from same manufacturer and of same model series when multiple units of same item are required.
- B. Instruments, control devices, and accessories shall be free of mercury and asbestos.
- C. Use plant instrument air source pressure or furnish pressure regulator with filter and output gage.
- D. Furnish insect-proof screens on vents.

2. PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Flow meters:

1. Orifice plates: ISA SP3.
2. Turbine flow meters: ISA SP31.
3. Submit certified calculation sheets verifying meter selection for operating conditions at minimum and maximum flow rate.

B. Temperature measurement:

1. Thermocouples: ISA SP1.1.
2. RTDs: ISA SP1.3.
3. Temperature gages: ISA SP1.4 and SP1.6.
4. Thermowells:
  - a. SAMA RC-17 application and dimensional standards.

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**Section 40 91 00 – Primary Process Measuring Devices**

C. Analytical measurement:

1. Combustible gas detectors: ISA SP12.13.
2. Carbon monoxide detectors: ISA SP92.02.
3. Chlorine detectors: ISA SP92.06.

D. Control valves:

1. Furnish control valves and accessories as complete assembly with fittings, and interconnection wiring.
2. Verify control valve sizing in accordance with ISA S75.01.

E. Verify pressure relieving device sizing for gas, liquid, and steam applications in accordance with ASME Boiler and Pressure Vessel Code, Section VIII – Rules for Construction of Pressure Vessels.

2.2 INSTRUMENT VALVES

A. Low-pressure water, air, gas, and steam below 300 psig and 500°F service:

1. Type: Ball.
2. Material: Type 316 stainless steel, ASTM A479.
3. Pressure rating: 1,500 psig at 100°F.
4. Internals: Type 316 stainless steel ball, teflon packing.

2.3 INSTRUMENT MANIFOLDS

A. Type: 2-valve for pressure applications and 3-valve for differential pressure applications.

B. Pressure class: ASME/ANSI B16.34 Class 2500.

C. Material: ASTM A479 Type 316 stainless steel.

D. Internals: Carbide ball seat and graphoil packing.

2.4 CONDENSATE POTS

A. Provide condensate pot on flow transmitter and drum level impulse tubing installed on steam service.

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**Section 40 91 00 – Primary Process Measuring Devices**

2.5 INSTRUMENT ENCLOSURE

- A. Construction: Molded polyurethane or other chemical, ultraviolet light- and fire-resistant material.
- B. Enclosure shall fully enclose instrument and manifold.

2.6 INSTRUMENT WIRING

- A. Provide No. 16 AWG single twisted shielded pair cable for 24-volt dc analog signals in accordance with Section 26 05 00.
- B. Provide No. 16 AWG, 600-volt wire for 120-volt ac signals in accordance with Section 26 05 00.
- C. Provide No. 12 AWG, 600-volt wire for 120-volt ac power circuits in accordance with Section 26 05 00.

END 40 91 00

DIVISION 43 – PROCESS GAS AND LIQUID HANDLING  
**Section 43 23 13 – Packaged Deaerator and Boiler Feed Pump**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

- a. Packaged deaerator and boiler feed pump including storage tank, motors, and accessories.

1.2 INFORMATIONAL SUBMITTALS

A. Quality assurance data:

1. Manufacturer's data report including shop and field inspection certificates as required by ASME Boiler and Pressure Vessel Code.
2. Loads imposed on building structure.
3. Information regarding analysis of critical speed.
4. Equipment support and foundation requirements.
5. Certified Material Test Reports (CMTRs) for boiler feedwater pump impellers and shafts.

1.3 ACTION SUBMITTALS

A. Shop Drawings:

1. Composite arrangement drawings.
2. Ratings.
3. Models.
4. Connection sizes and types.
5. Performance data.
6. Materials, etc. of equipment and accessories.
7. Outline drawings of component equipment.
8. Wiring diagrams.

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**Section 43 23 13 – Packaged Deaerator and Boiler Feed Pump**

9. Flow diagram of pressure parts locating and identifying function of each instrument connection.

- B. Source quality control: Certified copies of boiler feed pump manufacturer's standard performance test results in graphical and tabular form. Graphical form shall show total head in feet, brake horsepower in HP, NPSHR in feet, and pump efficiency plotted as ordinate, against pump flow in gpm as abscissa.

**1.4 CLOSEOUT SUBMITTALS**

- A. Operating and maintenance manuals for equipment including spare parts lists, bill of materials, operating and maintenance procedures. Include equipment outline drawings and data sheets in manuals.
- B. Complete price list of recommended spare parts for 5 years of operation.

**1.5 QUALITY ASSURANCE**

- A. Equipment provided shall be new and of proven capability and not prototype design. Design qualification of complete pump set and motor shall be based on testing or operating experience with similarly sized units operating under equivalent conditions of service.
- B. Equipment shall be suitable for condensate and make-up water quality.
- C. Materials of construction shall be those proven by service in similar designs and for similar operating conditions.
- D. Materials shall meet or exceed strength and corrosion-erosion resistance of materials specified.
- E. Regulatory requirements:
  1. Materials shall be identified by ASTM Specification Number, AISI type number or other industry recognized means of identifying composition and properties of material.
  2. Pressure retaining materials and bolting shall conform to design stress guidelines of latest edition of ASME VIII.

**2. PRODUCTS**

**2.1 PERFORMANCE GUARANTEES**

- A. Deaerator:

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1. Heater shall operate satisfactorily and provide deaeration and carbon dioxide removal at all loads up to maximum loads.
  2. Heater shall discharge feedwater at saturation temperature at all loads.
  3. Heater shall operate without shock, water hammer, vibration, or objectionable noise.
  4. Oxygen content of effluent by ASTM D888 Method A in determination of dissolved oxygen during any operating condition.
- B. Boiler feedwater pump (based on shop test, except as noted):
1. Pump capacity at design point.
  2. Total head at design point.
  3. Pump efficiency at design point.
  4. Pump speed at design point.
  5. NPSH requirements indicated on characteristic curve.
  6. Pump brake horsepower in accordance with HI tolerances.
  7. Maximum shutoff head.
  8. Minimum pump flow rate.
  9. No critical speed within 25% of pump operating speed.
  10. Field vibration readings. Acceptance criteria shall be in accordance with latest edition of API 610.

2.2 DEAERATOR

- A. Service: Heat and deaerate treated water makeup and condensate. Deaerator shall meet duty and service conditions on Data Sheet.
- B. Type:
1. Horizontal, cylindrical storage tank.
  2. Internal vent condensing section.
- C. Vapor and water piping between heater and storage tank. Pressure equalization between storage and deaerating sections shall not interfere with condensate drainage at any operating condition.



**DIVISION 43 – PROCESS GAS AND LIQUID HANDLING**  
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- D. Provide design to control back flash during load rejection.
- E. Units offering spray valves: Arrange for convenient service of valves.
- F. Feedwater outlet connection: Extend 3” (75 mm) into storage section and equip with vortex breakers.
- G. Provide impingement baffles at piping connections which could cause erosion. See Data Sheet for baffle requirements.
- H. Water inlet header inside heater shall be designed to withstand maximum steam pressure with full vacuum inside header.
- I. Design overflow connection to limit drain down of tank and to ensure overflow is submerged during initiation of overflow condition. Provide stainless steel piping internal to heater section as required.
- J. Construction:
  - 1. Construct in accordance with ASME Code for Unfired Pressure Vessel and HEI Standards.
  - 2. NDE testing:
    - a. Radiograph 100% of vessel shell and head seams, longitudinal and circumferential.
    - b. Wet fluorescent magnetic particle testing shall be performed on nozzles.
  - 3. Stress-relieve welds by post-weld heat treatment in accordance with NACE RP0590-07.
  - 4. Heating and storage section shells fabrication: Welded.
  - 5. Trays:
    - a. Riveted or stamped construction.
    - b. Shop installed.
  - 6. Supports and bolting: Stainless steel.
  - 7. Completely assemble heater and storage section prior to shipment and match mark to assure proper field assembly.
  - 8. Weld piping connection between heater and storage section.

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9. Heater and storage tank shells and internals shall be braced and reinforced to resist horizontal earthquake forces in accordance with seismic design requirements stated in Section 40 05 00. Weight used for design shall be normal operating weight assumed to be acting at center of gravity. Supports shall be designed to transmit earthquake forces to supporting steel.
10. Lifting attachments: Provide welded, lifting lugs at each end of storage and heater sections. Design lug to support twice weight of section in vertical and horizontal directions applied at same time.

**K. Vent condenser:**

1. Construction: Manufacturer's standard using materials specified.

**L. Piping connections:**

1. Connections shall be arranged to suit specific service, be accessible, and shall be subject to review of Engineer.
2. Weld end details: ASME B16.25.
  - a. Nominal wall thickness 0.375" (9 mm) and less: ASME B16.25, Figure 2, Detail A.
  - b. Wall thickness greater than 0.375" (9 mm): ASME B16.25, Figure 5 or 6.
3. Nozzles that do not require stronger design shall withstand minimum loading of 500 lb force and 1,000 ft-lbs moment in all directions.
4. Nozzle connections: See Data Sheets.

**M. Accessories:**

1. Required steam, water, drip, drain, vent, and instrument and control devices.
2. Vent orifices.
3. Safety relief valve(s):
  - a. Quantity: As required to meet capacity requirements and comply with HEI.
  - b. Capacity: As required to prevent exceeding vessel design pressure and following.

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- 1.) Relieve full capacity of maximum water fill rate.
  - 2.) Relieve full capacity of maximum steam supply rate from steam supply.
  - 3.) As required to comply with HEI recommendations.
- c. Flanged inlet and outlet.
- d. Assume backpressure for sizing relief valves to be 10% of set pressure.
4. Access:
- a. Deaerator: 20" minimum diameter manhole with hinges or davit in each end arranged to allow convenient removal of trays.
  - b. Storage section: 20" minimum diameter manhole in each end with hinges or davit.

**2.3 BOILER FEEDWATER PUMPS**

- A. Provide pumps and associated equipment suitable for continuous operation with no cyclic or hydraulic limitations at design conditions or any other load between minimum continuous safe flow and 125% of design capacity.
- B. Service: Pump shall meet duty and service conditions on attached Data Sheet.
- C. Pumps shall be capable of operating continuously over their full operating range without overheating, cavitating, excessive noise or vibration, surging or instability when operating in single or in parallel with other pumps.
- D. Pumps shall be “identical” as defined by HI standards.
- E. Pump characteristics:
1. Continuously rising head as capacity is reduced; maximum head at zero flow.
  2. Shut-off head shall be neither less than 115% nor more than 130% of rated head.
- F. Testing of complete pump sets and performance tolerances shall be in accordance with HI standards.

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- G. As minimum, guidelines of ASME Section VIII, Division 1 shall be addressed in design of pressure retaining parts of assembly.
- H. Changes in capacity or total head, after award of Contract but prior to release for fabrication, which do not impact pump size or motor ratings shall not impact cost of equipment.
- I. Terminal points shall be in accordance with applicable ASTM material specifications and ASME B31.1.
- J. Operating point shall be at or near best efficiency point (BEP) for pumps. Operating point for pump shall be not less than 50% of BEP flow.
- K. Mechanical design features:
  - 1. Flanges: ANSI B16.5 for design pressures and temperatures.
  - 2. Pump impellers may be semi-open or closed. If semi-open impellers are used, provisions shall be made in design to restore original axial clearances if wear occurs. Flat casing wearing rings shall be provided on all pumps where fully closed impellers are used. Wear rings shall have a minimum Brinell hardness difference of 100 between impeller wear surfaces and wear rings, per Contractor's standard.
  - 3. Impellers shall be keyed to shaft.
  - 4. Size shafts to transmit maximum horsepower required by largest size diameter impeller available for pump size. Shafts shall be solid.
  - 5. Provide shaft sleeves on all pumps. Lock to shaft mechanically and seal to prevent leakage between shaft and sleeve.
  - 6. Suction specific speed: Less than 10,000.
- L. Do not line wetted surfaces.
- M. Minimum corrosion allowance: 1/8" (3 mm) on noncorrosion-resistant materials.
- N. Avoid critical speed excitation or resonance for each service. Design discharge head/motor stand design to exclude primary excitation frequencies of 0.5X, 1X and 2X of pump operating speed. Complete correction of resonance problems prior to shipment.
- O. Materials:

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1. Refer to Data Sheets for materials to be incorporated in Work.
2. Furnish austenitic stainless steel in solution annealed, unsensitized condition.
3. Products that contain asbestos including items such as packing or gaskets even though item is encapsulated or asbestos fibers are impregnated with binder material not allowed
4. Select nonwetted parts of pump assembly to ensure compatibility of pumped fluid and environment. Alternate materials may be offered for consideration.

**P. Mechanical seals:**

1. Type: Single balanced mechanical seals, bellows or single spring-type, designed to permit operation to maximum continuous speed without resulting in unwinding or off-center operation. Seals shall be of cartridge-type design.
2. Pumps: Self-flushing with process fluid whenever possible. If external flush is required for any service, identify requirements of flow and pressure.
3. Compatible with service fluid for pH and corrosion resistance.
4. Seal faces:
  - a. Soft: Silicon carbide.
  - b. Hard: Tungsten carbide or silicon carbide.
5. Unless otherwise specified, mating seal ring(s) shall be of a one-piece design manufactured from tungsten carbide or silicon carbide.

**Q. Bearings:**

1. Pumps shall be supplied with roller or sleeve bearings, with a minimum B10 life of 100,000 hours.
2. 1/2 hp - 15 hp (0.4 kW – 11 kW): Roller bearing grease-lubricated or sleeve bearing oil-lubricated.
3. 15 hp - 500 hp (11 kW – 375 kW): Roller bearing oil-lubricated.
4. Oil seal and integral dirt and water seal at each end of reservoir.
5. Provide positive oil indication with external oil reservoir for oil-lubricated bearings.

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6. Bearing housings shall have a drain plug and fitted with labyrinth-type positive sealing for protection of lubricant and bearings.
  7. Use of snap-rings, springs, or bushing inserts (bearing carriers) not allowed.
  8. Thrust loads, momentary and continuous, shall be accommodated by thrust bearing in pump.
  9. Service factor for thrust bearing: Minimum 1.5.
- R. Couplings: Flexible-disk spacer couplings to permit normal pump and driver maintenance without need for moving either pump or driver. Provide OSHA-approved coupling guard.
- S. Baseplate:
1. Fabricate baseplate and above head and bend parts of thrust bearing assembly, motor stand and support and fasteners required for assembly from noncorrosion-resistant materials, such as carbon steel.
  2. Metal facing and load carrying surfaces shall be machined. Baseplates of welded steel construction are preferred. If furnished they shall be:
    - a. Provided with raised rim for retaining drips.
    - b. Extended under all parts of equipment mounted thereon.
    - c. Sloped to tapped drain connection at one or both ends.
    - d. Provided with anchor bolt holes and grout holes.
    - e. Design to accommodate all equipment on single base.
  3. Design to withstand mechanical forces that could cause misalignment of equipment such as those due to piping strains, thermal expansion, and hydraulic piping thrust.
  4. Provide sufficient holes in baseplate furnished to allow for grout filling and air venting. Actual base or baseplate stiffness shall be incorporated in lateral and torsional analysis of rotating elements. Analysis shall take into account form of support and its stiffness.

**2.4 VALVE STATIONS**

- A. Boiler feed pump minimum flow recirculation to deaerator.

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1. Control valves: Suitable for throttling service.
  2. Valve body material: 2.25% chrome.
  3. Valve trim material: Suitable for flashing service.
- B. Condensate makeup to deaerator. Control valves shall be capable of throttling flow from 10% to 100% condensate flow.

**2.5 SOURCE QUALITY CONTROL**

**A. Deaerator:**

1. Hydrostatic testing: ASME Section VIII.
2. Surface preparation and protection:
  - a. Interior: Clean surfaces with 16 to 30 mesh steel grit. Grit shall be free of silica and silica compounds.
  - b. Exterior: After hydrostatic tests, clean to base metal; apply one coat primer of type suitable for design temperatures.
  - c. Immediately after completion of cleaning operations, interior shall be thoroughly and completely dried and coated with water-soluble rust-preventive concentrate; soluble in hot water only.
  - d. Machined surfaces: Coat with suitable rust inhibitor.
  - e. Suitably protect equipment for shipment; plug or blank off openings on outside of tank. Piping connections shall have plastic caps secured with waterproof tape.
  - f. Provide activated alumina desiccant for long-term storage. Silica gel or clay drying agents are not acceptable.

**B. Boiler feed pumps:**

1. Cleaning:
  - a. Cleaning of surfaces, which are not to be painted or coated, shall be done according to manufacturer's recommended practice. Conduct cleaning operations such that stainless steel and nickel alloys are not contaminated with lead, copper, mercury, or other low-melting point metals; chlorides, sulfur, halogens, and ferritic steel materials.

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- b. Machined or mating surfaces, and pipe and components for lube oil systems, shall be free of rust. Clean internal surfaces of particulate and contaminants, such as sand, metal chips, weld slag, etc. Surface shall be free of organic contaminants such as oil, paint, and preservatives as determined by a visual examination.
  - c. External noncorrosion-resistant metallic surfaces of pumps and motors shall be primed and finished in accordance with manufacturer's standards. Assemblies shall be flushed and cleaned prior to packaging. Stainless steel and similar corrosion-resistant materials shall not be treated or painted with a rust preventative. Noncorrosion-resistant materials shall be provided with a high-grade primer and top-coat over blast clean and smooth surface prior to packaging for shipment.
  - d. After complete cleaning and drying of internal and external surfaces, exposed openings shall be covered or blocked with rigid covers. Activated alumina desiccant shall be used to avoid condensation.
2. Identification and tagging: Each part of complete assembly shall be permanently marked in accessible locations. There shall be large, visible nameplates that identify:
- a. Equipment model and type.
  - b. Service conditions: Capacity, TDH, fluid temperature, rotational speed, BHP (kW).
  - c. Impeller diameter.
  - d. Year built.
  - e. Serial numbers and shop order numbers.
3. Hydrostatic testing.
- a. Pressure retaining parts shall undergo hydrostatic testing.
  - b. Test pressure of 1.5 times design pressure shall be held for at least 30 minutes.
  - c. No leakage is acceptable through pressure boundary wall or assembled parts.
  - d. Rotating shaft packing is excluded from no leakage requirement.



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- e. User may, at its option, witness hydrostatic testing.

END 43 23 13

DIVISION 44 – POLLUTION AND WASTE CONTROL EQUIPMENT  
**Section 44 11 16 – Industrial Dust Collectors**

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Design-Build Contractor:

a. Cyclone dust collector.

1.2 INFORMATIONAL SUBMITTALS

A. Submittals shall include data concerning:

1. Dimensions.

2. Materials of construction.

3. Capacities.

4. Sound generation.

5. Air pressure drops.

6. Fan curves.

2. PRODUCTS

2.1 DUST COLLECTOR DC-2

A. Manufacturer: Bridging documents based on Donaldson Torit Dust Collector.

B. Type: Cyclone.

C. Construction: 20-gage black steel.

D. Cfm: 440 at 4.9" w.g.

E. Storage capacity: 4.8 cu ft (pull-out dumpster with casters).

F. Fan: 10" diameter radial blade centrifugal, direct drive, sparkproof construction.

G. Filters: Polyester felt bag type, sizing as required by manufacturer

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2.2    INSTALLATION

- A. Install in accordance with NFPA 91, NFPA 68, and NFPA 664.
- B. Isolate dust systems from dust collector fans with 4" minimum flexible connections.
- C. Install blast gates on branches in vertical branch ducts near equipment.
- D. Provide hoods as necessary for proper dust removal from each piece of equipment.
- E. Install units in accordance with manufacturer's written instructions.

END 44 11 16