SECTION 00 9111

ADDENDUM NUMBER 1

PARTICULARS

DATE: NOVEMBER 19, 2024

PROJECT: MEDFORD WATER OPERATION CENTER

ARCHITECT'S PROJECT NUMBER: 22085

OWNER'S PROJECT NUMBER: CIPW-22-00280

OWNER: MEDFORD WATER

ARCHITECT: SODERSTROM ARCHITECTS

TO: PROSPECTIVE BIDDERS:

THIS ADDENDUM FORMS A PART OF THE CONTRACT DOCUMENTS AND MODIFIES THE ORIGINALPROCUREMENT DOCUMENTS DATED 11/7/2024, WITH AMENDMENTS AND ADDITIONS NOTED BELOW.

ACKNOWLEDGE RECEIPT OF THIS ADDENDUM IN THE SPACE PROVIDED IN THE BID FORM AND BELOW. FAILURE TO DO SO MAY DISQUALIFY THE BIDDER.

PLEASE ALSO NOTE THAT WE ANTICIPATE CLARIFYING IMPORT SITE MATERIAL AS PART OF BID FORM IN FUTURE ADDENDUM

CHANGES TO THE PROJECT MANUAL - INTRODUCTORY REQUIREMENTS, PROCUREMENT REQUIREMENTS AND CONTRACTING REQUIREMENTS:

SECTION 00 0110 - TABLE OF CONTENTS

Revise Section 07 6100 07 6100 - Sheet Metal Roofing – Alternate to be **Section 07 6110**

Revise Section 14 5000 – Vehicle Lifts to be **Section 14 4500**

Add SECTION 23 3400 - HVAC Fans

Add SECTION 23 7223 - Packaged Air-to-Air Energy Recovery Units

Add SECTION 23 7323 - Custom Central Station Air-Handling Units

Add SECTION 23 8143 - Air Source Heat Pumps

SECTION Contract Documents / Information for Bidders

Revise Bid Form to indicate 150 kW of PV

CHANGES TO THE PROJECT MANUAL - SPECIFICATIONS:

SECTION 01 5713 – Temporary Erosion and Sediment Controls

Add section in its entirety. (Note – this section was previously listed in the table of contents, but was inadvertently omitted).

SECTION 01 9113 – General Commissioning Requirements

Add section in its entirety. (Note – this section was previously listed in the table of contents, but was inadvertently omitted).

SECTION 23 3400 - HVAC Fans

Add section in its entirety.

SECTION 23 7223 - Packaged Air-to-Air Energy Recovery Units

Add section in its entirety.

SECTION 23 7323 - Custom Central Station Air-Handling Units
Add section in its entirety.

SECTION 23 8143 - Air Source Heat Pumps
Add section in its entirety.

SECTION 26 0000 - Electrical Basic Requirements
Delete Transfer Switch from 1.07,B.

SECTION 26 0573 - Electrical Distribution System Studies
Delete Selective Coordination Study throughout section.

SECTION 26 3213 - Engine Generators
Delete Transfer Switches references from section in Part 1.

SECTION 26 3313 Battery Energy Storage
Add Sequence of Operations in Part 3.

CHANGES TO DRAWINGS:

DRAWING A.G1.01
1. Add sheet C5.30 – Product Cut Sheet. (Note – this sheet was included in the previously issued set, but was inadvertently omitted from the Sheet Index)
2. Remove sheet L1.00 from the Sheet Index as it is not included in the set.

DRAWING A.G2.01
1. Added vertical grab bar at Detail 7
2. Added Detail 9

DRAWING A.G3.01
1. Added High-Piled Storage code information

DRAWINGS C6.00, C6.10, C6.11, C6.12, C6.13, C6.14, C6.15, C6.16, C6.17, and C6.20
1. Sheets added in entirety (Note – these sheets were previously listed in the table of contents, but were inadvertently omitted).

DRAWING A.A1.04 –
1. Sheet added in entirety. (Note – this sheet was previously listed in the table of contents, but was inadvertently omitted).

DRAWING A.A4.01
1. Revised height of opening in Details 4 and 10
2. Updated dimensions in Details 1 and 7
3. Removed material tag at Detail 5
4. Revised material tag at Detail 9

DRAWING A.A4.02
1. Revised dimensions in Details 21 and 26
2. Added material tags in Details 7 and 9
3. Added Keynote 05-0001 in Detail 8

DRAWING A.A5.01
1. Revised dimensions in Details 2, 4, and 5

DRAWING A.A5.08
1. Revised dimension in Detail 2
2. Revised title of Detail 6

DRAWING A.A9.01

1. Revised Room 107 – North wall
2. Revised Room 141 – Flooring
3. Removed Notes 5 and 8
4. Revised hatching for FRP-1 and FRP-2 at legend

DRAWING S.AG3.01

1. Revised Code Type to indicate building is non-sprinklered.

DRAWING D.G1.01

1. Corrected all Structural sheets noted in Sheet Index.
2. Added Technology sheets to the Sheet Index (Note – these sheets were included in the previously issued set, but were inadvertently omitted from the Sheet Index)

DRAWING V.M0.02

1. Revised fan schedule to include additional comments for EFV-3 and EFV-4.

DRAWING A.E2.12

1. Revised lighting at Rooms 123, 129, 130, 131, 132, and 138

DRAWING A.E3.11

1. Revised Disconnect means to be receptacles for DF-1/2/3/4.

DRAWING A.E3.12

1. Add Receptacles for video wall.

DRAWING A.E6.02

1. Revised Panelboard 2PA adding power for video wall.

BIDDER QUESTIONS

Q1: Is there an estimated budget for construction?

Answer: $35 - $40 million, based on an estimate performed roughly 6 months prior.

Q2: Who was the third-party estimator for this budget?

Answer: Construction Focus

Q3: Is the Prequalification Form sort of self-certifying? Any attachments needed with the form?

Answer: Just the one-page form needs to be filled out. No attachments are required.

Q4: How can we list the value on the Bid Bond when we don't know the final bid price until the due date and time? Can we just state the Bid Bond is 10% of the value of the bid?

Answer: The sample Bid Bond in the solicitation is only for demonstration purposes. OK to use the standard Bid Bond format from your surety.

Q5: How will the 50K cu yd of fill be measured?

Answer: Estimate is for bid purposes only. The actual fill amount will be calculated at the time of construction. Additional information regarding this fill and how to notate the Bid Form will be in a later addendum.

Q6: Do you intend to pay extra for the actual amount of fill?

Answer: Bid Form is a placeholder. Actual amounts TBD and may increase or decrease from this estimate. The material cost in your bid should include the placement of the material.

Q7: Are site CAD files available

Answer: Contact Mark Depner at mark.depner@medfordwater.org to request the CAD files from ZCS.

Q8: Geotech report says site will be adding 12 inches of topsoil. Is that correct?

Answer: 12 inches of topsoil was removed from the site. The 12 inches of gravel to be added as noted in Section 1.1 of the Geotechnical Report will be part of this contract, and covered in the fill/import numbers noted on the Bid Form and in Question 5 above.

Q9: No removal of soil? What about vegetative growth?

Answer: The documents show where to place material. Existing material may be used for grading.

Q10: Will you be providing a list of attendees at this mandatory Pre-Bid meeting?

Answer: Yes. See attached list.

Q11: Plans call for a minimum 150 kW PV to be installed, but future solar is also mentioned. Please clarify.

Answer: A minimum 150 kW array to be installed as part of this project. Future battery storage and additional PV have been planned for in the form of breakers and larger gear.

Q12: The contract documents appear to require selective coordination to 0.01 second. However, the wording is generic to cover all types of NEC emergency systems. Typically, a whole building emergency system falls under NEC 702, Optional Stand-By emergency system, which does not require selective coordination. Provide the NEC classification for this emergency system (NEC 700, 701, 702 or 708)

Answer: The system in an NEC 702 classified system. Coordination down to 0.01s is not required.

Q13: The specs are written around a standard emergency system, with an Automatic Transfer Switch (ATS). As designed, the electrically operated breakers in MDS become the “ATS”. Please provide clarification for how this system will operate.

- Does the switchboard controller control the breaker operations?
    - Answer: Yes
- Does the generator controller operate all nine of these electrically operated breakers?
    - Answer: Yes, The intent is to have one microgrid controller control the generators, electrically operated breakers and the PV Interters
- Is there a load-shedding scheme to disconnect non-essential loads if the generator(s) are overloaded?
    - Answer: Yes, on generator overload EV Charging is to be loadshed.

- How do these breakers operate when there's no power at the switchboard? Onboard ups?
    - Answer: We will need an onboard UPS to ensure backup power to the microgrid controller.
- MDS has connections to photovoltaic (PV) and a future battery energy storage system (BESS). Are these designed to operate in an "island mode", providing power if the generator and utility loose power? (specs say to disconnect PV when utility is lost)
    - Answer: Yes, the intent is for the PV system, the generators and the future BESS to operate in an island mode on loss of Utility Power.
- What is the control scheme to operate the PV and BESS breakers?
    - Answer: The microgrid controller will have to interface with the future BESS and the PV system as well as the breakers to monitor power flow and ensure the gensets are operated as little as possible to conserve fuel.
- Recommend utilizing an "islanding control system" that operates all these systems (PV, BESS, load shedding, plus when to turn on/off the generators)
    - Answer: The system as designed requires an "islanding control system"

Q14: Are Owner Furnished items to be furnished through the General Contractor?

Answer: Owner furnished is provided by Owner and is not part of the General Contractor responsibility unless it also says Contractor install. In that case Owner provides the product (using a separate procurement process) and GC installs. If item is Owner provided/Owner install there will be a separate procurement process for those items.

APPROVAL OF ADDITIONAL PRODUCTS/SYSTEMS:

None included with this addendum.

Bidders are reminded that all questions related to the Bid Documents or the project must be submitted in writing in accordance with Section 22 of the Information for Bidders. Received questions will only be answered by Addenda. After the stated December 4, 2024 deadline, no individual questions will be answered and bidders will be responsible for making their own interpretation of the bid documents.

ACKNOWLEDGEMENT: All Bidders shall acknowledge receipt and acceptance of this Addendum on the Bid Form. Bids submitted without acknowledgment may be considered informal.

BOARD OF WATER COMMISSIONERS

CITY OF MEDFORD, OREGON

By: _____

Brad Taylor, General Manager

Receipt acknowledged and conditions agreed to this _____ day of _____, 2024.

Bidder: _____

By: _____

(Signature)

_____

(Print Name)

END OF SECTION

Medford Water Operation Center
CIPW-22-00280

Mandatory Pre-bid Teams Meeting November 14, 2024 10:00 am

Attendance Sheet

Name	Company	Email
Brad Taylor	Medford Water	brad.taylor@medfordwater.org
Kris Stitt	Medford Water	kris.stitt@medfordwater.org
Mark Depner	Medford Water	mark.depner@medfordwater.org
Erica Jankowski	Soderstrom Architects	ericaj@sdra.com
Malia Waters	ZCS	maliawaters@zcsea.com
Spencer Lemmon	Bremik Construction	sl@bremik.com
Spencer Bradley	Bremik Construction	sb@bremik.com
Tim Besheone	Andersen Construction	tbesheone@andersen-const.com
Alex King	Ordell Construction	aking@ordellconstruction.com
Makayla Woodford	Deschutes Fencing	makaylawoodford2@gmail.com
Josh Geyer	Battlecreek Construction	josh@battlecreekbuilt.com
Theron Logan	Timber Ridge Contracting	tlogan@timberridgenw.com
Colin Sowers	Pacific Electrical Contractors	colin@pacificelectrical.com
Wyatt Sharrard	Pacific Electrical Contractors	wyatt@pacificelectrical.com
Madison Pihl	First Cascade	madisonp@firstcascade.com
Philip Graff	Knife River Materials	philip.graff@kniferiver.com
Allen Purdy	S+B James Construction	allenpurdy@sbjames.com
Jeff Scheid	S+B James Construction	jeffscheid@sbjames.com
Tim Bowden	S+B James Construction	timbowden@sbjames.com
Mike Ussary	Pilot Rock Excavation	mike@pilotrockx.com
Ryan Beugli	Outler Construction	ryan@outlierbuilt.com
Shalina Hamlet	Vitus Construction	shalina@vitusconstruction.com
Garrett Collins	Engage Electric	garrett@engageelectric.com
Kyle Drahuschak	JB Steel	kyled@jbsteelconstruction.com
Bryce Whetzel	Johnson Controls	bryce.wetzel@jci.com
Wayne Sargent	DSL Builders	waynes@dsl-builders.com
Tom Walker	Adroit Construction Co.	tomw@adroitbuilt.com
Jason Stranberg	Adroit Construction Co.	jason@adroitbuilt.com
Shane Moody	JW Fowler	estimating@jwfowler.com
Zach Pesznecker	DeaMore Skylights	zach@deamor.com

BID FORM					
NO.	DESCRIPTION	UNIT	QTY	UNIT PRICE	EXTENDED BID PRICE
1.	Construction of all buildings, structures, and associated sitework and off-site improvements (Items 1-5 in the Project Description in Section 00 0102 Project Information of the Project Manual) – Line Item No. 5 will be calculated separately below and should not be included in this number	Lump Sum	1		
2.	Communications Tower and associated foundation (Item 6 in the Project Description in Section 00 0102 Project Information of the Project Manual)	Lump Sum	1		
3.	Solar Panels – **150 kW array**	Lump Sum	1		
4.	Imported Site Fill	Cubic Yard	50,000 CY		
	Quantity provided is for bid purposes only. Use an average unit cost for imported site fill. A before and after survey will be used to calculate final quantity paid for using the unit prices provided below for specific materials.				
5.	Base Bid – IMP Roof Assembly	Lump Sum	1		
	Alt #1 – Standing Seam Roof Assembly	Lump Sum	1		
	The lesser of the two lines in Item 5 will be used to determine the final Bid Price				

Dollars $.

Total Amount in Words | Total Amount in Figures

UNIT COSTS			
NO.	DESCRIPTION	UNIT	PRICE
1	¾" minus Structural Fill (or equivalent as listed in Geotechnical Report)	CYD	
2	Pit run / 4" minus subgrade rock (or equivalent as listed in Geotechnical Report)	CYD	
3	On-site or imported earth fill (landscape areas to top of subgrade)	CYD	
4	On-site or imported topsoil (landscape areas topsoil)	CYD	

SECTION 00 0110

TABLE OF CONTENTS

END OF SECTION

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SECTION 01 5713 - TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Prevention of erosion due to construction activities.

B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.

C. Restoration of areas eroded due to insufficient preventive measures.

D. Compensation of the owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.02 RELATED REQUIREMENTS

A. Section 31 1000 - Site Clearing: Limits on clearing; disposition of vegetative clearing debris.

B. Section 31 2200 - Grading: Temporary and permanent grade changes for erosion control.

C. Section 32 1123 - Aggregate Base Courses: Temporary and permanent roadways.

1.03 PERFORMANCE REQUIREMENTS

A. Comply with requirements of EPA (NPDES) for erosion and sedimentation control, as specified by the NPDES, for Phases I and II, and in compliance with requirements of Construction General Permit (CGP), whether the project is required by law to comply or not.

B. Also comply with all more stringent requirements of State of Oregon Erosion and Sedimentation Control Manual.

C. Best Management Practices Standard: FHWA FLP-94-005.

D. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.

1. The owner will obtain permits and pay for securities required by authority having jurisdiction.
2. The owner will withhold payment to Contractor equivalent to all fines resulting from non-compliance with applicable regulations.

E. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.

F. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.

1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 2 years.

G. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.

1. Control movement of sediment and soil from temporary stockpiles of soil.
2. Prevent development of ruts due to equipment and vehicular traffic.
3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to the owner

H. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.

1. Prevent windblown soil from leaving the project site.
2. Prevent tracking of mud onto public roads outside site.
3. Prevent mud and sediment from flowing onto sidewalks and pavements.
4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to the owner.

I. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to the owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
   2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.

J. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to the owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

K. Open Water: Prevent standing water that could become stagnant.

L. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Certificate: Mill certificate for silt fence fabric attesting that fabric and factory seams comply with specified requirements, signed by legally authorized official of manufacturer; indicate actual minimum average roll values; identify fabric by roll identification numbers.

C. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished.

D. Maintenance Instructions: Provide instructions covering inspection and maintenance for temporary measures that must remain after Substantial Completion.

PART 2 PRODUCTS

2.01 MATERIALS

A. Mulch: Use one of the following:
   1. Wood waste, chips, or bark.
   2. Erosion control matting or netting.
   3. Polyethylene film, where specifically indicated only.

B. Grass Seed For Temporary Cover: Select a species appropriate to climate, planting season, and intended purpose. If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.

C. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
   1. Average Opening Size: 30 U.S. Std. Sieve, maximum, when tested in accordance with ASTM D4751.
   2. Permittivity: 0.05 sec^-1, minimum, when tested in accordance with ASTM D4491/D4491M.
   3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355/D4355M after 500 hours exposure.
   4. Tensile Strength: 100 pounds-force, minimum, in cross-machine direction; 124 pounds-force, minimum, in machine direction; when tested in accordance with ASTM D4632/D4632M.
   5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632/D4632M.
   6. Tear Strength: 55 pounds-force, minimum, when tested in accordance with ASTM D4533.
   7. Color: Manufacturer's standard, with embedment and fastener lines preprinted.
   8. Manufacturers:
      a. BP Amoco, Amoco Fabrics and Fibers: www.geotextile.com

b. TenCate: www.tencate.com
c. North American Green: www.nagreen.com
d. Propex Geosynthetics: www.geotextile.com

D. Silt Fence Posts: One of the following, minimum 5 feet long:
1. Hardwood, 2 by 2 inches in cross section.

E. Gravel: See Section 32 1123 for aggregate.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 SCOPE OF PREVENTIVE MEASURES

A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.

B. Construction Entrances: Traffic-bearing aggregate surface.
1. Width: As required; 20 feet, minimum.
2. Length: 50 feet, minimum.
3. Provide at each construction entrance from public right-of-way.
4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.

C. Linear Sediment Barriers: Made of silt fences.
1. Provide linear sediment barriers:
a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.
b. Along the top of the slope or top bank of drainage channels and swales that traverse disturbed areas.
c. Along the toe of cut slopes and fill slopes.
d. Perpendicular to flow across the bottom of existing and new drainage channels and swales that traverse disturbed areas or carry runoff from disturbed areas; space at maximum of 200 feet apart.
e. Across the entrances to culverts that receive runoff from disturbed areas.
2. Space sediment barriers with the following maximum slope length upslope from barrier:
a. Slope of Less Than 2 Percent: 100 feet..
b. Slope Between 2 and 5 Percent: 75 feet.
c. Slope Between 5 and 10 Percent: 50 feet.
d. Slope Between 10 and 20 Percent: 25 feet.
e. Slope Over 20 Percent: 15 feet.

D. Storm Drain Curb Inlet Sediment Trap: Protect each curb inlet using one of the following measures:
1. Filter fabric wrapped around hollow concrete blocks blocking entire inlet face area; use one piece of fabric wrapped at least 1-1/2 times around concrete blocks and secured to prevent dislodging; orient cores of blocks so runoff passes into inlet.
2. Straw bale row blocking entire inlet face area; anchor into pavement.

E. Storm Drain Drop Inlet Sediment Traps: As detailed on drawings.

F. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.

G. Soil Stockpiles: Protect using one of the following measures:
1. Cover with polyethylene film, secured by placing soil on outer edges.
2. Cover with mulch at least 4 inches thickness of pine needles, sawdust, bark, wood chips, or shredded leaves, or 6 inches of straw or hay.

H. Mulching: Use only for areas that may be subjected to erosion for less than 6 months.
   1. Wood Waste: Use only on slopes 3:1 or flatter; no anchoring required.

I. Temporary Seeding: Use where temporary vegetated cover is required.

3.04 INSTALLATION

A. Traffic-Bearing Aggregate Surface:
   1. Excavate minimum of 6 inches.
   2. Place geotextile fabric full width and length, with minimum 24 inch overlap at joints.
   3. Place and compact at least 8 inches of 2 inch diameter drain rock.

B. Silt Fences:
   1. Store and handle fabric in accordance with ASTM D4873.
   2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch high barriers with minimum 36 inch long posts spaced at 6 feet maximum, with fabric embedded at least 4 inches in ground.
   3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch high barriers, minimum 48 inch long posts spaced at 6 feet maximum, with fabric embedded at least 6 inches in ground.
   4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 20 feet, use nominal 32 inch high barriers with woven wire reinforcement and steel posts spaced at 4 feet maximum, with fabric embedded at least 6 inches in ground.
   5. Install with top of fabric at nominal height and embedment as specified.
   6. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.
   7. Fasten fabric to wood posts using one of the following:
      a. Four nails per post with 3/4 inch diameter flat or button head, 1 inch long, and 14 gauge, 0.083 inch shank diameter.
      b. Five staples per post with at least 17 gauge, 0.0453 inch wire, 3/4 inch crown width and 1/2 inch long legs.
   8. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches high with post spacing not more than 4 feet.

C. Temporary Seeding:
   1. When hydraulic seeder is used, seedbed preparation is not required.
   2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
   3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1000 sq ft.
   4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000 sq ft.
   5. Incorporate fertilizer into soil before seeding.
   6. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch deep.
   7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
   8. Repeat irrigation as required until grass is established.

3.05 MAINTENANCE

A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches or more rainfall at the project site, and daily during prolonged rainfall.

B. Repair deficiencies immediately.

C. Silt Fences:
   1. Promptly replace fabric that deteriorates unless need for fence has passed.
   2. Remove silt deposits that exceed one-third of the height of the fence.
   3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.

D. Clean out temporary sediment control structures weekly and relocate soil on site.

E. Place sediment in appropriate locations on site; do not remove from site.

3.06 CLEAN UP

A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Engineer.

B. Clean out temporary sediment control structures that are to remain as permanent measures.

C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION

SECTION 01 9113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:

1. Scope of systems and equipment to be commissioned.
2. Commissioning duties and procedures at the site.

1.02 RELATED SECTIONS

A. Division 01, General Requirements applies to this Section.

B. Contents of Division 22, 23, and 26 apply to this Section.

C. In addition, reference the following:

1. 22 08 00, Commissioning of Plumbing
2. 23 08 00, Commissioning of HVAC
3. 26 08 00, Commissioning of Electrical

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by:

1. Division 01, General Requirements.
2. 22 08 00, Commissioning of Plumbing
3. 23 08 00, Commissioning of HVAC
4. 26 08 00, Commissioning of Electrical

B. In addition, meet the following:

1. Current edition of the ASHRAE Guideline 0, The Commissioning Process.

1.04 QUALITY ASSURANCE

A. Quality assurance as required by:

1. Division 01, General Requirements.
2. 22 08 00, Commissioning of Plumbing
3. 23 08 00, Commissioning of HVAC
4. 26 08 00, Commissioning of Electrical

1.05 WARRANTY

A. Warranty of materials and workmanship as required by Division 01, General Requirements.

1. Division 01, General Requirements.
2. 22 08 00, Commissioning of Plumbing
3. 23 08 00, Commissioning of HVAC
4. 26 08 00, Commissioning of Electrical

1.06 DEFINITIONS

A. Commissioning Authority: The Commissioning Authority is the person or entity referred to throughout the Contract Documents as if singular in number who works with the Owner's Authorized Representative under a separate Contract.

B. Commissioning:

1. Commissioning is a process for achieving, verifying, and documenting that performance of a building and its various energy consuming systems meets the Design Engineer's design intent and the Owner's operational needs.

2. Commissioning includes tests for the operation of equipment and building systems to ensure that they operate as designed by the Design Engineer, and meet the needs of the building throughout the entire range of operating conditions.
3. Commissioning is a cooperative effort that requires participation by the Owner's Authorized Representative, General Contractor, system and equipment installers, building automation system installer, Testing and Balancing Agency, equipment manufacturers" representatives, Architect, Architect's design engineers, and Commissioning Authority.

C. Owner’s Project Requirements (OPR): Document that details the functional requirements and expectations of how the building will be used and operated. This may include project location, goals, cost considerations, equipment manufacturers, and environmental control requirements.

D. Basis of Design (BoD): A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines.

E. Commissioning Procedures:

1. Inspection and testing procedures that are written by the Commissioning Authority for equipment and systems within the scope of commissioning.
2. Inspection checklists typically address items of installation compliance with design intent and approved submittals.
3. Functional performance test procedures typically address all sequences for normal and emergency equipment and system operation. These procedures consist of a mix of One-Time Tests and Continuous Measurement.
4. One-Time Tests: Functional performance tests of equipment and systems that are performed by forcing specific conditions that are intended to trigger specific responses, per the design intent.

F. Continuous Measurements:

1. Functional performance tests of equipment and systems that are performed by observing parameters of normal operation over an extended period. This is typically accomplished by means of the BAS trend logging capabilities, by monitoring with stand-alone data logging equipment, or by some combination of both.
2. Temperature conditions in occupied spaces, control stability, and lighting levels in areas with daylighting controls are three typical subjects of continuous measurement.

G. Commissioning Plan: The document, provided by the Commissioning Authority, that states the required tests for all equipment and systems within the scope of commissioning.

H. Commissioning Meetings: Issues related to commissioning will be discussed as required during regularly scheduled progress meetings.

1.07 PERFORMANCE REQUIREMENTS

A. Testing, inspecting and performance monitoring tasks specified in this Section and in Sections 22 0800, 23 0800, and 26 0800 are the responsibility of the Commissioning Authority, unless specifically indicated otherwise, and not part of the General Construction Contract. These tasks are included in these Sections for the Contractor's information, so the Contractor can understand the standards of system performance that are required and more effectively coordinate with the process of commissioning.

B. The Commissioning Authority will verify for the Owner's Authorized Representative that commissioned mechanical, plumbing, electrical, and controls system function interactively and in compliance with the Project design intent, and to facilitate orderly and efficient transfer of building operating systems to the Owner.

C. Commissioning does not relieve the Contractor of Contract obligations.

1.08 EQUIPMENT AND SYSTEMS TO BE COMMISSIONED

A. Systems:

1. HVAC Equipment
2. HVAC Controls
3. Domestic Hot Water Equipment
4. Pumps for Pump Systems
5. Automatic Lighting Control Systems and Components
6. Emergency Generator and Automatic Transfer Switches
7. Uninterruptable Power Systems
8. Renewable Energy Systems
9. Automatic Receptacles
10. Energy Metering

1.09 COMMISSIONING DUTIES

A. Duties of Owner: Provide the OPR to the Architect/Engineer and Commissioning Authority prior to design development.

B. Duties of Architect:

1. Attend commissioning portion of Progress Meetings as necessary, minimum two meetings.
2. Lead the design team in assisting the resolution of deficiencies.

C. Duties of Architect's Mechanical Engineer:

1. Attend commissioning portion of Progress Meetings as necessary, minimum two meetings.
2. At the request of either the Owner's Authorized Representative or the Commissioning Authority, review Commissioning Procedures and submit comments to Owner's Authorized Representative.
3. Develop and provide the Basis of Design to Owner and Commissioning Authority prior to 50 percent CD.
4. Assist in resolution of problems and deficiencies that are discovered during commissioning.

5. Participate and respond to commissioning related issues by using the Commissioning Authority's web based commissioning software Facility Grid.

D. Duties of Architect's Electrical Engineer:

1. Attend commissioning portion of Project Meetings as necessary.
2. At request of either the Owner's Authorized Representative or the Commissioning Authority, review Commissioning Procedures and submit comments to Owner's Authorized Representative.
3. Develop and provide the Basis of Design to Owner and Commissioning Authority prior to 50 percent CD.
4. Assist in resolution of problems and deficiencies that are discovered during commissioning.
5. Participate and respond to commissioning related issues by using the Commissioning Authority's web based commissioning software Facility Grid.

E. Duties of Commissioning Authority:

1. Attend commissioning portion of Project Meetings as necessary, minimum two meetings.
2. Provide Commissioning Plan to Owner’s Authorized Representative for review and comment.
3. Utilize web based Commissioning software to manage all commissioning related checklists, tests, issues, and observation reports.
4. Perform a design review at mid-set construction document phase. Provide review comments to the owner and design team.
5. Prepare commissioning procedures for each commissioned system based on actual system configuration.
6. Commissioning Procedures written by Commissioning Authority will include, in field data collection format, the detailed test procedures, test conditions, and criteria for acceptance of test results.
7. Submit any commissioning procedures that are written by Commissioning Authority to the Owner's Authorized Representative for review and approval at least 1 week prior to scheduled field testing.
8. Provide personnel experienced in technical aspects of each system to be commissioned for execution of tests.
9. BAS Sequence Demonstration:
    a. Witness the Control Contractor's demonstration of their sequence tests.
    b. If any of the demonstrated sequences fails to operate per the controls submittal, witness the repeat demonstration after corrective action has been taken.
10. Execute the Commissioning Procedures.
11. Prepare and submit Observation Reports and Deficiency Reports as required, but within 3 days of noting any deficiency.
12. Submit to Owner's Authorized Representative a weekly written report of commissioning progress, unresolved deficiencies, and projected inspection, and test schedule during field testing.
13. Take the lead in timely evaluation of deficiencies, and advise Owner's Authorized Representative on resolution.
14. Assist in resolving commissioned system disputes by performing research to determine the scope of the dispute, and informing the involved parties on possible solutions to disputes.

15. During the systems warranty period(s) CxA to retest any systems that had their full testing deferred during the initial functional testing due to the lack of peak season conditions. This testing must ensure that all system sequences of operations and capacity have been verified.
16. Prepare a Commissioning Report that includes a summary of overall commissioning process, including deficiencies found, deficiency corrections, unresolved deficiencies, approved equipment and systems, discrepancies between final design intent and as-built systems, completed commissioning checklists, test documentation, and other commissioning documentation.

F. Duties of General Contractor:

1. Attend commissioning portion of Project Meetings as necessary, minimum four meetings.
2. Participate and respond to commissioning related issues by using the Commissioning Authority's web based commissioning software Facility Grid.
3. Coordinate and direct system installers in executing their commissioning tasks.
4. Direct subcontractors to participate and respond to commissioning related issues by using the Commissioning Authority's web based commissioning software Facility Grid. A desktop, laptop, tablet or iPad will be required.
5. Coordinate with Commissioning Authority on integration of construction and commissioning schedules.
6. Oversee and perform documentation requirements for all Pre-Functional Checklists.
7. Notify Commissioning Authority when all the following has been achieved. It is permissible, with prior approval by Commissioning Authority, to provide notification for individual systems as the following are all completed for each system.
    a. All controls point-to-point and sequence checkout is complete.
    b. All test and balancing is complete.
    c. Normal equipment schedules have been activated.
    d. All control overrides and temporary valves have been returned to normal automatic' control.
    e. All manual isolation valves have been left open.
    f. Piping and duct systems have been cleaned and tested.
    g. Heating water system is fully operational under normal automatic operation.
    h. Luminaires are installed with operational daylighting controls and occupancy sensors.
    i. Distribution boards, including overcurrent devices, containing breakers over 600 amps, are installed.
    j. Building inspector acceptance of emergency lighting system following their site inspection.
8. Provide all startup, flushing, pressure testing, etc results/reports for commissioned systems.

G. Duties of Installer's and Manufacturer's Representatives:

1. Attend commissioning portion of Project Meetings as necessary, minimum two meetings.
2. Participate and respond to commissioning related issues by using the Commissioning Authority's web based commissioning software Facility Grid.
3. Within three months of the award of the Contract, as part of the required submittals for the contract, Contractor submits manufacturer's startup and installation procedures as well as controls point-to-point and sequence checkout and provides in checkset format for each piece of equipment and controls.

4. Demonstrate proper system operation in the presence of the Commissioning Authority.
5. Commissioning does not relieve installers from obligations to complete Work as required by Contract Documents.

H. Duties of BAS Installer:

1. Attend commissioning portion of project meetings as necessary, minimum two meetings.
2. Participate and respond to commissioning related issues by using the Commissioning Authority's web based commissioning software Facility Grid.
3. Review and approve Commissioning Procedures as relevant to controls work.
4. Point-to-Point Checkout:
   a. Perform point-to-point checkout and calibration of all energy management system points.
   b. Document checkout and calibration on forms as approved by mechanical designer, and/or Commissioning Authority.
   c. Submit three copies of the completed point-to-point checkout forms to the Owner's Authorized Representative within five working days of completion of field checkout. Distribute copies to the Commissioning Authority and the designer.
5. Control Sequence Testing:
   a. Complete Pre-Verification Tests for all systems monitored and controlled by the BAS. These tests will be developed by the Commissioning Authority and will be located in Facility Grid.
6. Submit to Commissioning Authority, prior to Sequence Demonstration, two copies of installed control Drawings, sequence narratives, control wiring diagrams, and program code or block diagrams.
7. Sequence Demonstration:
   a. After completing and documenting all required sequence tests with own staff, demonstrate sequence tests to the Commissioning Authority. Demonstration is to be performed by the BAS installer's programmer who programmed the control system for this specific project.
   b. If any of the demonstrated sequences fails to operate per the controls submittal, take corrective action and demonstrate the failed sequence tests to the Commissioning Authority a second time.
   c. If the Control Contractor fails to demonstrate proper sequence operation in any of the second round of sequence tests, the Commissioning Authority's costs for witnessing all further demonstration of that sequence may be assigned to the Control Contractor by the Owner as a deduct to their contracted price. The Control Contractor will not be responsible for costs related to failure due to design or to other factors beyond their control, though it is expected to call any design concerns (and other factors beyond their control that might cause failure) to the attention of the Commissioning Authority and the Owner's Authorized Representative.
8. Assist Commissioning Authority with programming of the energy management system for trend logs to support functional performance testing during field testing.
9. Assist Commissioning Authority with execution of the Commissioning Procedures. Commissioning Authority will present test schedule at Progress Meeting at least one week ahead of scheduled tests.
10. The Commissioning Authority, acting with Owner authority, may request the Control Contractor to assist with or perform minor loop tuning adjustments, set point and schedule changes, and other similar minor field corrections.

11. Recommended changes to the controls sequences, program code, and recommendations for additional points must go through the Owner's Authorized Representative and the designer. The designer is the final authority on all recommended sequence changes, and will submit such changes to the Owner's Authorized Representative for implementation.
12. Submit to Owner's Authorized Representative, at least two weeks prior to Final Completion, two copies of as-built version of points list, including I/O and virtual points, controls Drawings, program printout, and sequence narratives.
13. Participate in resolution of problems and deficiencies that are discovered during commissioning.

I. Duties of Balancer:

1. Attend commissioning portion of Project Meetings as necessary, minimum two meetings.
2. Participate in resolution of problems and deficiencies that are discovered during commissioning.
3. Assist Commissioning Authority with execution of commissioning procedures.
4. Demonstrate accuracy of final balance report in the presence of the Commissioning Authority. This will be a 10 percent spot check.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 COMMISSIONING PROCEDURES AT THE SITE

A. Testing Techniques:

1. Each testing procedure may use a variety of techniques. Generally it is preferred to observe new and existing equipment and systems during normal operation.
2. When functional and emergency modes of operation occur rarely or seasonally, if possible, simulate the conditions that trigger these operational modes.
3. Simulation of conditions may involve changing set points, changing schedules, simulating pneumatic system pressures or energy management system voltages and currents, disconnecting power, jumpering contacts, or other such procedures.
4. Whenever temporary adjustments are made, restore the system to its original condition once tests are completed.
5. When testing requires observing equipment operation over an extended period, use the building energy management system's trend logging capabilities or independent monitoring equipment.
6. Do not use the building automation system trend logging in the commissioning process prior to point-to-point checkout by Controls Contractor and approval of point-to-point checkout by Commissioning Authority.
7. Measurement of room lighting levels during evening hours with only artificial lighting, during mid-morning, around noon and mid-afternoon with only natural lighting and with both natural and artificial lighting. Repeat same measurements following calibration of room daylighting sensor.

B. Commissioning Documentation:

1. The Contractors are required to perform startup and checkout of their systems (prefunctional testing) and document the results in Facility Grid. The Commissioning Authority will provide electronic forms that may be used by the Contractors. The Contractors may use their own forms if they contain all the required information on the Commissioning Authority's forms, but prior approval must be obtained.

a. Where numeric data is required, a narrative entry or simple check-off is not acceptable.
b. Annotate trend logs and monitored data as necessary to clarify meaning, and attach to relevant test reports.
c. Do not attach irrelevant data to test reports.

2. The Contractor sends the startup and checkout forms to the Commissioning Authority when they are complete and functional. The Contractor sends a "Certificate of Readiness" with the forms which will signal that functional testing can begin.
3. The technician who performed the pretesting and checkout of the system completes the Pre-Functional Checklists using the web based commissioning software Facility Grid.
4. E-mail an "issues log" weekly to inform the design and construction team of issues that need resolution. The "issues log" will open and close items as they are discovered and resolved until all items are closed.
5. The Commissioning Authority will assemble all the information from the Commissioning Plan (test forms, trend logs, issues log, and basis of design) into a final Commissioning Report.

C. Coordination of Commissioning and Equipment Startup: Do not initiate functional performance testing for equipment or systems in advance of their startup and checkout by affected equipment or system installers and manufacturers' representatives.

D. Test Acceptance Criteria:

1. Acceptance Criteria are the test results that are required before the mode of performance or inspection item in question will be considered acceptable.
2. Any procedures in Specification Sections 22 0800, 23 0800, or 26 0800 that begin with "Verify that...." have an implied acceptance criterion that the sequence as stated is proven to occur and is documented with visual observation notes, measurements, trend logs, and/or monitored data.
3. Acceptance criteria for other functional modes and checklist items are as stated in each section of the Commissioning Plan.
4. Input will be sought when necessary from the Architect's Engineer to determine if test results indicate compliance with Design Intent.
5. The Commissioning Authority will recommend acceptance or rejection of commissioned system work based on test results.

E. Resolution of Deficiencies:

1. Adjust, repair, or replace defective equipment and systems to meet Commissioning Procedure Acceptance Criteria as directed by Owner's Authorized Representative.
2. Inform the Owner's Authorized Representative and Commissioning Authority of the date for completion of corrective activities.
3. If the date for completion of corrective work passes without resolution of deficiencies, Owner's Authorized Representative reserves the right to obtain supplementary services and equipment to correct the problem as indicated in General Conditions.

F. Rechecking and Retesting Charges:

1. In the event of a second failure of a specific commissioning procedure item or test, the responsible party may be assessed charges by Owner's Authorized Representative.

2. Charges will be based on each party's actual expenses, including normal hourly billing rates for preparation, testing, and travel time, and materials, equipment rental, and travel expenses as applicable.

G. Construction and Acceptance Milestones for Tasks Related to Commissioning:

1. Equipment, ductwork, and piping installation.
2. Equipment startup.
3. Pre-functional checklists.
4. Substantial completion.
5. Point-to-point checkout and sequence testing of controls.
6. Test and balance.
7. Commissioning field testing.
8. Owner training.
9. Occupant move-in.
10. Final completion.
11. Seasonal testing.
12. Commissioning report submittal.

END OF SECTION

SECTION 23 3400 - HVAC FANS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:

1. Mixed Flow In-Line Fans
2. Ceiling Exhaust Fans
3. In-Line Centrifugal Fans
4. Directional Destratification Fan

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material gauges and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. For belt-driven fans, indicate the number of belts provided for design duty.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Motors: Premium efficiency. Electrically Commutated Motors (ECM) where scheduled on Drawings.
2. Sound power levels as scheduled on Drawings. If not scheduled, within 5 percent of Basis of Design at design flow.
3. Project Altitude: Base air ratings on sea-level conditions for project sites below 2,000 feet in elevation. Base air ratings on actual site elevations for project sites above 2,000 feet in elevation.
4. Operating Limits: Classify according to AMCA 99.
5. 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.
6. AMCA Compliance: Products are to comply with performance requirements and are to be licensed to use the AMCA-Certified Ratings Seal.
7. NEMA Compliance: Motors and electrical accessories are to comply with NEMA standards.

8. UL Standard: HVAC Fans are to comply with UL 705. Fans used in grease exhaust applications are to be UL 705 - Supplement SC listed for grease exhaust. Fans used for smoke control applications are to be UL 705 - Supplement SD listed for Power Ventilators for Smoke Control.
9. Belt-driven fans used for smoke control applications are to have 1.5 times the number of belts required for the design duty, with the minimum number of belts being two.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
C. Lift and support units with manufacturer's designated lifting or supporting points.

1.08 COORDINATION

A. Coordinate size and location of structural-steel support members.
B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.01 MIXED FLOW IN-LINE FANS

A. Manufacturers:
   1. Greenheck
   2. Cook
   3. Twin City
B. Housing and Outlet:
   1. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
   2. Tubular fan housing completely welded and coated with a minimum of 2-4 mils of Polyester Urethane, electrostatically applied and baked. No uncoated metal fan parts allowed.
   3. Housing and bearing support constructed of welded structural steel members to prevent vibration and rigidly support shaft and bearings.
   4. Housings include welded steel vanes to straighten airflow prior to exiting fan discharge.

5. Fan mounted in either vertical or horizontal configurations and field rotation of motor position in 90 degree increments. Bearing life not reduced below specified level in different configurations. Accommodate base mount or ceiling hung mounting without structural modifications to fan.
6. An access door supplied for impeller inspection and service.
7. OSHA compliant belt guard or motor cover to be included to completely cover motor pulley and belt(s).

C. Impeller:

1. Fan impeller is mixed flow design, electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19.
2. Fan impeller manufactured with continuously welded steel airfoils and coated with a minimum of 2-4 mils of polyester urethane, electrostatically applied and baked.
3. Wheel and fan inlet have precise running tolerances for maximum performance and operating efficiency.

D. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings.

Reference Section 23 05 13, Common Motor Requirements for HVAC Equipment.

E. Drive:

1. Fan shaft turned and polished steel sized for first critical speed of at least 25 percent over maximum operating speed for each pressure class.
2. Fan shaft bearings are heavy-duty grease lubricated, self aligning, or roller pillow block types.
3. Bearings to be designed with low swivel torque to allow outer race of bearing to pivot or swivel within cast pillow block. Bearings 100 percent tested for noise and vibration by manufacturer. Bearings 100 percent tested to ensure inner race diameter is within tolerance to prevent vibration.
4. Bearings selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each pressure class Average Life or (L-50) of 400,000 hours.
5. Bearings fixed to fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws not allowed.
6. Bearings have extended lube lines with fittings to allow for lubrication.

F. Accessories:

1. Access Doors: Shaped to conform to scroll, with quick opening latch type handles and gaskets.
2. Protective coating on fan wheel and interior of fan housing where scheduled. Apply coating before balancing fans and repair any breaks in coating which occur during balancing. One 6-mil coat of white plasite #7122 and one 6-mil coat of black plasite #7122.
3. Vibration isolation as scheduled and specified. Reference Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

2.02 CEILING EXHAUST FANS

A. Manufacturers:

1. Greenheck
2. Cook
3. Broan

4. Twin City
5. Panasonic

B. Description: Centrifugal fan, direct drive, cabinet and exhaust grille. AMCA rated. Sound level as scheduled. Fan shrouds, motor, and fan wheel are to be removable for service.

C. Wheel: Double width, double inlet, forward curved blades:

D. Housing: Acoustically insulated steel casing, factory standard finish, bottom access through grille, ducted outlet, egg crate inlet grille. Provide stainless steel grille where scheduled.

E. Drives: Direct drive.

F. Back draft damper.

G. Motor: Integrally mounted with pre-lubricated sealed ball bearings. Engineered and rated to run continuously.

1. Variable-Speed Controller: Provide solid-state control to reduce speed from 100 percent to less than 50 percent.

H. Isolation: Rubber-in-shear vibration isolators.

2.03 IN-LINE CENTRIFUGAL FANS

A. Manufacturers:

1. Greenheck
2. Cook
3. Twin City

B. Description: In-line centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. Wheel: Cast aluminum backward inclined with inlet cone statically and dynamically balanced within its own bearings. Provide coating on wheel, electro-statically applied and baked, where scheduled.

D. Housing:

1. Heavy gauge steel or aluminum housing, suitable for Fan Class, factory standard finish.
2. Removable panels for access to all interior components.
3. Horizontal configuration.
4. Inlet and discharge duct collars.
5. 1-inch thick, 1.5 pounds per cubic foot density fiberglass liner.
6. Support bracket adaptable to floor, sidewall, or ceiling mounting.
7. Provide coating on interior of housing, electro-statically applied and baked, where scheduled.

E. Bearings and Drives:

1. Bearings: Heavy duty pillow block type, self greasing ball bearings with ABMA 9 life at 50,000 hours.
2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil.
3. Drive: Direct drive matched to fan loads with speed controller. Motor encased in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.

a. Electrically Commutated Motor (ECM) where indicated on Fan Schedule on Drawings.

F. Accessories:

1. AMCA 99 Type B spark proof construction where scheduled.
2. Variable-Speed Controller: Provide solid-state control to reduce speed from 100 percent to less than 50 percent for motors 1/2 HP or smaller.

G. Vibration Isolation: Wheel and motor mounted on integral double deflection neoprene isolators.

H. Vibration isolation as scheduled and specified. Reference Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

1. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. ODP for motors located indoors and TEFC for motors exposed to moisture.

2.04 DIRECTIONAL DESTRATIFICATION FAN

A. Propeller:

1. Constructed of aluminum blades riveted to a steel hub.

B. Propeller Guard:

1. Comply with OSHA guidelines for safety.
2. Constructed of structural steel members to prevent vibration and to support the weight and load of the motor and propeller.

C. Electronically Commutated (EC) Motor:

1. Motor Enclosure: Totally Enclosed Non-Vented (TENV) - No opening in the frame or brackets.
2. Permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
3. Factory-installed 10-foot power cable with plug for ease of installation. Power cable and plug shall be wired for 115V operation.
4. Speed controllable down to 20 percent of full speed (80 percent turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
5. Accessible for maintenance from the exterior of the fan housing.

D. Handle:

1. 12-gauge galvanized steel.
2. Pivot points for field-adjustment of the fan’s hanging position up to 45 degrees in either direction (90 degrees total adjustment range).

E. Housing:

1. Durable co-polymer composite material.

F. Options/Accessories:

1. Remote Speed Control:
   a. Control specifically designed to provide 0–10-volt DC signal.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Install in accordance with manufacturer's instructions.

B. Install power ventilators level and plumb.

C. Fans used in welding, chemical, and/or fume exhaust applications are to be of spark-proof construction and are to be protected with coatings as required to protect parts in the air stream from the chemicals and materials the fan will be exposed to.
D. Units using vibration isolation devices are scheduled on Drawings.
E. Support suspended units from structure threaded steel rods and vibration isolation device scheduled on Drawings.
F. In seismic zones, restrain support units.
G. Install units with clearances for service and maintenance.
H. Provide fixed sheaves required for final air balance.
I. Provide safety screen where inlet or outlet is exposed.
J. Pipe scroll drains to nearest floor drain.
K. Provide backdraft dampers on discharge of exhaust fans and as indicated on Drawings.
L. Duct installation and connection requirements are specified in other Division 23, HVAC Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors per Section 23 33 00, Air Duct Accessories.
M. Install ducts adjacent to power ventilators to allow service and maintenance.
N. Ground equipment.
O. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
P. Equipment Startup Checks:
    1. Verify that shipping, blocking, and bracing are removed.
    2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
    3. Verify that cleaning and adjusting are complete.
    4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
    5. Verify lubrication from bearings and other moving parts.
    6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
    7. Disable automatic temperature-control operators.
Q. Starting Procedures:
    1. Energize motor and adjust fan to indicated rpm.
    2. Measure and record voltage and amperage.
R. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

S. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

T. Shut unit down and reconnect automatic temperature-control operators.

U. Replace fan and motor pulleys as required to achieve design airflow.

V. Provide totally enclosed fan cooled motors when motor is located outdoors, whether under a cover or not, or exposed to moisture. Provide protective covering for electronically commutated motors located in outdoor or wet/wash-down locations.

W. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

X. Adjust damper linkages for proper damper operation.

Y. Lubricate bearings.

Z. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

AA. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

BB. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC fans. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

3.02 CEILING EXHAUST FANS

A. Suspend units from structure; use steel wire or metal straps.

END OF SECTION

SECTION 23 7223 - PACKAGED AIR-TO-AIR ENERGY RECOVERY VENTILATORS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:

1. Indoor Packaged Energy Recovery Ventilators:
    a. Shipping and Handling
    b. Factory Testing
    c. Cabinet, Casing and Frame
    d. Supply and Exhaust Fans
    e. Electrical
    f. Fixed Plate Heat Exchanger
    g. Drain Pan
    h. Filters
    i. Dampers
    j. Standard Terminal Block

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment (with Addendum 1).
2. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils (with Addenda 1, 2 & 3).
3. ANSI/AHRI Standard 340/360 - Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
4. AHRI 1060 I-P - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment.
5. ASHRAE Standard 84 - Method of Testing Air-to-Air Heat/Energy Exchangers.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Product Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, electrical characteristics and connection requirements.
2. Certified fan performance curves with system operating conditions indicated.
3. Certified fan sound-power ratings.
4. Filters: Data for filter media, filter performance data.
5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Interior surfaces of units meet erosion and growth resistance requirements of ASHRAE 62.1, latest edition, as well as construction requirements for equipment.
2. 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.
3. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
4. Energy-Efficiency Ratio: Meet minimum requirements shown on Drawings.
5. Coefficient of Performance: Meet minimum requirements shown on Drawings.
6. AHRI Certification: Provide AHRI certified and listed units.
7. Sound Power Level Ratings: Comply with AHRI 270, Sound Performance Rating of Outdoor Unitary Equipment (with Addendum 1).
8. Entire unit to be ETL Certified per UL Standard 1995 and bear an ETL sticker.
9. Performance: Scheduled capacities and face areas are minimum accepted values. Scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Provide minimum 5 year manufacturer warranty on energy .

1.07 EXTRA MATERIAL

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

1. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.01 INDOOR PACKAGED ENERGY RECOVERY VENTILATORS

A. The following manufacturers will be considered provided they comply with Contract Documents:

1. Valent
2. Greenheck
3. AAON
4. Semco
5. Renewaire

B. Shipping and Handling:

1. Provide each unit completely factory assembled and shipped in one piece.
2. Ship packaged units fully charged with refrigerant as scheduled.
3. Units to have decals and tags to indicate caution areas and aid unit service.
4. Provide unit nameplates fixed to the main control panel door.

5. Provide electrical wiring diagrams attached to the control panels.
6. Provide installation, operating and maintenance bulletins and start-up forms supplied with each unit.

C. Factory Testing:

1. The unit to undergo a complete factory run test prior to shipment. Factory test sheets to be shipped with unit.

D. Cabinet, Casing, and Frame:

1. Standard double-wall construction for sidewall access doors and floor areas to be provided with 22 gauge solid galvanized steel inner liners to protect insulation during service and maintenance. Provide a minimum of 2-inch thick, 3/4-pound density Insulation, neoprene coated glass fiber or foam injected insulation with a minimum density of 2 pounds per cu.ft. Design unit cabinet to operate at total static pressures up to 6.5-inches wg. Insulation on ceiling and end panels secured with adhesive and mechanical fasteners.
2. Exterior surfaces constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat. Finished surface to withstand a minimum 1000-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
3. Provide service doors for access to all unit components. Service doors constructed of heavy gauge galvanized steel with a galvanized steel interior liner. Service doors mounted on multiple, stainless steel hinges and secured by a latch system that is operated by quarter turn handles.
4. Provide lifting brackets with lifting holes to accept cable or chain hooks.

E. Supply and Exhaust Fans:

1. Provide fan assemblies statically and dynamically balanced at the factory, including a final trim balance, prior to shipment. Provide fan assemblies to employ solid steel fan shafts. . Provide bearings sized to provide an L-50 life at 200,000 hours. Entire fan assembly to be isolated from the fan bulkhead and mounted on isolators.
2. Provide heavy-duty premium efficiency fan motors, 1800 rpm open drip-proof (ODP) type with grease lubricated ball bearings with external lubrication points.

F. Electrical:

1. Unit wiring to comply with NEC requirements and with applicable UL standards. Electrical components to be UL recognized where applicable. Wiring and electrical components provided with unit to be number and color-coded and labeled according to the electrical diagram provided for easy identification. Provide unit with a factory wired weatherproof control panel. Unit to have a single point power terminal block for main power connection. Provide terminal board for low voltage control wiring. Provide each compressor and condenser fan motor furnished with contactors and thermal overload protection. Supply and return fan motors to have contactors and external overload protection.
2. Phase failure and under voltage protection on three-phase motors provided to prevent damage from single phasing, phase reversal, and low voltage conditions.
3. The unit manufacturer to install power and control wiring.
4. Provide ground fault protection to protect against arcing ground faults.

G. Fixed Plate Heat Exchanger:

1. Fixed plate heat exchanger constructed with aluminum.

H. Drain Pan:

1. Provide stainless steel positively sloped drain pan with the cooling coil. Provide drain pan connected to a threaded drain connection extending through the unit base. Provide units with stacked cooling coils with a secondary drain pan piped to the primary drain pan.

I. Filters:

1. Provide 2-inch thick pleated panel filters with MERV-8 rating. Provide filters frame mounted and to slide into galvanized steel racks contained within the unit. Provide filter racks to protect both sides of energy recovery device.

J. Dampers:

1. Provide outside air dampers sized to handle 100 percent of the supply air volume. Provide low leak dampers. Provide damper blades with rubber edge and end seals. Damper leakage to be less than 0.2 percent at 1.5-inches static pressure differential. Low leak damper to be Class 2 per AMCA Standard 511.

K. Standard Terminal Block:

1. Unit to be provided with a terminal block for field installation of controls by others. Damper actuators by controls installer.

PART 3 - EXECUTION

3.01 INDOOR PACKAGED ENERGY RECOVERY VENTILATORS

A. General Installation Requirements:

1. Install in accordance with manufacturer's instructions.
2. Use touch-up paint to repair scratches and minor damage to equipment prior to start-up.
3. Duct installation requirements are specified in other Division 23, HVAC sections. Drawings indicate the general arrangement of ducts.
4. Electrical:
   a. Electrical System Connections: Comply with applicable requirements in Division 26, Electrical Sections for power wiring, switches, and motor controls.
   b. Ground equipment according to Division 26, Electrical.
   c. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
5. Drain Pan:
   a. Pipes drain connection to floor drain.
   b. Clean drain pan.
6. Filters:
   a. Provide access for filter installation.
   b. Install in accordance with Construction Documents, manufacturer's written requirements and instructions.
7. Dampers:
   a. Install in accordance with Construction Documents, manufacturer's written requirements and instructions.
8. Standard Terminal Block:
   a. Wiring by others.

B. Field Quality Control:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
2. Perform the following field quality-control tests and inspection and prepare test reports:
    a. After installing rooftop air conditioners and after electrical circuitry has been energized, test units for compliance with requirements.
    b. Inspect for and remove shipping bolts, blocks, and tie-down straps.
    c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Remove malfunctioning units, replace with new units, and retest as specified above.
4. Startup Service:
    a. Engage a factory-authorized service representative to perform startup service.
    b. Protect or remove energy recovery devices prior to starting the units to insure damage does not occur to the devices or media. Replace at no cost to Owner if devices/media get damaged.
    c. Complete installation and startup checks according to manufacturer's written instruction and do the following;
        1) Inspect for visible damage to unit casing.
        2) Inspect internal insulation.
        3) Verify that labels are clearly visible.
        4) Verify that clearances have been provided for servicing.
        5) Verify that controls are connected and operable.
        6) Verify that filters are installed.
        7) Adjust vibration isolators.
        8) Inspect operation of barometric dampers.
        9) Lubricate bearings on fan.
        10) Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
        11) Start unit according to manufacturer's written instructions.
            (a) Start refrigeration system in summer only.
            (b) Complete startup sheets and attach copy with Contractor's startup report.
        12) Inspect and record performance of interlocks and protective devices; verify sequences.
        13) Operate unit for an initial period as recommended or required by manufacturer.
        14) Inspect outside-air dampers for proper stroke and interlock with return-air dampers.
        15) Verify operation of remote panel, including pilot-light operation and failure modes.
        16) After startup and performance testing, change filters, vacuum heat exchanger, lubricate bearings.
5. Adjusting:
    a. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

b. Occupancy Adjustments: Within 12 months of date of Substantial Completion, provide onsite assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

6. Demonstration:
   a. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop air conditioners. Reference Division 01, General Requirements.

END OF SECTION

SECTION 23 7323 - CUSTOM CENTRAL STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:

1. Casing
2. Plenum Fan
3. Fan Accessories
4. Plenum Fan Array
5. Motor and Drive
6. Hydronic Coils
7. Filters
8. Dampers
9. Flat Plate Heat Exchanger
10. Electrical

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc. (ANSI/AMCA 210, same as ANSI/ASHRAE 51).
2. AHRI 260 I-P - Sound Rating of Ducted Air Moving and Conditioning Equipment.
3. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils (with Addenda 1, 2, & 3).
4. AHRI 430 I-P - Performance Rating of Central Station Air-handling Unit Supply Fans (with Addendum 1).
5. AHRI 1060 I-P - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment.
6. AHRI Directory of Certified Product Performance.
7. AFBMA 9-90 - Load Ratings and Fatigue Life for Ball Bearings.
8. ASTM B117 - Salt Spray (Fog Testing).
9. ASTM C1071 - Thermal and Acoustical Insulation (Mineral Fiber, Duct Lining Material).
10. ASTM D1654 - Standard Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
11. ASTM D1735 - Water Resistance of Coatings Using Water Fog Apparatus.
12. ASTM D3359 - Standard Test Methods for Measuring Adhesion by Tape Test.
13. ASTM E84 - Surface Burning Characteristics of Building Materials.
14. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
15. Units with factory wiring to be UL/ETL/CSA approved and labeled.
16. Filter media to be ULC listed.
17. AMCA 99-1401-66 Operating Limits for Central Station Air Handlers.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Product Data:
   a. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, and electrical characteristics and connection requirements.
   b. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
   c. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
   d. Water Coils: Computer selection data for each coil bank indicating entering/leaving air conditions, entering/leaving fluid conditions, heating/cooling capacity, fluid flow, face velocity, air pressure drop, fluid pressure drop and circuiting. Coil selections corrected for elevation and glycol content if applicable.
   e. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
   f. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
2. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
3. Manufacturer's Instructions: Include installation instructions.
4. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, accessories listed in this specification, and wiring diagrams.
5. Certificates: Certify that coil capacities, pressure drops and selection procedures meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Certification: Certify air-handling units in accordance with AHRI 430 I-P.
2. Heating, Cooling, and Air Handling Capacity and Performance Standards: AHRI 430 I-P, AHRI 410, ASHRAE 51, and AMCA 210.
3. Performance Criteria:
   a. Provide fans and motors capable of stable operation at design conditions cubic feet per minute and 110 percent pressure.
   b. Select fan operating point to right hand side of peak static pressure point and near the peak of static efficiency.
   c. Operating Limits: AMCA 99-1401-66.
4. Provide units constructed by a manufacturer who has been manufacturing air handling units for at least five years.
5. Ship units in one piece where possible and in shrink wrapping to protect the unit from dirt, moisture and/or road salt. Shipping splits can be provided for installation. Provide lifting lugs on each slide of the split to facilitate rigging and joining of segments.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved Manufacturers:

1. Energy Labs
2. Haakon
3. Huntair
4. Innovent
5. Temtrol
6. Alliance
7. Governair

2.02 GENERAL

A. Configuration - Fabricate with:

1. Supply Fan
2. Exhaust Fan
3. Cooling Coils
4. Heating Coils
5. Filters
6. Dampers
7. Air-to-Air Energy Recovery

B. Fabrication: Conform to AMCA 210 and AHRI 430 I-P.

C. Description: Provide factory-fabricated indoor air handling unit(s) with capacity and accessories as indicated on the schedule. Units to have overall dimensions as indicated and fit into the space available with adequate clearance for service. Units to come completely assembled. Where shipping constraints prohibit shipment of fully assembled units, disassemble units in factory into sections no smaller than necessary. Protect disassembled sections with weathertight shrinkwrap. Furnish units with sufficient gasket and bolts for reassembly in the field by the contractor. Electrical components and assemblies to comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems. Units to comply with NFPA 70, National Electrical Code, as applicable for installation and electrical connections of ancillary electrical components of air handling units.

2.03 CASING

A. Construction: Construction of the air handling unit to consist of a 10 gauge coated welded steel structural base with formed 16 gauge galvanized steel or 18 gauge aluminum exterior casing panels. Provide exterior casing panels attached to the gasketed steel frame with corrosion resistant fasteners. Provide casing panels completely removable from the unit exterior without affecting the unit's structural integrity. (Units without framed type of construction to be considered, provided the exterior casing panels are made from 14 gauge galvanized steel, maximum panel center lines are less than 20-inches and deflection is less than L/200 at 150 percent of design static pressure.) Air handling unit casing to be of the “no-through-metal” design. Casing to incorporate insulating thermal breaks to ensure that, when fully assembled there is no path of continuous unbroken metal to metal conduction from inner to outer surfaces. Provide necessary support to limit casing deflection to L/200 of the narrowest panel dimension. Caulk and seal panel seams for an airtight unit. Leakage rates to be less than 1 percent at 150 percent of design static pressure. Exterior Panel Finish: Painted with a polyester resin coating designed for corrosion resistance meeting or exceeding ASTM B-117 Salt Spray Resistance of 1,000 hrs at 95 degrees F.

B. Double Wall - Interior Liner:

1. Each unit to have double wall construction with 20 gauge solid galvanized, stainless steel, or aluminum liner in the entire unit. 18 gauge perforated galvanized or aluminum liner in all fan sections. Provide removable double wall interior panels from the outside of the unit without affecting the structural integrity of the unit.
2. Provide perforated sections furnished with neoprene, tedlar, or mylar liner used to prohibit the erosion of the insulation into the air stream.
3. For all sections with solid liners, provide internal liner suitable for washing with a pressure washer or steam cleaner without risk of wetting the insulation. Provide liner installed over top of the panel flanges and each liner seam sealed with a lap joint. Install wall liner over top of the base water dam such that any water run-off from the liner will drip into the water tight base rather than into the wall panel. Install roof liner over top of the roof support so that water cannot enter the roof insulation.
4. Protect insulation edges with metal lagging. Insulation systems using stick pins or adhesives are not acceptable.

C. Floor: Provide unit perimeter base completely welded and fabricated using heavy gauge structural steel tubing. Provide C-Channel cross supports welded to perimeter base steel tubing and located on maximum 24-inch centers to provide support for internal components. Base rails to include lifting lugs welded to perimeter base at the corner of the unit or each section if disassembled. Paint entire base frame with a phenolic coating for long term corrosion resistance. Provide internal walk-on floor 16 gauge galvanized steel or 14 gauge aluminum tread plate and secured to the cross supports and perimeter base with corrosion resistant fasteners. Provide outer floor of the unit made from 16 gauge galvanized steel or 18 gauge aluminum sealed and secured to the underside of the unit. Provide 2-inch double wall floor, foam insulated. Provide floor seams that are gasketed for thermal break and sealed for airtight and watertight construction. Single wall floors with glued and pinned insulation and no sub floor are not acceptable. Provide base frame attached to the unit at the factory.

1. Provide auxiliary drains in fan sections downstream of cooling coils and in mixing sections.
2. Terminate drain connections on floor mounted air handling units at the side of the unit.

D. On exterior units pitch roof panels 1/4-inch per foot for drainage and with standing seams.

E. Insulation: Entire unit to be insulated with a minimum 2-inch (R13) thick foam-injected insulation. Coefficients to meet or exceed a 2.0 PCF density material rating. Insulation to meet the erosion requirements of UL 181 facing the air stream and fire hazard classification of 25/50 (per ASTM-84 and UL 723 and CAN/ULC S102-M88). Encapsulate insulation edges within the panel.

F. Access Doors:

1. Provide unit equipped with solid double wall insulated, hinged access doors. Provide foam filled extruded aluminum or galvanized steel door frame of same gauge as unit cabinet construction and interior liner with a built in thermal break barrier and dual full perimeter gasket forming an air tight seal. Provide door hinge assembly die cast zinc with stainless steel pivot mechanism, completely adjustable. Provide ETL, UL and CAL-OSHA approved tool operated safety latch on fan section access doors. Doors must be the same thickness as the unit casing.
2. Access Door Handles: Provide minimum of two "Ventlok" Model #310 or approved equivalent, heavy duty high pressure latches operable from either side of the door.
3. Minimum door size 24-inches wide and 60-inches high (where height and width permits). Provide larger door in fan section if required for motor removal. One door for each section.
4. Positive pressure doors open inward and negative pressure doors open outward.
5. Provide wired glass window at the following location for inspection at fan/motor section or humidifier.
6. Where double wall interior liner is specified to be suitable for pressure washing, construct access doors of same construction.

G. Blank-Offs: Provide blank-off panels where required to ensure no air bypass between sections, through perforated panels or around coils or filters.

H. Motor/Fan Removal: Provide structural steel beam within air handler to facilitate motor and fan wheel removal. Orient steel beam over motor/fan and over access door.

2.04 PLENUM FAN (EXHAUST)

A. Plenum Fan (PF) SWSI Fans: Provide single width single inlet arrangement 3 plenum fan as indicated on the schedule. Provide fan blades that are hollow airfoil in shape, welded to the center and wheel side plates. Provide heavy duty fan bearings, self-aligning; Dodge concentric “Grip Tight” type with full contact on shaft bearings selected for a minimum L-50 life of 200,000 hours at maximum horsepower and operating speed for the classification. Rigid support for the inlet bearing must be removable for access to the wheel. Inlet cone precision spun. Provide fan shaft turned, ground and polished solid steel rated at maximum RPM below critical speed. Fan wheel and sheaves keyed to the shaft. Provide IRD balanced fan IRD balanced (per ANSI/AMCA 204-96 fan application category BV-3) at design RPM with belts and drives in place to a vibration velocity less than or equal to 0.157-inch per second measured horizontal and vertical at each bearing pad. Vibration amplitudes are in inches/second-peak. All values are filter-in at the fan speed. Fan rated in accordance with AMCA 210 for performance and AMCA 300 for sound.

B. Provide metal belt guard for fans equipped with belt drives.

C. Provide flexible duct connections to separate fan from adjacent sections. Reference Section 23 33 00, Air Duct Accessories.

2.05 FAN ACCESSORIES

A. Furnish and install pressure relief fittings furnished on bearings.

B. Furnish and install stainless steel shaft.

C. Furnish and install internally spring isolated fan, motor and drive on a structural steel base complete with UV rated flexible connection. Formed metal isolation bases will not be acceptable. Provide seismically restrained isolator type with 2-inch deflection in accordance with code and AHJ. Reference Section 23 05 48, Vibration and Seismic Controls for HVAC Equipment.

D. Furnish and install fan inertia base. Provide base constructed from structural steel and a minimum 14 gauge bottom pan. Formed members are not acceptable. If recommended by manufacturer, provide 1/2-inch rebar welded in place on 12-inch centers in both directions; concrete fill (4-inches deep) is furnished by contractor. The unit must be in a permanent location before pouring concrete.

E. Airflow Monitoring Device:

1. Provide airflow monitoring device at the inlet of supply and exhaust fans. Air monitoring device to consist of an array of differential pressure flow sensors mounted at opposing 90 degree positions around the inlet of the plenum fan. Provide flow sensors manifolded together with pneumatic tubing to form a piezometric ring. Each fan assembly and air monitoring device to have been tested for airflow vs. differential pressure and AMCA 610 certified. 4-20 mA low pressure transducer with accuracy of plus or minus 2 percent full span and temperature compensated from 25 degrees F to 150 degrees F, mounted on fan inlet plate or fan bulk head wall to provide feedback and input to BMS. Air monitoring device not to obstruct the fan inlet, be directly mounted across the fan inlet or have any effect on fan air performance or sound power levels.
2. Display to be as follows: Provide a method of displaying digitally, in real time, the fan's current airflow. Provide display capable of showing the airflow of all fans simultaneously. For interaction with a controller, the display to output one 0-10 VDC signal for each fan being monitored. The display to require no maintenance throughout its life. Output signal to be accurate to plus or minus 8.5 percent of natural span, including non-linearity, hysteresis and non-repeatability. Display must be water tight allowing for use in outdoor locations. If the display is not water tight, install in a weatherproof housing.

F. Extended lubrication lines to exterior of unit casing.

2.06 PLENUM FAN ARRAY (SUPPLY FANS)

A. The fan array is to consist of multiple, direct driven, arrangement 2 plenum fans spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. Provide fan array constructed per AMCA requirements for the duty specified (Class III). Fans selected to deliver design air flow at the specified operating TSP at the specified motor speed and as scheduled. Fan array selected to operate at a system total static pressure that does not exceed 90 percent of the specified fans peak static pressure producing capability at the specified fan speed. Provide (supply air or return air) fan array with a coplanar silencer for sound absorption. The coplanar silencers (sound attenuators) will reduce the bare fan discharge sound power levels as noted below and/or in the Drawings. If NOT otherwise specified, the acoustical silencers to reduce the bare fan discharge sound power levels by a minimum of 15 db, re 10-12 watts with center frequencies of 125, 250, 500, 1000, 2000, 4000, and 8000 HZ when compared to the same Air Handling Unit without the silencers.

B. Motors:

1. Motors to be electronically commutated or IEEE inverter duty, premium efficiency TEAO T-frame motors selected at the specified operating voltage, RPM, and efficiency as specified or scheduled. Provide each motor with an AEGIS bearing protection ring to prevent Electrical Discharge Machining (EDM) damage to the motor bearings.
2. Provide each fan/motor assembly dynamically balanced to meet AMCA Standard 204-96, category BV-5, Grade 1.0 with peak to peak deflection equal to or less than 0.08 mil at the design operating speed for the fan/motor cartridge.

C. Provide each fan motor individually wired to a control panel containing Variable Frequency Drive(s) (VFD) or starter(s), as specified. Wire sizing to be determined, and installed, in accordance with applicable NEC standards.

D. Electrical: Provide a complete electrical system required to run the fan array system including equipment, material, electrical enclosure and electrical components. Provide for single point electrical connection unless scheduled otherwise.

E. Fan Array Technology Control:

1. Fan Array with Dedicated Variable Frequency Drive for Each Motor:
    a. Provide a VFD for each fan motor with drive capacity sized for the motor's maximum TEAO rating.

F. Flow Monitoring System:

1. Provide each fan assembly equipped with AMCA 610 certified airflow monitoring probes. Flow measuring system to consist of a flow measuring station with two static pressure taps and two total pressure tubes located at the throat of the fan inlet cone. Flow measuring station not to obstruct the inlet of the fan and have no effect on fan performance (flow or static) or sound power levels. A surface mounted indicator to provide:
    a. Output control signal transmitter (4-20mA)(0-10 volt) for use in BMS.
    b. Digital CFM readout (mounted on unit exterior).

G. Provide metal belt guard for fans equipped with belt drives.

H. Provide flexible duct connections to separate fan from adjacent sections. Reference Section 23 33 00, Air Duct Accessories.

2.07 MOTOR AND DRIVE

A. Fan motors are to be mounted and isolated on same integral base as fan.

B. Motors: Totally enclosed fan cooled. Reference Section 23 05 13, Common Motor Requirements for HVAC Equipment.

C. Provide shaft grounding on motors served by variable frequency drives.

D. Direct drive or V-belt drive sized for 150 percent of motor horsepower, with variable sheaves for 7.5 hp or lower motors and fixed sheaves for 10 hp and greater motors.

E. Variable frequency drives specified in Section 23 09 13, Variable Frequency Drives.

2.08 HYDRONIC COILS

A. Coils to be certified by manufacturer in accordance with AHRI 410, capacities as indicated on drawings.

B. Extended surface type consisting of copper tubing mechanically expanded to bond with plate fins. Design for serpentine flow with one or more feeds from common supply and return headers. Arrange for counter flow operation with supply connections at the bottom.

C. Performance: Provide capacity indicated at water flows no greater than scheduled.

D. Factory Testing: Leak test coils under water at 300 PSIG minimum.

E. Working Pressure: 150 PSIG.

F. Construction:

1. Provide coil fins with minimum thickness of 0.0095-inch of aluminum, as shown on Drawings. Mechanically expand tubes into the fins.
2. Provide coil tubes of 5/8-inch outside diameter seamless copper, 0.025-inch nominal tube wall thickness, expanded into fins, brazed at joints. Provide soldered U-bends having a minimum tube wall thickness of 0.025-inch.
3. Casing: 16 gauge galvanized steel.
4. Headers: Seamless copper tube brazed to heat transfer tubes. Provide high point air vent fitting and low point drain fitting.
5. Connections: Same end for supply and return unless noted otherwise.
6. Intermediate Supports: Provide for coils with finned length greater than 44-inches, with maximum spacing of 42-inches.

G. Cooling Coil Drain Pans: Welded 16 gauge 304 stainless steel, cross broken, double sloped to drain connections, designed to extend entire length of cooling coils including headers and return bends, minimum 2-inches deep. Bottom drain pan insulated with closed cell foam to prevent condensation below unit. Must meet ASHRAE Standard 62.1, most current edition. For coil banks with heights larger than 48-inches, provide intermediate drain pans at no greater than 48-inch intervals. For suspended units, provide a UL listed float switch, Water Gard Electronic Condensation Control System as manufactured by Water Gard Inc., with magnetic, weighted, or clip-on sensor assembly, power transformer powered from unit, LED remote warning light, push button reset, and emergency shut off of air handling unit on overflow.

2.09 FILTERS

A. Provide filters of the type and MERV rating or efficiency indicated on the schedule. Provide factory fabricated filter sections of the same construction and finish as the unit. Housing to accommodate filters corresponding to ASHRAE 52-76 Standards. Face loaded pre- and final filters to have Type 8 frames as manufactured by AAF, FARR or equal. Side service filter sections to include hinged access doors on both sides of the unit. Air unit manufacturer to provide internal blank-offs to prevent air bypass around the filters. Filters manufactured by Farr, Purolator, AAF or approved equivalent. Provide filters in compliance with ANSI/UL 900 - Test Performance of Air Filters. Clean pressure drop not to exceed indicated pressure drop on the schedule. Reference Section 23 40 00, HVAC Air Cleaning Devices, for product specifications.

B. Filter Access: Provide filters that are accessible from front or rear if indicated on drawings or to slide out when access is not available.

C. Filter Gauges: Manufacturer to provide Dwyer 2000 magnehelic gauges or approved equivalent. Magnehelic gauges to be accurate to plus or minus 2 percent of full range. One gauge to be provided for each filter bank. Provide gauges recessed into the cabinet casing.

2.10 DAMPERS

A. Performance: Maximum leakage of 3 CFM/SF at 1-inch WG differential pressure, AMCA Certified, maximum pressure rating of 13-inches WG differential pressure, maximum velocity of 6,000 fpm, minus 72 degrees F to 275 degrees F temperature rating.

B. Frame: 16 gauge galvanized steel channel, reinforced at corners.

C. Blades: Airfoil shaped, minimum 16 gauge galvanized steel at 6-inch maximum width. Parallel blades for outside air and return air mixing arranged to discharge against each other, opposed blade for throttling service.

D. Seals: Stainless steel compression edge seals, vinyl bulb blade seals mechanically attached.

E. Bearings: Self-lubricating stainless steel sleeve or Celcon bearing.

F. Axles: Minimum 1/2-inch plate steel, square or hexagonal shaped, mechanically attached to blade with jack-shaft assemblies for multiple dampers.

G. Actuator: Factory or field installed electric modulating except two-position where indicated, sized for torque required plus 25 percent, mechanical spring return mechanism, suitable for 2-10 VDC or 4-20 MA AC, UL or CSA listed, electronic current overload protection, two-position indicator switches where indicated.

H. Provide heating coil bypass damper so that damper is closed with motor shaft retracted and at a full heating position with motor fully extended.

2.11 FLAT PLATE HEAT EXCHANGER

A. Air-to-air regenerative energy recovery to be an integral part of unit from the manufacturer.

B. No field assembly, ducting, or electrical wiring to be required with energy recovery.

C. Energy recovery provided through a flat plate air-to-air heat exchanger providing sensible energy transfer.

D. Sensible energy transfer to be without the use of any moving parts, motors, belts, and/or pulleys.

E. Construction:

1. Flat plate heat exchanger to be constructed with corrugated aluminum plates with 3 angstrom molecular sieve and extruded aluminum framing.
2. Individual plates to be constructed with 0.008-inch thick, 99.5 percent pure aluminum with smooth surfaces where exposed to air flow.
3. Stainless steel drain pans to be provided under entire heat exchanger.

F. Face and bypass dampers to be provided for economizer and frost control over flat-plate heat exchanger.

G. Provide automatic motorized inlet and outlet dampers with maximum 750 fpm from face velocity to alternate air streams through energy recovery device.

2.12 ELECTRICAL

A. Power: Provide single point power connection for all three phase equipment and single point power connection for all single phase equipment for each unit. Wire single phase components such as lights, convenience outlet, controls, heaters, etc. from panel with circuit breaker for each device. Provide GFCI duplex receptacles with weatherproof cover plate on exterior unit.

B. Provide electrical work in accordance with NEC and Division 26, Electrical. Reference Section 26 05 09, Equipment Wiring. Provide ETL listed wiring, control panels, and devices.

C. Fan Motor Wiring and Control: Provide wiring connections to fan motors from unit mounted variable frequency drives or starters. Mount devices in control panel inside unit service corridor or on outside of unit. Provide enclosures vented and conditioned from unit supply air. Use flexible conduits for making connections to vibration isolated equipment.

D. Lights: Vapor tight luminaire guard, 1-15 watt 120 volt LED lamp, clear glass globe. Provide one light for each accessible air handler section. Provide switch with lighted handle and weatherproof cover plate on exterior of unit. Provide lighting and switch prewired complete to a single point external junction box. Provide separate disconnect for lighting to allow maintenance of unit.

E. Provide combination starters and disconnects or variable frequency drives for each motor as indicated on Drawings.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Install in accordance with manufacturer's instructions and requirements. Maintain manufacturer's recommended clearances.

B. Bolt sections together with gaskets. Seal and/or fill openings between casing and AHU components and utility connections to prevent air leakage.

C. Make connections to ductwork. Duct installation requirements are specified in other Division 23, HVAC Sections. Drawings indicate the general arrangement of ducts.

D. Cleaning: Prior to acceptance, thoroughly clean exposed portions of the units, remove shipping labels and traces of foreign substance.

E. Field Quality Control:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
2. Perform the following field quality-control tests and inspections and prepare test reports:
   a. After installing units and after electrical circuitry has been energized, test units for compliance with requirements.
   b. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Remove malfunctioning units, replace with new units, and retest as specified above.

F. Startup Service:

1. Engage a factory-authorized service representative to perform startup service.
2. Protect or remove energy recovery devices prior to starting the units to ensure damage does not occur to the devices or media. Replace at no cost to Owner if devices/media get damaged or are no longer in "as-new" condition.
3. Complete installation and startup checks according to manufacturer's written instructions and do the following:
   a. Inspect for visible damage to unit casing.
   b. Inspect for visible damage to furnace combustion chamber.
   c. Inspect for visible damage to coils, energy recovery devices and fans.
   d. Inspect internal insulation.
   e. Verify that labels are clearly visible.
   f. Verify that clearances have been provided for servicing.
   g. Verify that controls are connected and operable.
   h. Verify that filters are installed.
   i. Adjust vibration isolators.
   j. Inspect operation of barometric and motorized dampers.
   k. Lubricate bearings on fan.
   l. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
   m. Start unit according to manufacturer's written instructions. Complete startup sheets and attach copy with Contractor's startup report.
   n. Inspect and record performance of interlocks and protective devices; verify sequences.
   o. Operate unit for an initial period as recommended or required by manufacturer.
   p. Inspect outside-air dampers for proper stroke and interlock with return-air dampers.
   q. Start system and measure and record the following:
      1) Coil leaving air, dry- and wet-bulb temperatures.
      2) Coil entering air, dry- and wet-bulb temperatures.
      3) Outside air, dry-bulb temperature.
   r. Inspect controls for correct sequencing of heating, mixing dampers, cooling, and normal and emergency shutdown.
   s. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
      1) Supply air volume.
      2) Return air volume.
      3) Relief air volume.
      4) Outside air intake volume.
   t. After startup and performance testing, change filters, vacuum heat exchanger and coils, lubricate bearings, adjust belt tension, and inspect operation of power vents.

G. Adjusting:

1. Adjust initial temperature, humidity, and CO2 set points.
2. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3. Occupancy Adjustments: Within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

H. Demonstration: Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units. Reference Division 01, General Requirements.

3.02 FAN ACCESSORIES

A. Install flexible duct connections between fan and discharge ductwork. Ensure that metal bands of connectors are parallel with minimum 1-inch flex between ductwork and fan while running.

3.03 HYDRONIC COILS

A. Make connections to coils with unions or flanges.

B. Comb damaged and bent fins.

C. Install coils to drain in accordance with manufacturer's recommendations.

D. Install filters upstream of supply and exhaust air handler coils prior to fan operation.

E. Pipe drain connection to floor drain.

F. For duct mounted cooling coils, provide drain pan.

G. Piping: Comply with applicable requirements in Division 23, HVAC. Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.

3.04 ELECTRICAL

A. Electrical System Connections: Comply with applicable requirements in Division 26, Electrical sections for power wiring, switches, and motor controls.

B. Ground equipment according to Division 26, Electrical.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

END OF SECTION

SECTION 23 8143 - AIR SOURCE HEAT PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:

1. Split System Heat Pumps

1.02 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.04 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment (with Addendum 1).
3. NRCA: Provide roof curbs in accordance with NRCA.

1.06 WARRANTY

A. Warranty of materials and workmanship as outlined in Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Refrigeration Compressor(s): 5-year warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Split System Heat Pump:

1. Indoor Make-up Air Units:
   a. Aaon
   b. Daikin
   c. Trane
   d. York
2. Outdoor Air-Cooled Heat Pump Units:
   a. Aaon
   b. Daikin
   c. Trane
   d. York

2.02 SPLIT SYSTEM HEAT PUMPS

A. Indoor fan unit matched to outdoor heat pump unit. Self-contained, packaged, factory-assembled, pre-wired unit with direct expansion evaporator coil, cabinet supply fan, filter housing and controls. Accessories, economizer assembly, etc. as scheduled and shown on Drawings.

B. Components:

1. Steel cabinet with baked enamel finish or galvanized steel; minimum 1/2-inch thick, 1-1/2# liner with cleanable facing or solid interior metal panel, minimum 2-inch MERV-8 pre-filter and 4-inch MERV-14 final filter. Easily removable access panels.

C. Refrigeration System: HFC Refrigerant or other refrigerant with zero ozone depletion potential (ODP). Basis of design: R-454B.

D. Air System:

1. Supply Fan (Evaporator Fan): centrifugal multi-speed direct drive with internal vibration isolation.
2. Indoor Motor: Premium efficiency with permanently lubricated bearings thermal overload protection. Provide optional high static motor.
3. Indoor Coil: Seamless copper tubes expanded into aluminum fins. Galvanized or polymer drain pan sloped in all directions.

E. Controls: Factory-wired to internal terminal strip or board for connection to Building Management System (BMS). See Sections 23 09 00, 23 09 80, and 23 09 90 for points list and sequences to be achieved.

F. Electrical: Furnish magnetic contactors. Arrange for single point electrical connection. Provide all associated field wiring.

G. Outdoor Air-Cooled Heat Pump Units:

1. Coils: Seamless copper tubes with copper or aluminum plate fins mechanically bonded to tubes.
2. Fans: Direct driven, propeller type, arranged for vertical discharge, with safety guards. Motors: Permanently lubricated, on vibration isolators.
3. Compressor: Serviceable hermetic design, with external spring isolators, automatically reversible oil pump, located in a section separated from condenser fans and coil. Provide low ambient controls to 20 degrees F.
4. Refrigerant: HFC refrigerant or other refrigerant with zero ozone depletion potential (ODP). Basis of
5. Controls: High- and low-pressure cut-out switches, compressor overload devices, anti-short cycle controls to prevent compressor from restarting for approximately five minutes after shutoff. Provide a transformer for control circuits. Provide automatic defrost controls that operate during heating, only when temperatures are below 36 degrees F, set to minimize energy use.
6. Casing: Galvanized steel, designed for outdoor installation. Finished with baked enamel. Provide openings for power and refrigerant connections. Panel: Removable to provide access for servicing.
7. Connections for liquid line, suction line, and power supply.

H. Outdoor Coil Defrost Control: Function on the basis of time and coil temperature. Timer to actuate a defrost mode if coil temperature is low enough to indicate frost condition. Defrost termination time maximum 10 minutes or when the defrost thermostat is satisfied. Electric resistance heaters operational automatically during the defrost cycle.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Examine areas and conditions under which units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Verify that electric power is available and of the correct characteristics.

C. Install in accordance with manufacturers written instructions and guidelines.

D. Coordinate installation of unit with building components to allow adequate airflow to/from the units and for maintenance clearances. Mount outdoor units on a concrete housekeeping pad if on grade, or on a built-up roofing curb flashed and sealed in accordance with roofing warranty requirements.

E. Provide adequate bracing and vibration isolation in accordance with seismic code requirements and acoustical engineers requirement.

F. Provide adequate drainage connections and routing for condensate piping to indirect waste receiver.

G. Provide shut off valves, site glasses, and routing pressure gauges, and all other appurtenances required for refrigerant system maintenance and operation.

H. Set initial temperature set points. Instruct operating personnel in adjustment of setpoints and controls.

I. See Division 01, General Requirements and Section 23 00 00, HVAC Basic Requirements for additional requirements.

J. Provide service and maintenance of units for one year from date of substantial completion.

K. Furnish to Owner, with receipt, for each packaged heating and cooling unit:

1. One set filters for each unit.

END OF SECTION

SECTION 26 0000 - ELECTRICAL BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work included in 26 00 00, Electrical Basic Requirements applies to Division 26, Electrical work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of electrical systems for proposed project.

B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.

C. Definitions:

1. Provide: To furnish and install, complete and ready for intended use.
2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work furnished.
4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent", substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's Authorized Representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.02 RELATED SECTIONS

A. Contents of Section applies to Division 26, Electrical Contract Documents.

B. Related Work:

1. Additional conditions apply to this Division including, but not limited to:
   a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.
   b. Drawings
   c. Addenda
   d. Owner/Architect Agreement
   e. Owner/Contractor Agreement
   f. Codes, Standards, Public Ordinances and Permits

1.03 REFERENCES AND STANDARDS

A. References and Standards per Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, individual Division 26, Electrical Sections and those listed in this Section.

B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
   1. State of Oregon:
      a. OAR - Oregon Administrative Rules
      b. 2021 OESC - Oregon Electrical Specialty Code
      c. 2022 OFC - Oregon Fire Code
      d. 2022 OMSC - Oregon Mechanical Specialty Code
      e. 2021 OPSC - Oregon Plumbing Specialty Code
      f. 2022 OSSC - Oregon Structural Specialty Code
      g. 2021 OEESC - Oregon Energy Efficiency Specialty Code
      h. 2011 Oregon Elevator Specialty Code

C. Reference standards and guidelines include but are not limited to the latest adopted editions from:
   1. ABA - Architectural Barriers Act
   2. ADA - Americans with Disabilities Act
   3. ANSI - American National Standards Institute
   4. APWA - American Public Works Association
   5. ASCE - American Society of Civil Engineers
   6. ASHRAE Guideline 0, the Commissioning Process
   7. ASTM - ASTM International
   8. CFR - Code of Federal Regulations
   9. EPA - Environmental Protection Agency
   10. ETL - Electrical Testing Laboratories
   11. FCC - Federal Communications Commission
   12. FM - FM Global
   13. IBC - International Building Code
   14. IEC - International Electrotechnical Commission
   15. IEEE - Institute of Electrical and Electronics Engineers
   16. IES - Illuminating Engineering Society
   17. ISO - International Organization for Standardization
   18. MSS - Manufacturers Standardization Society
   19. NEC - National Electric Code
   20. NECA - National Electrical Contractors Association
   21. NEMA - National Electrical Manufacturers Association
   22. NETA - National Electrical Testing Association
   23. NFPA - National Fire Protection Association
   24. OSHA - Occupational Safety and Health Administration
   25. UL - Underwriters Laboratories Inc.

D. See Division 26, Electrical individual Sections for additional references.

E. AIS Certificate: Certify that products comply with American Iron and Steel (AIS) provision for the Consolidated Appropriations Act of 2017 (Section 746 Division A of Title VII), and subsequent statutes, mandating domestic preference.

1.04 SUBMITTALS

A. See Division 01, General Requirements for Submittal Procedures as well as individual Division 26, Electrical Sections.

B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.

C. In addition:

1. "No Exception Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.
2. Provide product submittals and shop drawings in electronic format only. Electronic format must be posted to ftp site. For electronic format, provide one file per division containing one bookmarked PDF file with each bookmark corresponding to each Specification Section. Provide a table of contents identifying the products being submitted for each specification section. Arrange bookmarks in ascending order of Specification Section number. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. All transmissions/submissions to be submitted to Architect. Deviations will be returned without review.
    a. Provide separate submittals for power system study (per Specification Section 26 05 73) and electrical equipment (for example, switchboards and panelboards).
    b. Provide separate submittals for lighting control cutsheets, and for lighting control shop drawings.
3. Product Data: Provide manufacturer's descriptive literature for products specified in Division 26, Electrical Sections.
4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the Specifications and Drawings.
    a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.
    b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference individual Division 26, Electrical specification Sections for specific items required in product data submittal outside of these requirements.
    c. See Division 26, Electrical individual Sections for additional submittal requirements outside of these requirements.

5. Maximum of two reviews of complete submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of these additional reviews at Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.
6. Resubmission Requirements: Make corrections or changes in submittals as required, and in consideration of Engineer’s comments. Identify Engineer’s comments and provide an individual response to each of the Engineer’s comments. Cloud changes in the submittals and further identify changes which are in response to Engineer’s comments.
7. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet ASCE 7-16 requirements for non-structural components. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Division 01 and in Structural documents.
    a. Special Seismic Certification to be provided for the following equipment and components that are part of the designated seismic system pursuant to Section 13.2.2, ASCE/SEI (Structural Engineers Institute).
        1) Emergency and standby power systems equipment including generators, fuel tanks, and automatic transfer switches.
        2) Switchboards.
        3) Transformers.
        4) UPS and associated batteries/racks.
        5) Distribution panels including electrical panelboards, control panels, including fire alarm, and auxiliary or remote power supplies.
8. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required per Division 26, Electrical Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals. Electric motors are supplied and installed by Division 23 unless otherwise specified. During shop drawing stage of the project, verify correct disconnect sizes, conductor sizes, etc., and bring any discrepancies to the attention of the Mechanical trade. Be responsible for any modifications to electrical equipment or installations as a result of equipment incompatibility discovered after shop drawing review.
9. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.
10. Substitutions and Variation from Basis of Design:
    a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.

b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals." For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.

11. Shop Drawings: Provide coordinated shop drawings which include physical characteristics of all systems, device layout plans, and control wiring diagrams. Reference individual Division 26, Electrical specification Sections for additional requirements for shop drawings outside of these requirements.
    a. Provide Shop Drawings indicating access panel locations, size and elevation for approval prior to installation.
12. Samples: Provide samples when requested by individual Sections.
13. Resubmission Requirements:
    a. Make any corrections or change in submittals when required. Provide submittals as specified. The Engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.
    b. Resubmit for review until review indicates no exception taken or "make corrections as noted."
14. Operation and Maintenance Manuals, Owner's Instructions:
    a. Submit, at one time, electronic files (PDF format) of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.
        1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.
        2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment.
        3) Include Warranty per Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.
        4) Include product certificates of warranties and guarantees.

5) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.
6) Include commissioning reports.
7) Include copy of startup and test reports specific to each piece of equipment.
8) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.

b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 26 00 00, Electrical Basic Requirements, Demonstration.
c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

15. Record Drawings:
a. Maintain at site at least one set of drawings for recording “As-constructed” conditions. Indicate on drawings changes to original documents by referencing revision document, and include buried elements, location of conduit, and location of concealed electrical items. Include items changed by field orders, supplemental instructions, and constructed conditions.
b. Record Drawings are to include equipment and fixture/connection schedules that accurately reflect "as constructed or installed" for project.
c. At completion of project, input changes to original project on Revit Model and make one set of black-line drawings created from Revit Model in version/release equal to contract drawings. Submit Revit Model and drawings upon substantial completion.
d. At completion of project, show changes and deviations from the Drawings in red on one set of black-line drawings. Include written Addendums, RFIs, and change order items. Make changes to Drawings in a neat, clean, and legible manner.
e. Record drawings solely referencing field orders, supplemental instructions, etc. without any revision markups based on the change responses are not acceptable.
f. Provide a full size laminated copy of the overall single line diagram(s) to permanently affix at the Main Electrical Room or Engineering Office that is readily visible by onsite personnel.
g. See Division 26, Electrical individual Sections for additional items to include in record drawings.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements: Work and materials installed to conform with all local, State and Federal codes, and other applicable laws and regulations. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.

B. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.

C. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e. distribution equipment, duct banks, light fixtures, etc.) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.

D. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.

E. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.

F. Making, supervising, or directing the making of an electrical installation which does not meet minimum safety standards is not allowed.

G. Except as authorized by the Authority Having Jurisdiction, do not remove, transfer, alter or otherwise tamper with an inspection permit, label, tag or other indicia of inspection placed on or at an electrical job site, electrical installation or electrical product.

1.06 WARRANTY

A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty under Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.07 COORDINATION DOCUMENTS

A. Prior to construction, prepare and submit coordinated layout drawings (composite drawings), to coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, plumbing equipment/fixtures, fire sprinklers, plumbing, lights, cable tray and electrical services with architectural and structural requirements, and other trades (including plumbing, fire protection, electrical, ceiling suspension, and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.

B. Coordination drawings to be provided for the following systems, at a minimum, for review and approval:

1. Routing of Raceways and Boxes
2. Cable Trays
3. Transformers
4. Switchgear/Switchboards
5. Panelboards
6. Engine Generators
7. ~~Transfer Switch~~
8. Central Lighting Inverter
9. Lighting

C. Prepare Drawings as follows:

1. Coordination models/drawings may be created using Revit 3D modeled elements or a 3D CAD software. The modeled elements to be graphically represented within the model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the model elements. Model elements must have the ability to be spatially coordinated with other modeled elements using either Revit, Autodesk Navisworks or Autodesk A360.
2. Drawings in Revit Model. Revit Model release equal to design documents. Drawings to be same sheet size and scale as Contract Drawings and indicate location, size and elevation above finished floor of equipment and distribution systems.
3. Review and revise, as necessary, section cuts in Contract Drawings after verification of field conditions.
4. Incorporate Addenda items and change orders.
5. Provide additional coordination as requested by other trades.

D. Advise Architect in event conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.

E. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.

2.02 STANDARDS OF MATERIALS AND WORKMANSHIP

A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL or ETL listed and labeled or be approved by State, County, and City authorities prior to procurement and installation.

B. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

C. Hazardous Materials:

1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.03 ACCESS PANELS

A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.

B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 26, Electrical Sections. In the absence of specific requirements, comply with the following:

1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
   a. Ceiling access panels to be minimum of 24-inch by 24-inch.
   b. Wall access panels to be minimum of 12-inch by 12-inch.
   c. Provide screwdriver operated catch.
   d. Manufacturers and Models:
      1) Drywall: Karp KDW.
      2) Plaster: Karp DSC-214PL.
      3) Masonry: Karp DSC-214M.
      4) 2 hour rated: Karp KPF-350FR.
      5) Manufacturers: Milcor, Elmdor, Acudor, or approved equivalent.

PART 3 - EXECUTION

3.01 ACCESSIBILITY AND INSTALLATION

A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

B. Install equipment requiring access (i.e., junction boxes, light fixtures, power supplies, motors, etc.) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in passageways, doorways, scuttles or crawlspaces which would impede or block the intended usage.

C. Install equipment and products complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly. When requirements of installation instructions conflict with Contract Documents, request clarification from Architect prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines.

D. Earthwork:

1. Confirm Earthwork requirements in Contract Documents. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
    a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with related earthwork Sections. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.
    b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.
    c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.

E. Firestopping:

1. Confirm requirements in Division 07, Thermal and Moisture Protection. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
    a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

F. Plenums:

1. In plenums, provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify Architect/Engineer of discrepancy.

G. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

H. Provide miscellaneous supports/metals required for installation of equipment and conduit.

3.02 SEISMIC CONTROL

A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, and individual Division 26 Electrical Sections.

B. Equipment Importance Factor: 1.5.

C. General:

1. Earthquake resistant designs for Electrical (Division 26) equipment and distribution, i.e. power distribution equipment, generators, UPS, etc. to conform to regulations of jurisdiction having authority.
2. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.
3. Provide stamped shop drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for conduit and equipment. Submit shop drawings along with equipment submittals.
4. Provide stamped shop drawings from licensed Structural Engineer of seismic flexible joints for conduit crossing building expansion or seismic joints. Submit shop drawings along with seismic bracing details.
5. Provide means to prohibit excessive motion of electrical equipment during earthquake.

3.03 REVIEW AND OBSERVATION

A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

B. Notify Architect, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:

1. Underground conduit installation prior to backfilling.
2. Prior to covering walls.
3. Prior to ceiling cover/installation.
4. When main systems, or portions of, are being tested and ready for inspection by AHJ.

C. Final Punch:

1. Prior to requesting a final punch visit from the Engineer, request from Engineer the Electrical Precloseout Checklist, complete the checklist confirming completion of systems' installation, and return to Engineer. Request a final punch visit from the Engineer, upon Engineer's acceptance that the electrical systems are ready for final punch.
2. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.04 CUTTING AND PATCHING

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:

1. Proposed floor cutting/core drilling/sleeve locations to be approved by Project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).

2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftspeople of each respective trade in conformance with appropriate Division of Work.
3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.
4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and/or walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.
5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.05 EQUIPMENT SELECTION AND SERVICEABILITY

A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

3.06 DELIVERY, STORAGE AND HANDLING

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:
   1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Products and/or materials that become damaged due to water, dirt, and/or dust as a result of improper storage and handling to be replaced before installation.
   2. Protect equipment to avoid damage. Close conduit openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.
   3. Protect bus duct and similar items until in service.

3.07 DEMONSTRATION

A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, and individual Division 26, Electrical Sections.

B. Upon completion of work and adjustment of equipment, test systems and demonstrate to Owner's Authorized Representative, Architect, and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

D. Training and Demonstration per Section 01 91 13, General Commissioning Requirements and 26 08 00, Commissioning of Electrical.

3.08 CLEANING

A. Confirm Cleaning requirements in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

B. Upon completion of installation, thoroughly clean electrical equipment, removing dirt, debris, dust, temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.09 INSTALLATION

A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

B. Install equipment and fixtures in accordance with manufacturers' installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

D. Provide miscellaneous supports/metals required for installation of equipment.

3.10 PAINTING

A. Confirm requirements in Division 01, General Requirements and Division 09, Finishes. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:

1. Ferrous Metal: After completion of work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces (i.e., hangers, hanger rods, equipment stands, etc.) with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.
2. In Electrical Room, on roof or other exposed areas, equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.
3. See individual equipment Specifications for other painting.
4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.

5. Conduit: Clean, primer coat and paint interior/exterior conduit exposed in public areas with two coats paint suitable for metallic surfaces. Color selected by Architect.
6. Covers: Covers such as manholes, vaults and the like will be furnished with finishes which resist corrosion and rust.

3.11 ACCESS PANELS

A. Confirm Access Panel requirements in Division 01, General Requirements. In the absence of specific requirements in Division 01, General Requirements, comply with individual Division 26, Electrical Sections and the following:

1. Coordinate locations/sizes of access panels with Architect prior to work.

3.12 ACCEPTANCE

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In the absence of specific requirements, comply with individual Division 26, Electrical Sections and the following:

1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:
   a. Cleaning
   b. Operation and Maintenance Manuals
   c. Training of Operating Personnel
   d. Record Drawings
   e. Warranty and Guaranty Certificates
   f. Start-up/Test Document and Commissioning Reports

3.13 FIELD QUALITY CONTROL

A. Confirm Field Quality Control requirements in Division 01, General Requirements, Section 26 00 00, Electrical Basic Requirements and individual Division 26, Electrical Sections.

B. Tests:

1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in operation and maintenance manuals.
2. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.14 LETTER OF CONFORMANCE

A. Provide Letter of Conformance, copies of manufacturers' warranties and extended warranties with a statement that Electrical items were installed in accordance with manufacturers' recommendations, UL listings and FM Global approvals. Include Letter of Conformance, copies of manufacturers' warranties and extended warranties in Operation and Maintenance Manuals.

END OF SECTION

SECTION 26 0573 - ELECTRICAL DISTRIBUTION SYSTEM STUDIES

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:

1. Protective Devices
2. Short Circuit Study
3. ~~Selective Coordination Study~~
4. Arc Flash Risk Assessment
5. Arc Flash Labels

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:

1. Section 26 22 00, Low Voltage Transformers
2. Section 26 24 14, Switchboards
3. Section 26 28 00, Overcurrent Protective Devices
4. Section 26 28 16, Enclosed Switches and Circuit Breakers
5. Section 26 32 13, Engine Generators

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
2. IEEE 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
3. IEEE 1584, Guide for Performing Arc Flash Calculation.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition provide:

1. Power system studies required under this Section with submittals for electrical equipment, including overcurrent protective devices.
2. Electrical equipment ordered prior to submittal of power system studies are not compliant with these specifications, and are subject to removal and replacement at no cost to Owner where not in compliance with Code and Contract Documents for selective coordination.
   a. Provide written verification with Stamp or Seal and signature of preparing Engineer.
3. Provide samples of NFPA 70E compliant arc flash hazard labeling for electrical equipment.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Study Preparer Qualifications: Qualified engineer of switchgear manufacturer or approved professional engineer.
   a. Experienced in preparation of studies of similar type and magnitude.
   b. Familiar with software analysis products specified.
2. Computer Software for Study Preparation: Use latest edition of commercially available software utilizing specified methodologies.
   a. Acceptable Software Products:
      1) EasyPower
      2) Operation Technology, Inc; ETAP.
      3) SKM Systems Analysis, Inc; Power Tools for Windows.
   b. The above manufacturers are known to be acceptable for study purposes. At the completion of the study, provide an electronic EasyPower file of the project to the Owner/Engineer. The file is to include all files required to edit and evaluate the electronic model, including libraries, one-lines, scenarios, TCC curves and all reports.
3. Contractor Responsibility: Provide project-related data needed by study preparer, including equipment, wire sizes, insulation types, conduit types, actual circuit lengths and available fault currents from utility. Provide information in a timely matter to allow studies to be completed prior to release of equipment.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. Analyze specific electrical and utilization equipment (according to NEC definition), actual protective devices to be used, and actual feeder lengths to be installed.

1. Scope of Studies: New distribution wiring and equipment, from primary source to buses, branch circuit panelboards and equipment rated 50A or larger at utilization voltage.
2. Primary Source, for Purposes of Studies: Utility company transformer secondary.
3. Study Methodology: Comply with requirements and recommendations of NFPA 70, IEEE 399, and IEEE 242.
4. Report: State methodology and rationale employed in making each type of calculation; identify computer software package(s) used.

B. One-Line Diagrams: Prepare schematic drawing of electrical distribution system, with electrical equipment and wiring to be protected by protective devices; identify nodes on diagrams for reference on report that includes:

1. Calculated fault impedance, X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at main switchboard bus and downstream devices containing protective devices.
2. Breaker and fuse ratings.
3. Generator kW and voltage ratings, percent impedance, X/R ratios, and wiring connections.
4. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.

5. Identification of each bus, with voltage.
6. Conduit materials, feeder sizes, actual lengths, and X/R ratios.

2.02 PROTECTIVE DEVICES

A. Provide protective devices of ratings and settings as required so that protective device closest to fault will open first.

B. Replace existing protective devices to achieve specified performance.

C. Analyze and determine ratings and settings of protective devices to minimize damage caused by fault and so that protective device closest to fault will open first.

1. Required Ratings and Settings: Derive required ratings and settings of protective devices in consideration of upstream protective device settings and optimize system to ensure selective coordination.
2. Motors with Solid-State Protective Modules: Select settings for best possible motor protection, taking into consideration actual installed motor torque and current and thermal characteristics.
3. Identify any equipment, both new and existing, that is underrated.
4. Identify specified protective devices that will not achieve required protection or coordination but with minor changes can be made to do so; provide such modified devices at no additional cost to Owner and identify them on submittals as "revised in accordance with Protective Device Coordination Study"; minor changes include different trip sizes in same frame, time curve characteristics of induction relays, CT ranges, etc.
5. Identify specified protective devices that will not achieve required protection or coordination and cannot be field adjusted to do so, and for which adequate devices would involve change to contract sum.
6. In all cases where adequate protection or coordination cannot be achieved at no extra cost to Owner, provide a discussion of alternatives and logical compromises for best achievable coordination.
7. Do not order, furnish, or install protective devices that do not meet performance requirements unless specifically approved by Engineer.

D. Protective Device Rating and Setting Chart: Summarize in tabular format required characteristics for each protective device based on analysis; include:

1. Device identification.
2. Relay CT ratios, tap, time dial, and instantaneous pickup.
3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
4. Fuse rating and type.
5. Ground fault pickup and time delay.
6. Input level and expected response time at two test points that are compatible with commonly available test equipment and ratings of protective device.
7. Highlight devices that as furnished by Contractor will not achieve required protection.

E. Specified equipment has been designed and selected to achieve specified performance; ensure that equipment actually installed provides that performance.

F. In addition to requirements specified elsewhere, provide overcurrent protective devices having ratings and settings in accordance with results of system studies.

2.03 SHORT CIRCUIT STUDY

A. Calculate fault impedance to determine available 3-phase short circuit and ground fault currents at each bus and piece of equipment during normal conditions, alternate operations, emergency power conditions, and other operations that could result in maximum fault conditions.

1. Show fault currents available at key points in system down to fault current of 1,000 A at 480 V and 208 V.
2. Include motor contributions in determining momentary and interrupting ratings of protective devices.
3. Primary Fault Level Assumptions: Obtain data from utility company.

2.04 ~~SELECTIVE COORDINATION STUDY~~

A. ~~Selective coordination required for all emergency, legally required, and elevator systems.~~

B. ~~For all overcurrent devices in systems requiring coordination, perform an organized time-current analysis of each protective device in series from individual device back to source, under normal and emergency power conditions.~~

1. ~~Graphically illustrate that adequate time separation exists between series devices, including upstream primary device.~~
2. ~~Plot specific time-current characteristics of each protective device on log-log paper.~~
3. ~~Organize plots so that upstream devices are clearly depicted on one sheet.~~
4. ~~Also show following on curve plot sheets:~~
   a. ~~Device identification.~~
   b. ~~Voltage and current transformer ratios for curves.~~
   c. ~~3-phase and 1-phase ANSI damage curves for each transformer.~~
   d. ~~No-damage, melting, and clearing curves for fuses.~~
   e. ~~Cable damage curves.~~
   f. ~~Transformer inrush points.~~
   g. ~~Maximum short circuit cutoff point.~~
   h. ~~Simple one-line diagram for portion of system that each curve plot illustrates.~~
   i. ~~Software report for each curve plot, labeled for identification.~~

C. ~~Devices to coordinate down to 0.01 seconds.~~

2.05 ARC FLASH RISK ASSESSMENT

A. Calculate arc flash incident energy (AFIE) levels and flash protection boundary distances to determine required level of personal protective equipment (PPE) at each bus and piece of equipment during normal conditions, emergency power conditions, and other operations that could result in maximum arc flash incident energy levels.

1. Show flash protection boundary distance.
2. Include incident energy levels.

2.06 ARC FLASH LABELS

A. Provide label compliant with NFPA 70E guidelines indicating personal protective equipment (PPE) recommended for servicing of electrical equipment while energized, as well as calculated incident energy levels and arc flash protective boundary distance.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Provide services of qualified field engineer and necessary tools and equipment to test, calibrate, and adjust installed protective devices to conform to requirements determined by coordination analysis.

B. Adjust installed protective devices having adjustable settings to conform to requirements determined by coordination analysis.

C. Submit report showing final adjusted settings of protective devices.

3.02 ELECTRICAL POWER SYSTEM STUDIES

A. Short Circuit Analysis Study:

1. Provide complete short circuit study, equipment interrupting and withstand evaluation. Study to include complete electrical distribution system, including contributions from normal source of power without alternative sources of power. Include complete low voltage distribution systems as specified in this Section.
2. Study Basis: thoroughly cover normal and alternative operation modes that can produce maximum fault conditions, including simultaneous motor contributions.
3. Perform study in accordance with applicable ANSI/IEEE Standards.
4. Study Input Data: Utility company short circuit single and three phase contribution, and X/R ratio; resistance and reactance components of each feeder, busway and branch impedance; motor and generator contributions; applicable circuit parameters and contribute to short circuit duty.
5. Calculate short circuit momentary duties and interrupting duties on basis of maximum available fault current at each switchgear bus, switchboard, motor control center, panelboard, transfer switch, busway plug, dry-type transformer primary and secondary and other significant locations throughout system affected by available fault current (including large equipment, disconnects, control panels, uninterruptible power supplies, etc.).
6. Perform equipment evaluation study to determine adequacy of overcurrent protection devices by tabulating and comparing short circuit ratings of these devices with available fault current. Notify Owner in writing where problem areas or inadequacies appear in electrical equipment.
7. Study Report: In bound final report, include sheets listing tabulated information from study, including feeder impedances, motor, utility and generator impedances and fault contributions, and resulting short circuit current including asymmetrical, symmetrical, three, five and eight cycle fault current levels, and line-to-neutral and three-phase-bolted-fault current levels at each calculated point in electrical distribution system.

B. ~~Selective Coordination Study:~~

1. ~~Perform time-current coordination analysis with aid of computer software intended for this purpose. Include determination of settings, ratings, or types for overcurrent protective devices supplied.~~
2. ~~Where necessary, make an appropriate compromise between system protection and service continuity with service continuity considered more important than system protection.~~

3. ~~Provide sufficient number of computer generated log-log plots to indicate degree of system protection and coordination by displaying time-current characteristics of series connected overcurrent devices and other pertinent system parameters.~~
4. ~~Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:~~
   a. ~~Device tag and title, one-line diagram with legend identifying the portion of the system covered.~~
   b. ~~Terminate device characteristic curves at a point reflecting maximum symmetrical fault current to which the device is exposed.~~
   c. ~~Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.~~
   d. ~~No more than 3 devices per TCC.~~
   e. ~~Plot the following listed characteristic curves, as applicable:~~
      1) ~~Power utility's overcurrent protective device.~~
      2) ~~Medium-voltage equipment overcurrent relays.~~
      3) ~~Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.~~
      4) ~~Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.~~
      5) ~~Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.~~
      6) ~~Cables and conductors damage curves.~~
      7) ~~Ground-fault protective devices.~~
      8) ~~Generator short-circuit decrement curve and generator damage point.~~
      9) ~~Circuit breakers in each motor-control center and panelboard, one of each type and rating.~~
5. ~~Selective coordination of devices by use of manufacturer's tested combination data is acceptable. Devices to be shown on time current curves as required and specifically noted as a tested combination to the appropriate available fault.~~
6. ~~Study includes separate, tabular computer printout containing suggested device settings of adjustable overcurrent protective devices, equipment where device is located, and device number corresponding to device on system one-line diagram.~~
7. ~~Provide computer generated system one-line diagram which clearly identifies individual equipment buses, bus numbers, device identification numbers and maximum available short-circuit current at each bus when known.~~
8. ~~Discussion Section which evaluates degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.~~
9. ~~Call significant deficiencies in protection and/or coordination to attention of Engineer and recommendations made for improvements as soon as they are identified.~~
10. ~~Contractor responsible for supplying pertinent electrical system conductor, circuit breaker, generator, and other component and system information in timely manner to allow time-current analysis to be completed prior to final installation.~~

C. Arc Flash Risk Assessment:

1. Perform arc flash risk assessment with aid of computer software intended for this purpose.
2. Perform arc flash risk assessment in conjunction with short-circuit analysis and time-current coordination analysis.
3. Submit results of assessment in tabular form, and include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.
4. Perform analysis under worst-case arc flash conditions, and final report describes, when applicable, how these conditions differ from worst-case bolted fault conditions.
5. Arc flash risk assessment includes recommendations for reducing AFIE levels and enhancing worker safety.
6. Proposed vendor demonstrates experience with arc flash risk assessment by submitting names of at least ten actual arc flash risk assessments it has performed in past year.
7. Proposed vendor demonstrates capabilities in providing equipment, services, and training to reduce arc flash exposure and train workers in accordance with NFPA 70E and other applicable standards.
8. Proposed vendor demonstrates experience in providing equipment labels in compliance with NEC and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.

END OF SECTION

SECTION 26 3213 - ENGINE GENERATORS

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:

1. Packaged Engine Generator System
2. Engine
3. Fuel System
4. Lubrication
5. Inlet Air System
6. Exhaust System
7. Cooling System
8. Heaters
9. Engine Speed Governing System
10. Batteries and Charger System
11. Automatic Starting System
12. Generator
13. Generator Control Panel
14. Generator Remote Annunciation Panel
15. Weather-Resistant Enclosure
16. Accessories

B. Scope of Work:

1. Paralleling generator sets are to be OFCI (Owner Furnished and Contractor Installed). Procurement of the generators themselves will be handled by the Owner directly. Contractor to supply all necessary connections and install the generators to ensure a complete and operational system.

C. System Description:

1. Two paralleling capable engine generator sets, in conjunction with the necessary control and accessories, will comprise complete operating package for KW ratings as shown on Drawings for installation at local elevation and ambient temperature extremes (average maximum and average minimum) as follows:
   a. Elevation: 1,500 -feet.
   b. Ambient temperature range: -4 degrees F (-20 degrees C) to 104 degrees F (40 degrees C).
2. Provide engine generator sets and ~~transfer switches~~ **electrically operated breakers** compliant with specified level, class, and type for Emergency Power Supply System (EPSS) under NFPA 110.
3. Provide permanent switching means for temporary alternate source of power to comply with NFPA-70 requirements.
4. Provisions and connection of paralleling switchgear to comply with NFPA-70 requirements ~~and requirements of Section 26 36 00, Transfer Switches~~. Include control wiring with BESS PLC Control system for automatic start/stop control to generator control panel equipment.
5. Provide monitoring of start/stop control wiring as required by NFPA 70. Loss of integrity to start the generator(s).

6. Provide diesel fuel source, unless otherwise noted, including storage, pumps, sensors, piping, venting and other associated equipment. Refer to Plumbing Drawings for additional fuel system requirements. In addition to the 8-hour belly tank, the generator fuel system will be connected to a larger central tank. Remotely accessible fuel level sensors are to be provided for communication with the larger central tank pump system. Provide return fuel pump as part of generator set package.
7. Provide exhaust system in compliance with current federal EPA tier for exhaust emissions, and any state and local environmental air quality standards.

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:

1. Section 26 05 73, Electrical Distribution System Studies.
2. Section 26 28 00, Overcurrent Protective Devices.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Conform to requirements of the following generator set installation and on-site testing to codes and standards, as applicable. Include necessary features to meet requirements of these standards.
   a. IEEE 446, Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
   b. NFPA 37, Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines.
   c. NFPA 70, National Electrical Code. Equipment suitable for use in systems compliant to Articles 700, 701, and 702.
   d. NFPA 110, Standard for Emergency and Standby Power Systems. Prototype tests required by this standard will have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.
2. Generator set and supplied accessories to meet the requirements of the following standards:
   a. NEMA MG1. Alternator to comply with requirements of this standard.
   b. UL 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.
   c. UL 1236, Battery Chargers for Charging Engine-Starter Batteries.
   d. UL 2200, Stationary Engine Generator Assemblies. List generator set to UL 2200 or submit to an independent third party certification process to verify compliance as installed.
3. Comply with the following control system requirements:
   a. EN50082-2, Electromagnetic Compatibility - Generic Immunity Requirements, Part 2: Industrial.
   b. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
   c. FCC Part 15, Subpart B.
   d. UL 508, Industrial Control Equipment. Entire control system of generator set UL 508 listed and labeled.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Shop Drawings: Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.
2. Product Data: Provide data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, ~~transfer switches,~~ remote alarm annunciators, auxiliary equipment, sub-base fuel tank and tie into main site fuel tank, and weather-resistant enclosure. Technical literature describing diesel engine generator set performance including certified engine horsepower curves and deratings for project site altitude and ambient temperature conditions.
3. Factory Test Reports: Indicate results of factory testing showing minimum 1-hour test with 1/2-hour at continuous 100 percent load at 0.8 power factor. Record voltage stability, frequency stability, and transient response at 1/4, 1/2, full load, and 90 percent single step.
4. Start-up Test Reports: Include in project closeout documentation. Refer to Part 3 of this Section for testing requirements.
5. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
6. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
7. Manufacturer Seismic Qualification Certification:
    a. Submit certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in ASCE 7-16, Chapter 13, Seismic Design Requirements for Nonstructural Components. Include the following:
        1) Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
        2) Term "withstand" means "the unit will remain in place without separation of any parts from device when subjected to seismic forces specified and unit will be fully operational after seismic event."
        3) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
        4) Detailed description of equipment anchorage devices on which certification is based on their installation requirements.
8. Manufacturer's Field Reports: Indicate procedures and findings.
9. Operation Data: Include instructions for normal operation, with description and illustration of engine and generator controls and indicators.
10. Maintenance Data: Include instructions for routine maintenance and testing requirements, service manuals for engine, analysis for engine wear, and emergency maintenance procedures.

11. Maintenance Agreement: Provide optional authorized dealer service contract to perform routine maintenance and service for a period of 5 years to Owner for comment and/or approval.
12. Maintenance Materials: Furnish the following for Owner's use in maintenance of engine generator.
    a. Extra Filter Elements: One of each type, including fuel, oil and air.
    b. Parts books which illustrate and list assemblies, subassemblies and components, except standard fastening hardware (nuts, bolts and washers).
    c. Preventative maintenance instructions on complete system that cover daily, weekly, monthly, biannual, and annual maintenance requirements and include complete lubrication chart.
    d. Routine Test Procedures for electronic and electrical circuits and for main AC generator.
    e. Troubleshooting Chart covering complete generator set showing description of trouble, probable cause and suggested remedy.
    f. Recommended Spare Parts List showing consumables required during routine maintenance and testing.
13. Completed emergency generator and automatic transfer switch training checklist.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section with minimum ten years documented experience with a local supplier and service organization.
2. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum five years documented experience. Generator supplier is responsible for engine, generator, battery charger, engine block heater, sub-base day tank in accordance with Section 23 11 13, Facility Fuel - Oil Piping and Systems, fuel transfer pumps, automatic transfer switches, weather-resistant enclosure, automatic start/stop control equipment and circuitry, seismic bracing, and other auxiliary equipment so that there is one source of supply and responsibility. Authorized distributor must have 24-hour service facilities within 25 miles of Project and maintain qualified, factory trained service personnel that can respond to an emergency call within 4 hours notification.

1.06 WARRANTY

A. Warranty of materials and workmanship as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Manufacturer and supplier's standard warranty to be a period of not less than two years from date of initial start-up and include parts, labor, and travel expenses necessary for repairs at the jobsite, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours are not to be a limiting factor for the system warranty by either the manufacturer or supplier. Submittals received without written warranties as specified will be rejected.

2. Manufacturer and supplier's optional extended warranty to be a period of not less than five years from date of initial start-up or 2,500 operating hours, whichever comes first. Includes parts, labor, and travel expenses necessary for repairs at the jobsite, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Applicable deductible costs to be specified in the manufacturer's warranty. Submittals received without written warranties as specified will be rejected in their entirety.
3. Warranty nameplate of not less than 6-inches by 8-inches (152mm x 203mm) affixed to the generator set with the following:
    a. Warranty Period:
    b. Start-up Date:
    c. Termination Date:
    d. Supplier:
    e. Supplier Address:
    f. 24-Hour Emergency Number:
    g. Preventative Maintenance Vendor:

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Packaged Engine Generator:
    1. Caterpillar
    2. Cummins
    3. MTU Onsite Energy
    4. Or approved equivalent.

B. Approved manufacturers listed are allowed on condition of meeting specified conditions including available space for equipment (including Code required working clearances). Remove and replace electrical equipment installed not meeting these conditions at no cost to Owner.

C. Basis of Design: Packaged Engine Generator System design based on MTU Onsite Energy product line.

2.02 PACKAGED ENGINE GENERATOR SYSTEM

A. Generator set to meet requirements for Level 1, Class 2, Type 10 system as per NFPA 110. System to be capable of providing power within time frame based on specified type for the duration of the specified class following loss or failure of normal power supply and accept full load at each level of priority in single step.

B. Voltage and load rating of generator set as indicated on drawings. Load rating to be for standby service at 0.8 power factor and derated to allow for operation of accessories (cooling fan, pumps, radiator, fan, air cleaners, lubricating oil pump, fuel injection pump, jacket water pump, governor, charging generator, alternating current generator exciter regulator and alternator).

C. Unit Mounting:
    1. Provide engine and generator equipped with common steel weldment /sub-base for mounting engine generator unit to concrete slab or foundation.

2. Provide spring type vibration isolators and seismic restraints as required. Restraints/isolators to be in accordance with seismic design category and importance factor as indicated in Section 26 00 00, Electrical Basic Requirements, and to be adjusted per manufacturer's recommendations at start-up.
3. Isolators (Spring Type): Install isolators between generator set base and mounting surface. Provide isolators bolted to base with waffled or ribbed pad on their bottom surface.

2.03 ENGINE

A. Type: Water-cooled, four stroke cycle, compression-ignition, internal combustion, diesel type engine producing 1.5 HP per KW.

B. Emissions: Comply with current Federal EPA Tier for Exhaust Emissions and possess Best Available Current Technology to provide absolute minimum smoke, fumes, and exhaust emissions discharge.

C. Engine Speed: 1800 rpm.

D. Safety Devices: Engine shutdown on high engine temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.

E. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with HAND-OFF-AUTO selector switch on engine-generator control panel.

F. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include water temperature gauge, and lube oil pressure gauge on engine/generator control panel.

2.04 FUEL SYSTEM

A. Fuel Oil: No. 2 diesel conforming to all EPA, Federal, State and local regulations. Diesel engines requiring premium fuels will not be considered.

B. Fuel System Accessories: Fuel filter, fuel/water separator, fuel cooler (as required), fuel transfer pump, fuel priming pump, fuel lines, fuel injectors, and nozzles.

1. Fuel Filter: Provide dual fuel filters, independently valved with primary and secondary micron ratings per manufacturer's recommendation.
2. Fuel/Water Separator: In addition to standard fuel filters provided by engine manufacturer, install primary fuel/water separator in fuel inlet line to engine.
3. Fuel Cooler: As required, mounted on radiator to cool fuel before return to storage tank.
4. Fuel Priming Pump: Engine mounted integral manual fuel-priming pump to facilitate priming and bleeding air from system.
5. Fuel Injectors: Electronic, unit mounted in each cylinder head. Injection timing and duration electronically controlled by an engine-mounted Engine Control Module (ECM) to maximize combustion efficiency and minimize fuel consumption, emissions, and exhaust smoke levels.
6. Fuel Lines: Unit mounted fuel piping to be black iron or flexible fuel hose rated for this service. No galvanized piping will be permitted. Flexible Fuel Lines: Minimally rated for 300 degrees F and 100 PSI.

C. Fuel Storage:

1. Sub-base Tank: Provide UL 142 listed and labeled, double walled, fuel tank for Class II combustible liquid. Storage system to provide 8 hours of operation under full load conditions with a minimum capacity of 133 percent of specified class per NFPA 110. Furnish with interior and exterior epoxy coating for corrosion protection.
2. Provide tank with low and high (90%) level sensing devices and annular leak detection with an alarm panel.
3. Low level sensor set at minimum fuel necessary for full load running per NFPA 110 to report to remote generator annunciator.
4. Provide fuel tank with float operated overfill protection.
5. Provide required atmospheric and emergency vent piping for primary fuel storage tank and annular space between primary and secondary containment tank as indicated on Plumbing Drawings. Vent termination fittings furnished for annular vent of secondary containment will be atmospheric type.
6. Provide fuel supply and return lines between fuel storage tank and generator.
7. Provide subbase tank as package system.

2.05 LUBRICATION

A. Meet requirements as specified using lubricating oil conforming to MIL-L-2104, viscosity grade as recommended by engine manufacturer.

B. Provide engine with gear-type lubricating oil pump for supplying oil under pressure to main bearings, pistons, piston points, timing gears, camshaft bearings and valve rocker mechanism.

C. Provide full flow oil filters, conveniently located for servicing. Equip filter with spring loaded bypass valve to ensure oil circulation if filters are clogged. Provide suitable oil cooler as recommended by engine manufacturer.

D. Provide an oil drain line extension with manual shutoff valve as part of engine oil pan.

2.06 INLET AIR SYSTEM

A. Engine air cleaner to be engine mounted with dry element and restriction indicator to visually indicate to facility staff the need for filter replacement. Filter replacement no less than 250 operating hours or once per year.

2.07 EXHAUST SYSTEM

A. Engine manufacturer to ensure generator set will meet all applicable exhaust emission requirements at time of start-up.

B. Critical grade silencer, companion flanges, and flexible stainless steel exhaust fitting properly sized to be furnished by generator manufacturer. Silencer to be mounted so that its weight is not supported by engine nor will exhaust system growth due to thermal expansion be imposed on engine. Exhaust pipe size to be sufficient to ensure that exhaust back pressure does not exceed maximum limitations specified by engine manufacturer.

C. Long runs of pipe to be pitched away from the engine and water traps installed at the lowest point. Exhaust stacks to be extended to avoid nuisance fumes and odors. Outlets cut at 45 degrees to minimize noise.

2.08 COOLING SYSTEM

A. Equip generator set with rail-mounted, engine-driven radiator with blower type fan and accessories. Size cooling system to maintain safe engine temperature at full load conditions in an ambient temperature as specified under Part 1 of this Section without de-rating unit. Fill radiator with a 50/50 anti-freeze mixture consisting of an extended life coolant with minimum estimated life of 6,000 hours or 6 years. Coolant formula to contain no phosphates or silicates, and be recyclable. Generator set supplier is responsible for providing properly sized cooling system.

B. Engine jacket water cooling system to be closed circuit design with provision for filling, expansion, and deaeration, rated for ambient temperature and project elevation as specified under Part 1 of this Section. Equip with an engine driven, centrifugal-type water circulating pump and thermostatic valve to maintain engine at manufacturer's recommended temperature level. Coolant temperature to be internally regulated to disconnect external cooling systems until operating temperature is achieved.

C. Fan, fan drive, and belts to be covered with punched steel mesh guarding for personnel protection.

2.09 HEATERS

A. Engine Jacket Heater: Unit mounted, electrically powered, thermal circulation type water heater sized to maintain engine jacket water at 90 degrees F (32 degrees C) in ambient temperature range as specified for operation at 208 volt, 1 phase, 60 Hz AC power.

B. Provide engine jacket heater with an automatic control thermostat and oil pressure disconnect switch.

C. Incorporate manual shutoff valves to isolate heater during servicing.

D. Alternator Heater: Resistive strip heaters installed at alternator stator windings to prevent accumulation of moisture while generator is off. Provide control relays and contactors to disconnect heating when fuel solenoids are energized and reconnect 15 minutes after fuel solenoid is de-energized.

2.10 ENGINE SPEED GOVERNING SYSTEM

A. Governor to control engine speed while optimizing both steady state and transient engine performance and provide automatic frequency regulation. Control will monitor significant engine parameters, and adjust engine performance according to speed, altitude, temperature, aftercooler temperature, and engine condition. Incorporate revisable control software capable of reconfiguring engine operation to desired performance levels.

2.11 BATTERIES AND CHARGER SYSTEM

A. Batteries: Provide heavy-duty, diesel starting type, lead-acid batteries, complete with intercell connections, having sufficient capacity for cranking engine for at least 90 seconds at firing speed in ambient temperatures specified and with capacity for starting diesel engine a minimum of four times.

B. Battery Tray: Mount batteries in metal tray of corrosion resisting metal conforming to NEC 480.8. Construct tray such that spillage or boil-over of battery electrolyte will be contained within tray to prevent direct path to ground.

C. Battery Charger: Enclosed (weatherproof if exterior), wall mounted, constant voltage, heavy duty, industrial type designed for operation from 120 volt, 1 phase, 60 Hz, AC power. Charger suitable for keeping engine starting batteries in charged condition during periods when engine is idle. Rectifier element to utilize silicon diodes capable of continuous operation at full rated load using convection cooling in ambient temperatures up to 122 degrees F (50 degrees C). Charger automatically adjusts from full rated output to trickle charge and from trickle charge to full rated output, depending on battery state of charge. Provide charger equipped with DC voltmeter, DC ammeter, AC and DC circuit protection, and voltage surge suppression. Charger to have LED annunciator for low DC volts, rectifier failure, loss of AC power, and high DC volts.

2.12 AUTOMATIC STARTING SYSTEM

A. Engine Starting System: 24 volt DC, including dual starting motors, starter relay, and automatic reset circuit breaker to protect against butt engagement.

2.13 GENERATOR

A. Rating:

1. Generator to be capable of producing rated voltage and output at 0.8 power factor, based upon site conditions of altitude and ambient temperatures.
2. Provide generator rating applicable for standby service. Maximum voltage dip on full load and power factor is 15 percent.
3. Temperature Rise: 105 degrees C above 40 degrees C ambient.

B. Construction:

1. Provide generator with revolving field, single bearing type, coupled directly to engine flywheel through a flexible driving disc for positive alignment. Provide rotor dynamically balanced up to 25 percent overspeed.
2. Provide generator of heavy duty, compact design. Insulation Class H or better on stator and rotor, as recognized by NEMA MG-1 and both to be further protected with 100 percent epoxy coating to reduce possible fungus and/or abrasion deterioration.
3. Permanent magnet or AREP excitation system to derive excitation current from pilot exciter mounted on rotor shaft. System to enable alternator to sustain 300 percent of rated current for ten seconds during fault condition.

4. Digital Voltage Regulator: Microprocessor based with fully programmable operating and protection characteristics. Regulator capable of sensing true RMS in three phases of alternator output voltage, or operating in single phase sensing mode. Exhibit the following operational characteristics:
    a. Voltage regulation from no load to rated load within plus or minus 0.25 percent of rated voltage.
    b. Steady state voltage stability within plus or minus 0.25 percent of rated voltage.
    c. Alternator output voltage drift no more than plus or minus 0.25 percent of rated value at constant temperature.
    d. Alternator output voltage drift no more than plus or minus percent of rated value within 40 degrees C change over ambient temperature range of -40 degrees C to 70 degrees C.
    e. Steady state voltage modulation not to exceed 1 cycle per second.
    f. Voltage buildup with alternator output as low as 6 volts.
    g. At full throttle engine starting, output voltage overshoot no more than 5 percent of its rated value, with respect to volts/Hz curve. Meet ISO 8325-3 class G2 specifications.
    h. Telephone Influence Factor (TIF) of less than 50.
    i. Electronic Interference/Radio Frequency Interference (EMI/RFI) suppressed to MIL STD 461C Part 9 and VDE 875 level N.
    j. Maintain stable voltage control utilizing pulse width modulation. Alternator to produce clean AC voltage waveform, with not more than 5 percent total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3 percent in any single harmonic, and no third order harmonics or their multiples.
5. Voltage regulator to include the following features:
    a. Voltage Level Rheostat: Provide alternator output voltage adjustment of minus 10 percent to plus 10 percent of nominal, in addition to programmable output voltage level of minus 25 percent to plus 10 percent.
    b. Automatic Gain Adjustment: Provide output voltage compensation for changes in load or frequency.
    c. Manual Gain Adjustment: 0 to 10 percent to provide compensation for line losses between alternator output terminals and load.

C. Generator Set Performance:

1. For addition of load up to and including 100 percent of rated load, voltage dip not to exceed 15 percent of rated voltage. Voltage to recover to and maintain within steady band in not more than 1.5 seconds.
2. Frequency Regulation: Steady state no load to steady state rated load. Random frequency variation with any steady load not to exceed plus or minus 0.5 percent. For addition of load up to 90 percent of rated load, frequency to recover to steady state frequency band within 5 seconds.

2.14 GENERATOR CONTROL PANEL

A. Generator Set Control: Provide generator set with microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for generator set. Design control system also to allow local monitoring and control of generator set, and remote monitoring and control as described in this specification.

B. Generator set mounted control to include the following features and functions:

1. Control Switches:
    a. HAND-OFF-AUTO Switch: Selector switch to initiate the following control modes. When in HAND position generator set starts and accelerates to rated speed and voltage as directed by operator. Separate push-button to initiate starting is acceptable. In OFF position generator set to immediately stop, bypassing time delays. In AUTO position generator set to be ready to accept signal from remote device to start and accelerate to rated speed and voltage.
    b. EMERGENCY POWER OFF (EPO) Switch: Red "mushroom-head" pushbutton type with "Turn-to-Reset." Depressing emergency power off button to cause generator set to immediately shut down, and be locked out from automatic restarting.
    c. RESET Switch: Switch to clear fault and allow restarting generator set after it has shut down for any fault condition.
    d. PANEL LAMP Test Switch: Depressing panel lamp switch to cause entire panel to be lighted.
    e. SILENCE Switch: Depressing switch to cause all audible alarms to silence.

C. Generator Set AC Output Metering: Provide generator set with metering set including the following features and functions:

1. Digital Metering Set: Indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor within 1 percent accuracy at rated output. Generator output voltage to be available in line-to-line and line-to-neutral voltages, and display 3-phase voltages (line to neutral or line to line) simultaneously.

D. Generator Set Alarm and Status Display:

1. Generator Set Control: Include audible alarm and status indication lamps. Lamps to be high-intensity LED type. Lamp condition clearly apparent under bright room lighting conditions. Indicate existence of warning and shutdown conditions on control panel and comply with protection and diagnostic requirements of NFPA 110 for a Level 1 EPSS. Conditions indicated below for warning to be field-configurable for shutdown. Conditions required to be annunciated include:
    a. Control Switch Not in Auto (Visual, Audible)
    b. Emergency Stop Depressed (Visual, Audible, Shutdown)
    c. Battery Charger AC Failure (Visual, Audible, Shutdown)
    d. Low Oil Pressure (Visual, Audible, Shutdown)
    e. Low Coolant Temperature (Visual, Audible)
    f. High Engine Temperature Pre-Alarm (Visual, Audible)
    g. High Engine Temperature (Visual, Audible, Shutdown)
    h. High Oil Temperature (Visual)
    i. Low Coolant Level (Visual, Audible)
    j. Fail to Start/Overcrank (Visual, Audible, Shutdown)
    k. Overspeed (Visual, Audible, Shutdown)
    l. Low DC Voltage (Visual, Audible)
    m. High DC Voltage (Visual)
    n. Low Fuel Level (Visual, Audible)
    o. High AC Voltage (Shutdown)
    p. Low AC Voltage (Shutdown)
    q. Under Frequency (Shutdown)
    r. Overcurrent (Warning)

s. Overcurrent (Shutdown)
t. Short Circuit (Shutdown)
u. Generator Powering Load

E. Engine Status Monitoring: The following information to be available at digital status panel on generator set control:

1. Engine Oil Pressure (PSI or kPa)
2. Engine Coolant Temperature (degrees F or C)
3. Engine Oil Temperature (degrees F or C)
4. Engine Speed (rpm)
5. Engine Running Time Meter
6. Battery Voltage (DC Volts)

F. Engine Control Functions:

1. Include cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial Settings: 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
2. Include an idle mode control, which allows engine to run in idle mode in RUN position only. In this mode, alternator excitation system disabled.
3. Include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. Governor control to include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while unit is starting.

2.15 GENERATOR REMOTE ANNUNCIATION PANEL

A. Provide LED type remote alarm annunciator with horn. Provide audible and visual alarms called for by NFPA Standard 110 for Level 1 systems for local generator control panel. Provide spare lamps to allow future addition of other alarm and status functions to annunciator. Make provisions for labeling of annunciator in fashion consistent with specified functions. Provide alarm silence and lamp test switch(es). LED lamps to be replaceable, and indicating lamp color capable of changes needed for specific application requirements. Alarm horn to be switchable for annunciation points. Alarm horn (when switched on) to sound for first fault, and subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA 110. Interconnecting wiring between annunciator and other system components to be monitored and failure of interconnection between components to be displayed on annunciator panel.

B. Annunciator to include the following alarm labels, audible annunciation features, and lamp colors:

Row	Condition	LED 1	LED 2	Audible
1	Emergency Stop/Shutdown	Red		Yes
2	Failure to Start/Overcrank	Red		Yes
3	Low Coolant Temperature Warning		Yellow	Yes
4	High Coolant Temperature Shutdown/Warning	Red	Yellow	Yes
5	Low Oil Pressure Shutdown/Warning	Red	Yellow	Yes
6	Overspeed Shutdown/Warning	Red	Yellow	Yes

7	Low Coolant Level Shutdown/Warning	Red	Yellow	Yes
8	Low Fuel Level Shutdown/Warning	Red	Yellow	Yes
9	EPS Supplying Load	Green		No
10	Not in AUTO	Red		Yes
11	High Battery Voltage Shutdown/Warning	Red	Yellow	Yes
12	Low Battery Voltage Shutdown/Warning	Red	Yellow	Yes
13	Battery Charger Shutdown/Warning	Red	Yellow	Yes
14	Low Starting Air Pressure	Yellow		Yes
15	Spare			
16	Portable Generator/Docking Station		Yellow	Yes

C. Low battery voltage lamps to also be lighted for low cranking voltage or weak battery alarm.

D. Provide surface mounted enclosure.

2.16 WEATHER-RESISTANT ENCLOSURE

A. Provide generator set with a UL2200-listed, weather-resistant enclosure which allows generator set to operate at full rated load in an ambient temperature as specified under Part 1 of this Section. Enclosure to reduce sound level of generator set while operating at full rated load to maximum of 90 dBA at any location 23-feet (7 meters) from generator set in free field environment. Insulate enclosure with non-hygroscopic materials to achieve required sound levels. Comply with NEC requirements for all wiring materials and component spacing. Design total assembly of generator set, sub-base fuel tank, and enclosure to be lifted into place using spreader bars.

B. Factory assembled to generator set base and radiator cowling. Provide lockable, hinged, side and front access doors.

C. Doors to open 180 degrees to give full access to engine, generator control and termination area. Provide doors with retention devices for locking full open during servicing.

D. Provide louvered (rainproof) operation with doors locked closed and engine fully operational at maximum ambient temperature.

E. Minimum 14 gauge reinforced steel with cambered roof to prevent water accumulation. All exterior fastening hardware to be stainless steel to prevent corrosion.

F. Finish:

1. Factory standard color with black sub-base fuel tank.
2. Enclosure primed for corrosion protection and finish painted using two step electro-coating paint process, or equal, meeting performance requirements specified below. Prime and paint surfaces of metal parts. Painting process to result in coating that meets the following requirements:
   a. Impact resistance, per ASTM D2794, 120-inch-pounds.
   b. Water Soak, per ASTM D2247, 1000+ hours.

G. Anchor provisions to secure packaged unit to concrete pad are to be integral to structure. Design space for water drainage under enclosure wall/door panel areas into enclosures.

H. Working Clearance: Provided by access doors.

I. Provide the following factory supplied and installed items within the enclosure, including mounting brackets:

1. Battery charger.
2. Wet label LED luminaires on interior of enclosure with 90 minute battery back-up, one single-pole lighting switch at access point, wired to common terminal strip for contractor connection.
3. GFCI, 120 volt service receptacle (weatherproof FS series box).
4. Disconnect switches for heaters.
5. Mounting for contactors and relays and generator stator winding heater.
6. Silencer and exhaust flange.

J. Provide an external emergency power off (EPO) button at location shown on Drawings that is protected from accidental actuation.

K. Include rain hoods at inlet ducts.

L. Provide factory mounted and wired load center, in NEMA 12 enclosure with bolt-on breakers, to serve generator set accessories and enclosure. Connect to 120/208VAC, 1-phase, 3-wire normal power source.

1. For generators rated 201-600kW, load center rated for 125A.

2.17 ACCESSORIES

A. Unit Mounted Circuit Breaker:

1. Provide generator set with mounted main line circuit breaker, sized to carry rated output current of generator set and comply with selective coordination per Section 26 05 73, Electrical Distribution System Studies.
2. Circuit breakers to be sized by generator manufacturer to ensure alternator is protected under overcurrent conditions. Circuit breakers supplying power to NEC Article 700 and 701 loads will have electronic-trip unit with LSI and ground-fault alarm trip settings to protect alternator under overcurrent conditions. Generators supporting only NEC Article 702 loads are permitted to have a thermal magnetic trip main circuit breaker as indicated on Drawings. Supplier to submit time overcurrent characteristic curves and thermal damage for alternator, demonstrating effectiveness of protection provided. Provide auxiliary contact to report to remote annunciator panel in event of an open breaker condition.
3. Circuit breaker to be provided by the same manufacturer as Section 26 24 13, Switchboards.
4. Provide circuit breaker equipped with bus stub connections for compression fittings by Contractor.
5. Remote annunciator panel to monitor breaker and report trouble signal when open.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Concrete Pad: Provide concrete pad of 2500 to 3000 PSI concrete reinforced with 8 gauge wire fabric or No. 6 reinforcing bars on 12-inch centers. Provide 10-inch thick base of gravel below pad for support. Extend pad 6-inches on all sides from the exterior unit dimensions. Provide 8-inch thick pad.

B. Reference Section 26 05 26, Grounding and Bonding for Electrical Systems, for grounding requirements.

C. Install in accordance with manufacturer's instructions.

D. Install securely and in neat and workmanlike manner.

E. Provide branch circuits and power and control connections for accessories.

F. Install signaling and control circuiting as required for remote annunciation, battery charger alarm, automatic start-stop of generator set, etc.

G. Provide all wiring required for a complete and operable system.

H. Provide arc flash labels per Section 26 05 73, Electrical Distribution System Studies.

I. Provide services of manufacturer's representative to prepare and start system.

J. Perform field inspection and testing in accordance with these specifications.

3.02 PACKAGED ENGINE GENERATOR SYSTEM INSTALLATION

A. Coordinate mounting requirements with generator concrete slab pour (or mounting foundation) to eliminate vibration movement, per manufacturer's specifications.

3.03 HEATERS INSTALLATION

A. Prior to running circuits and ordering branch circuit breakers, contractor to confirm that block heater electrical characteristics match branch circuits shown.

3.04 ENGINE SPEED GOVERNING SYSTEM INSTALLATION

A. Configure engine control to avoid interruption of power whenever possible. In event of system faults which do not require immediate shutdown, program engine to continue operation at power levels sufficient to remain within performance limits. Display real time and historical data to allow user to optimize operation and provide accurate service information in event of malfunction. Information to be accessible through data link for remote monitoring. Data link failure is not to cause an interruption of engine operation. Governing system to include programmable warm-up at idle and cool down at idle function. While operating in idle state, control system to disable alternator excitation system.

3.05 BATTERIES AND CHARGER SYSTEM INSTALLATION

A. Prior to running circuits and ordering branch circuit breakers, contractor to confirm that battery charger electrical characteristics match branch circuits shown.

3.06 AUTOMATIC STARTING SYSTEM INSTALLATION

A. Provide wiring within transfer switches in accordance to NFPA-76A and NEC requirements.

B. Install and connect automatic transfer switch components of essential electrical system so that within 10 seconds of power supply drop in Utility Company's normal service, generator starts and automatically transfer loads to generator source.

3.07 GENERATOR CONTROL PANEL INSTALLATION

A. Mount control on generator set, or may be mounted in free-standing panel next to generator set if adequate space and accessibility is available. Control will be vibration isolated and prototype tested to verify durability of components in system under vibration conditions encountered.

3.08 GENERATOR REMOTE ANNUNCIATION PANEL INSTALLATION

A. Install at location shown on Drawings or in location that can be conveniently monitored by facility personnel.

3.09 WEATHER-RESISTANT ENCLOSURE INSTALLATION

A. Provide ample airflow for generator set operation.

B. Provide Code required clearance on all sides of enclosure.

3.10 TESTING

A. Reference Section 26 08 00, Commissioning of Electrical.

B. Before equipment is installed, submit to Architect factory certified test log of generator set, showing minimum one hour test with generator run continuously at full load at 0.8 power factor. Provide normal preliminary engine and generator tests before unit assembly.

C. Upon installation completion and prior to acceptance of installation, perform following tests by system manufacturer's local dealer representative(s) in presence of Architect, Authority Having Jurisdiction (AHJ), as well as Owner's engineer or designated appointee from each. Each individual generator will be tested:

1. Pre-Start Checks.
2. Cycle Crank Test (per manufacturer's recommendations).
3. Fuel Tank Level.
4. Oil Level.
5. Engine Generator Intake Obstructions.
6. Engine Generator Exhaust Obstructions.
7. Water Level.
8. Batteries Connection and Charge Condition.
9. Air Start Supply Pressure (if so equipped).
10. Transfer Switch Settings (in compliance with NFPA 110 and Owner direction).
11. Engine to Control Interconnects.
12. Engine Room Ventilation Obstructions.
13. Removal of Packing Materials.
14. Load Bank Testing: Provide load bank with sufficient capacity to operate single generator at full load. Do not use building loads for these tests.

a. Full Load Bank Test: Run each generator for minimum of 2 hours at 100 percent of nameplate rating of the generator. Record the following system characteristics: Cranking time, time to operating speed, voltage overshoot, frequency overshoot, time to steady-state, voltage, frequency, amps, oil pressure, engine coolant temperature, and battery charge rate.
b. One Step Full Load Test: Upon completion of the above 2-hour test, turn off load bank. Turn load bank on again as single step and record voltage and frequency stability with power line analyzer to show how generator reacted during first 10 seconds following addition of load.
c. 50 Percent Load Step Test: Reduce load bank by approximately 40 to 60 percent as single step, and then re-add the load. Record voltage and frequency stability at each step with power line analyzer.
d. Full Building Load Test: Open all breakers supplying primary power to site and allow emergency power system to run for minimum of 2 hours. Record the following system characteristics: time delay on start, cranking time, time to operating speed, voltage overshoot, frequency overshoot, time to steady-state with switches transferred to emergency position, voltage, frequency, amps, oil pressure, engine coolant temperature, battery charge rate, and time delay on retransfer to normal power. Comply with installation acceptance requirements for Level 1 Emergency Power Supply System (EPSS) under Chapter 7, NFPA 110.
    1) Test individual generator safety switches.

15. After all testing is complete, top off the fuel tank to its full capacity before turning over to the Owner.

D. Provide separate maintenance contract for specified maintenance service.

E. Provide service and maintenance of engine generator for one year from Date of Substantial Completion

F. Engine generator set supplier is to be an authorized dealer of engine generator set manufacturer and fully qualified and authorized to provide service and parts for both engine generator and such auxiliary equipment as may be required.

G. Provide manufacturer's warranty of a 2-year term, based on date of occupancy of facility.

H. Training to be provided by manufacturer's technical representative to instruct Owner's personnel in operation and maintenance of equipment provided. Completed emergency generator Owner's training checklist to be submitted with final shop drawings and O&M manuals. Checklist at end of this Section is to be used as an alternate if no formal training checklist is provided by manufacturer's technical representative. Note that some sections like paralleling switchgear, bypass isolation transfer switches and load shedding may not apply to this project.

3.11 EMERGENCY GENERATOR/OWNER'S TRAINING CHECKLIST

Item	Description
1	Identify equipment model, serial numbers, and location of identifying markings on the physical equipment.
2	Review system interface with other systems including fire alarm, elevator controllers,

	automatic transfer switches, HVAC, UPS systems, etc.
3	Describe product warranty requirements: Who to contact and contact numbers. Indicate owner obligations for warranty satisfaction and ongoing service.
4	Demonstrate system operation and describe design intent of system.
5	Describe system operation which would include, but not be limited to, checking fuel levels, systems functions, alarms, adjusting system setpoints, and general maintenance procedures.
6	Describe system fluid capacities for fuel/lube/coolant, change intervals and procedures for checking, draining, refilling fluids.
7	Describe remote annunciator features, alarm points reset procedures status and how to interpret the display.
8	Describe control panel features, alarms, troubleshooting, status, and how to interpret the display.
9	Review ATS location, quantity, logic controllers, shutdown functions, and interface with genset. For bypass isolations Type ATS's, demonstrate actual bypass isolation functional procedure.
10	Explain purpose and proper setting of the various timers in the automatic transfer switches.
11	Describe complete operation of load shedding system.
12	Explain full operation of the paralleling board controls including manual paralleling during emergencies.
13	Describe proper operation of the day tank(s).
14	For paralleling switchgear, specifically go through operating principals of manual operation procedures including manual paralleling, load controls, generator priority, logic/automation, and event logging.
15	Specifically go through cooling system operating principals and maintenance, including airflow, engine jacket heaters, and associated hoses.
16	Specifically go through operating principals and maintenance of starting system, batteries, and chargers.
17	Specifically go through fuel system, fuel pumps, manual priming procedures, and fuel filters.
18	Describe operation and general maintenance procedures for auxiliary fuel pump.
19	Describe troubleshooting, programming, and manual operation procedures.
20	Review safety and emergency shutdown procedures as applicable.
21	Describe product maintainability, spare parts provided, and resources for parts support.
22	Describe the use of O & M manuals and provide input on best practices.

Trainer	Company	Total Req'd Hours	Hours Trained	Date

Training Attendees:

Name/Role	Company

END OF SECTION

SECTION 26 3313 - BATTERY ENERGY STORAGE SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes provisions for a future Battery Energy Storage System (BESS) as part of the power generation, load management power distribution, and control system scope of supply. The Power System (PS) consists of the following as applicable:

1. Microgrid Resiliency Overview
2. Provisions for Future Battery Energy Storage System (BESS)
3. Microgrid Master Controller (MMC)
4. Solar Photovoltaics

1.02 RELATED SECTIONS

A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:

1. Section 26 05 73, Electrical Distribution System Studies.
2. Section 26 24 14, Switchboards.
3. Section 26 31 00, Photovoltaic Systems.

1.03 REFERENCES AND STANDARDS

A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. The BESS equipment covered by these specifications are in accordance with applicable standards:

1. ANSI - American National Standards Institute Standards.
2. ASTM - American Society of Testing and Materials.
3. EIA - Electronic Industries Association.
4. IEEE - Institute of Electrical and Electronic Engineers.
5. NEMA - National Electrical Manufacturer’s Association.
6. NESC/IEEE C2 - National Electrical Safety Code.
7. NEC/NFPA 70 - National Electric Code.
8. NFPA - National Fire Protection Association Codes and Standards.
9. UL – Underwriter’s Laboratories, factory listed.
10. IBC – International Building Code.
11. IEC – International Electrotechnical Commission.

1.04 SUBMITTALS

A. Submittals as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. Product Data: In addition, provide for each type of equipment:

1. Technical data on features, performance, electrical characteristics, ratings, weights, and finishes.
2. Rated capacities, operating characteristics, furnished specialties, and accessories.
3. Factory published product specification data sheets.
4. Sequence of Operations (SOO).

C. Shop Drawings: For each type of equipment, include the following:
   1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
   2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Front elevation.
   4. One-line diagram.
   5. Conduit entry locations.
   6. Floor plan.
   7. Automation/Communication Schematic.
   8. Electrical connection and interconnect schematic.

D. Manufacturer Seismic Qualification Certification: Submit certification that switchgear, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section on vibration and seismic controls for electrical systems. Include the following:
   1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Certificates of Compliance: Manufacturer of switchgear shall certify compliance with referenced standards.

F. Qualification Data:
   1. Support Services Vendor: Identify vendor firm name and contact, location, distance from project, years, and servicing product line.
   2. Testing Agency: As required in Article 1.05 on Quality Assurance.

G. Source quality-control test reports.

H. Field quality-control test reports.

I. Operation and Maintenance Data: In addition to items specified in Division 01 Section "Systems Manual and O&M Data," include the following:
   1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents:
   2. Fuses: Four of each type and rating.
   3. Output Circuit Breakers: Two of each type and rating.
   4. Output Circuit Breaker Open/Tripped Alarm Contacts: Two of each type and rating.
   5. Cabinet Ventilation Filters: Three complete sets.
   6. Circuit Board: One spare circuit board for each critical circuit.
   7. Provide a complete listing of available spares parts with O&M Documents.

J. Record Documents: The following information shall be provided for record purposes:
   1. Final as-built drawings and information.
   2. Assembly and Wiring diagrams.

3. Installation and operations information.

K. Certificates of Compliance: Manufacturer of switchgear shall certify compliance with referenced standards.

L. Qualification Data:

1. Support Services Vendor: Identify vendor firm name and contact, location, distance from project, years and servicing product line.
2. Testing Agency: As required in Article 1.05, Quality Assurance.

M. Source quality-control test reports.

N. Field quality-control test reports.

O. Operation and Maintenance Data: In addition to items specified in Division 01 Section "Systems Manual and O&M Data," include the following:

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
2. Fuses: Four of each type and rating.
3. Output Circuit Breakers: Two of each type and rating.
4. Output Circuit Breaker Open/Tripped Alarm Contacts: Two of each type and rating.
5. Cabinet Ventilation Filters: Three complete sets.
6. Circuit Board: One spare circuit board for each critical circuit.
7. Provide a complete listing of available spares parts with O&M Documents.

P. Record Documents: The following information shall be provided for record purposes:

1. Final as-built drawings and information.
2. Assembly and Wiring diagrams.
3. Installation and operations information.

1.05 QUALITY ASSURANCE

A. Quality assurance as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. The manufacturer of the assembly shall be the single-source manufacturer of the major components within the assembly.
2. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

C. Basis of Design: Drawings indicate size, profiles, and dimensional requirements of equipment and are based on Concentric. Other manufacturers' products complying with requirements may be considered.

D. Support Service Capability: Manufacturer approved support services Vendor to commission switchgear and available to provide ongoing maintenance services. Vendor shall be approved by manufacturer. Vendor shall be located within 1500 km (1000 miles) of project site. Vendor shall have performed these services on this product line for at least five years.

E. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

F. Equipment listed and labeled in accordance with a qualified testing agency and marked for intended location and application that is acceptable to the authorities having jurisdiction.

G. Applications and installations shall comply with the requirements of the codes and standards listed in this Section. Where required, certified test reports substantiating the compliance shall be submitted upon request.

H. Comply with the Electrical Code.

I. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Electrical Code by testing agency and marked for intended use.

1.06 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. If stored in areas subjected to weather, cover equipment to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

C. The ESS assembly shall be equipped to be handled by crane.

1.07 PROJECT CONDITIONS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for equipment, including clearances between equipment and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Environmental Limitations: Rate equipment for the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature Range: -40 Celsius to 40 Celsius.
2. Altitude: Derate as required if over 500 meters above sea level.

1.08 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 “Cast-in-Place Concrete.”

1.09 WARRANTY

A. Provide MMC minimum five (5) year manufacturer's warranty valid from date of turn-over to Owner.

1.10 MAINTENANCE SERVICE

A. The PSS shall maintain 24-hour parts and service capability within 500 miles of the project site. The distributor shall stock parts inventory to cover 95% within 48 hours. The dealer shall carry sufficient inventory of critical parts list for parts service within 24 hours.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Concentric

B. ABB

C. Eaton

D. Siemens

E. Schneider Electric

F. LG Electronics

2.02 FUTURE BATTERY ENERGY STORAGE SYSTEM (BESS) MODULE

A. Microgrid master controller (MMC) is to be capable of controlling and incorporating a future Battery Energy Storage System complete with bidirectional power inverters.

2.03 FEATURES

A. Microgrid Master Controller (MMC)

1. General Requirements:
   a. UL 508A
   b. IEC Compliant Wiring
   c. CE Compliant
   d. IEC 60730-1
2. The MMC shall have the following features:
   a. The MMC monitors the energy contribution from the solar panels Utility, generators, and in the future the BESS to balance outputs and maximize the power contribution from the renewables. When Utility power is not available the MMC will manage the paralleling gensets along with the PV system to minimize fuel consumption.
   b. The MMC must interface with all the PV inverters, gensets, and switchgear line-up. The MMC will have the following minimum functions for microgrid control and monitoring:
      1) Industrial controller housed in a rugged metal enclosure, resistant to vibration and shock.
      2) Wall mount control panel - capable to operate in Ambient Temperature of -40°C to 40°C at 5%-85% relative humidity (non-condensing).
      3) HMI (Human Machine Interface) touch screen display that includes Microgrid system one-line, control and monitoring of connected assets including load demand, and energy contribution from the various sources.
      4) Standard: Painted Steel Enclosure NEMA 3R.
      5) Automated Asset Start/Stop functionality based on mode selection.
      6) Commissioning mode to allow for efficient Microgrid setup and debug.
      7) Silent mode to turn off generators when renewable assets can power load.
      8) Selectable ESS modes for Peak Shave and Charge from Renewable sources only.
      9) ESS SOC Balancing.
      10) PV Curtailment to protect against high SOC and revers power on gensets.
      11) Smart Active/Reactive power dispatch.

12) Configurable System Power Reserve to increase microgrid reliability and overload protection. Includes genset spinning reserve request.
13) PV Power Ramp Rate Control.
14) Available PV power estimation.

B. Remote Monitoring System: Connectivity and Communication via remote asset management system.

1. General Requirements: User Interface:
   a. All data collected will be available in an interface accessed via an internet connection.
   b. Access is provided via a secure logon ID and password.
   c. There will be no User based fee to access the data.
   d. An unlimited number of Users can access the data at the same time.
   e. The User Interface will have the following functionality:
      1) A Site Summary which provides data on the overall performance of the entire site.
      2) Detailed Asset views on each individual piece of connected equipment.
      3) The ability to create time-data trends for all collected data.
2. Performance Requirements:
   a. Hardware will be installed to enable collection of data from all equipment via the following connections:
      1) Modbus TCP/IP
   b. Data Transmission shall be transferred for off-site storage and use via one of the following connections:
      1) Cellular connection (3G or 4G)
      2) WAN Internet connection
   c. Data Collection will be collected from the following equipment:
      1) Emission Equipment
      2) Fuel System Metering
      3) Energy Storage Systems
      4) Photovoltaic Inverters
      5) Weather Stations
      6) Power Meters
      7) System PLCs/Master Controllers
      8) Switchgear Controllers
      9) Others
   d. Data will be collected once per second (1 Hz)
   e. The following data types will be collected:
      1) Alarms
      2) Events
      3) Notifications
      4) Analog Operating Parameters
      5) Digital Operating Parameters
      6) Others
   f. Data Storage and Retention
      1) Data will be stored locally for a minimum of 30 days.
      2) Data will be stored off-site and backed up on a regular schedule.
      3) Data shall be available in the interface for active use for (13) thirteen months.
      4) Data shall be retained off-line for a length of (10) ten years.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with equipment manufacturer's written installation instructions, contract drawings and Codes. The equipment shall be installed in accordance with the manufacturer's recommendations.

3.02 **SEQUENCE OF OPERATIONS**

A. **The Renewable Energy Microgrid (REM) is designed to operate in either blue sky or islanding mode. In blue sky mode, the utility grid is functioning normally, and all buildings are operating as though connected to the grid in a conventional manner. The microgrid controller will be utilizing the solar generation and battery within the REM to minimize electricity costs via peak shaving. This includes centralized management of PV assets, building automation systems (BAS), and battery energy storage systems (BESS). Initially the BESS control will not be required because it is future.**

B. **When the utility grid fails, the main switchboard automatically trips the Utility breaker and the microgrid controller reconfigures all REM components to operate in islanding mode.**

C. **The REM proposed for the campus is sized to carry a limited load, as opposed to the normal operating load of the site. As such, when operating in islanding mode, the Generator loading is to be monitored by the microgrid controller so that EV Charging can be load shed prior to generator overload.**

3.03 FIELD QUALITY CONTROL AND START-UP

A. Provide the services of a qualified factory-trained manufacturer's representative for start-up of the equipment specified under this section. The manufacturer's representative shall provide technical assistance to the contractor in general installation 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, perform functional testing, and start-up the system.

C. Functional Testing shall include as a minimum:

1. Test in accordance with the Approved Project Sequence of Operations.
2. Verify and test system alarms in accordance with the Approved Project Sequence of Operations.
3. Test MMC, Switchgear, and Load as applicable.

3.04 FACTORY TESTING

A. Factory end of line tests before shipment: factory tests the BESS and other system components and accessories manufactured specifically for this Project. Performs tests at rated power. Reference system Commissioning Specifications for additional requirements.

3.05 DEMONSTRATION AND TRAINING

A. The manufacturer’s representative shall provide an eight (8) 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.

B. Recommended system checklists and log sheets.
   1. Recommended preventive maintenance.
   2. Instruction on the operation of the assembly, and major components within the assembly.

END OF SECTION