MINIMUM REQUIRMENTS FOR COMBUSTION TURBINE PROJECTS BUILD-OWN TRANSFER

TECHNICAL SPECIFICATIONS FOR COMBUSTION TURBINE GENERATOR

94.03.36.100

XCEL ENERGY

KIEWIT PROJECT NO. 20038657

ISSUED: DECEMBER 11, 2020

REVISION A – ISSUED FOR REVIEW

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TECHNICAL SPECIFICATIONS
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SECTION TS1

COMBUSTION TURBINE

1. SCOPE

1.1 This specification covers the design, fabrication, testing, delivery, and technical direction of the installation and initial operation of combustion turbine generator (CTG) unit(s). The scope of supply is shown in the *CTG Engineering Design Requirements (EDR)*. This specification covers the combustion turbine and all auxiliaries required for operation, starting, control, and protection. It shall be the responsibility of the Supplier to furnish equipment that has been designed and fabricated for the specified service. Where Supplier's standard specifications differ, Supplier must request Owner's approval for deviation.

1.2 The Supplier shall provide guarantees as indicated in the EDR.

1.3 The combustion turbine shall be designed to operate continuously and reliably while firing the fuels within the ranges specified in the EDR.

2. EQUIPMENT TO BE FURNISHED BY SUPPLIER

2.1 The CTG units shall be assembled pre-engineered modules including, but not limited to, the following equipment and auxiliaries:

2.1.1 Combustion turbine units including:

a. Multistage, axial flow compressor with corrosion protected blades

b. Combustion systems

c. Low NOx emission control systems

d. Multistage turbines

e. Single fuel operation on natural gas as stated in EDR

f. XX% H_2 blend retrofit option

g. Ignition systems

h. Inlet air system with inlet air filtration

i. Inlet air evaporative cooling system

j. Lubricating and hydraulic oil systems

k. Excitation system

l. DC power supply system

m. Microprocessor combustion turbine control system with DCS interface capability

n. Gas chromatograph (if required)

o. Borescope openings for compressor and turbine maintenance and inspection

p. Velocity type vibration sensors

q. Proximity type axial shaft position sensors

r. Proximity type vibration sensors

s. Thermocouples for measurement of exhaust temperature and bearing metal temperatures

t. Compressor inlet air plenum with drain valves

u. Turbine exhaust plenums / diffusers with outlet expansion joints

v. Air processing units

w. Rigid type load couplings

x. Exhaust frame blowers or cooling fans

y. Enclosure air blowers

z. Fire protection system in conformance with all applicable codes and regulations

aa. Fire detection system in conformance with all applicable codes and regulations

bb. Off-line and on-line water wash manifolds with piping to enclosure edge

cc. Base mounted terminal boxes and on-base interconnecting wiring in rigid metal conduits per NEC

dd. All necessary specialty maintenance/erection tools

ee. Portable Compressor Water Wash Skid common for both units

ff. All necessary startup spares for each CTG

gg. Supplier shall provide a complete list of 2 year operating spare parts.

2.1.2 Accessory systems modules including:

a. Lubrication and hydraulic oil systems

b. Fuel gas control systems

c. Starting system for each CTG

d. Metering and Relaying class current transformers and potential transformers, appropriate for equipment served

e. Shaft turning systems

f. Base mounted terminal boxes and interconnecting wiring in rigid metal conduits per NEC.

2.2 Balance of Plant equipment will be controlled through the existing Ovation system on site. TheCTG shall be controlled through the CTG supplier's control system. Supplier shall allow for datalink connection to the Ovation system.

2.3 Relaying and metering in accordance with Supplier's standards. Relay protection shall be sufficient to protect equipment and shall have the allowance for a typical substation.

2.4 Factory Assembly

2.4.1 All separately packaged accessory items shall be shop assembled to the maximum extent possible. The only exception shall be to meet shipping restrictions.

3. DESIGN REQUIREMENTS

3.1 General

3.1.1 All CTG units provided for a multiple unit installation shall be of identical design, layout, and componentry.

3.1.2 All CTG piping provided by the Supplier shall be in accordance with ASME B31.1.

3.2 The combustion turbine generators shall be designed for safe and reliable operation at all load conditions and with the range of environmental conditions and fuels specified. The various operations include:

3.2.1 Cold or warm start-up or immediate restart after coast-down including synchronization and loading to full capacity.

3.2.2 Continuous operation at 100% base load firing.

3.2.3 Emission requirements shall be met at all specified loads and operating conditions.

3.3 Structural Requirements

3.3.1 Seismic design as specified in the EDR.

3.3.2 Design Loads

a. The structural design of the equipment and support shall be based as a minimum, on the requirements of the 2018 International Building Code (IBC)

b. The CTG and accessory equipment shall be designed by the Supplier for the following loads:

1. Dead loads

2. Normal torque loads (turbine)

3. Live loads

4. Temperature and pressure loads

5. Emergency loads, such as turbine accident loads, generator short circuit loads and any temperature and pressure loads present during the emergency.

6. Wind Load

7. Seismic Load

8. Transportation Loads

9. Piping Loads

10. Impact Loads

3.3.3 Load Combinations

The following load combinations shall be considered, as a minimum, in the design of the turbine generator and accessory equipment:

a. Dead Load

b. Dead load plus live load plus all loads associated with normal operation of the equipment, e.g., temperature and pressure loads, piping loads, normal torque loads, impact loads, etc.

c. Dead load plus all loads associated with normal operation plus wind or seismic loads.

d. Dead load plus emergency loads plus wind loads plus seismic loads.

3.3.4 The turbine generator and accessories shall be functional after combined application of all the loads in their various load combinations. Load factors for the loads shall be determined by the Supplier using industry standards and the 2018 International Building Code (IBC) .

3.3.5 The loading combination producing the maximum stress shall be considered. The maximum stress shall not exceed the allowable stress permitted by the appropriate code for that combination.

3.3.6 The Supplier shall provide all foundation embedment drawings necessary for the installation of the CTG and the CTG system skids. Foundation bolts shall be provided by the Contractor. Any required fabricated embedments shall be provided by the Supplier.

3.4 Inlet Air System

The inlet air system shall consist of the following components:

3.4.1 Self-Cleaning Pulse Filter

3.4.2 Silencer – galvanized steel perforated liner (85 dBA @ 3 feet).

3.4.3 Ductwork.

3.4.4 Flexible connections.

3.4.5 Support structure, walkways, platforms, and ladders.

3.4.6 Control system.

3.4.7 The aerodynamic design shall be such that air intake velocities shall be uniform across the entire filter area.

3.5 Exhaust Gas System

3.5.1 The exhaust stack and silencer shall be furnished by others.

3.5.2 All control elements and bleed air connections required by the Supplier are to be included in the Supplier's scope.

3.6 Control System and Instrumentation

3.6.1 The CTG control system and instrumentation shall be provided in accordance with Supplier's standard specifications.

3.6.2 All hydrodynamic radial and thrust bearings in the combustion turbine generator shall be fitted with thermocouples for measuring the bearing metal temperatures. The bearing metal temperature monitoring shall be provided by the Supplier.

3.6.3 Vibration and Position Detectors: Non-contacting vibration, phase angle (keyphasor), and axial position transducers shall be provided for the combustion turbine generator. Two axial position proximity probes shall be supplied.

3.6.4 The vibration and axial position monitors shall be provided by the Supplier. The axial position monitor shall be of the dual voting type. If the Supplier's standard vibration system will function as the primary protection, then readings for each probe may be supplied in place of the monitors through the Supplier's control panel data highway.

3.7 Lubrication and Hydraulic Oil System

The lube and control oil systems shall include the following components and features as a minimum:

3.7.1 One (1) main lube oil reservoir mounted on skid including access opening for draining, cleaning and fitting, instrumentation, oil level indicator and alarm contacts, switches for sequential starting of pumps. The lube oil reservoir shall have built-in secondary containment or provisions to be set in a secondary containment structure.

3.7.2 One (1) Main AC motor driven lube oil pump and one (1) full capacity AC motor driven auxiliary lube oil pump

3.7.3 Partial capacity DC motor drive emergency lube oil pump

3.7.4 Main hydraulic oil pump

3.7.5 Full capacity AC motor driven auxiliary hydraulic oil pump

3.7.6 Dual oil filters with continuous flow transfer valve

3.7.7 Dual oil coolers with continuous flow transfer valve and removable bundles.

3.7.8 All piping from the oil filter to the lube oil feed points shall be stainless steel, butt-welded on all supply piping. The use of slip-on flanges is not acceptable.

3.7.9 All hydraulic oil piping or tubing for control and trip oil systems shall be stainless steel.

3.7.10 Oil system reservoir vent demister.

3.7.11 All oil piping shall be fabricated using butt welded fittings and flanges for disassembly. No socket welds are permitted in the bearing supply lines or hydraulic system downstream of the filters. All first pass welds shall be welded using a gas tungsten arc welding (GTAW) process. All first pass welds shall be inspected using liquid penetrant or magnetic particle examinations. All welding shall be in accordance with ASME requirements.

3.8 Vibration

3.8.1 During shop and field testing, the unfiltered vibration of the CTG unit measured by the Supplier installed probes shall not exceed the more restrictive of 0.25 inches per second housing vibration velocity or 3.0 mils relative shaft displacement. Verified runout may be vectorially deducted from the measured displacement.

3.8.2 Axial vibration shall not exceed 1 mil.

3.9 Materials

3.9.1 The Supplier's standard materials of construction are acceptable provided they are suitable for the service and conditions stated herein, and are in full compliance with the codes, standards, and conditions listed in this specification.

3.10 Fire Protection

3.10.1 A fire detection and automatic extinguishing system shall be provided for the turbine and accessory compartments. Detectors are required in all compartments to initiate a zoned release of extinguishing media in concentrations that meet the requirements of NFPA 12A.

3.11 Electrical

3.11.1 The electrical systems and components shall be provided in accordance with these specifications.

3.12 Generator

3.12.1 The generator shall be supplied in accordance with the EDR.

3.12.2 All generator cooler components in contact with cooling water shall be constructed of 304SS.

4. SPECIAL REQUIREMENTS

4.1 Emissions – Per the EDR

4.2 Hydrogen Retrofit Package Requirements

4.2.1 Hydrogen Fuel Blending Skid

a. Skid to blend 100% H2 and natural gas
    1. H2 and natural gas stop/control valves
    2. H2 and natural gas flow meters
    3. Instrument and controls

4.2.2 Hydrogen Package Additions and Modifications

a. Inert purge system hardware and instrumentation
b. Optical fire detection inside the enclosure
c. H2-capable gas speciation sensor
d. Ventilation system upgrade
e. Software modifications
f. Catalytic-bead LEL hazardous gas detection
g. Fuel system pipe material upgrade to address H2 embrittlement
h. SIL compliance (if required)
i. Analysis to ensure system is properly sized for higher volumetric h2-fuel and higher diluent flow demand to maintain emissions

4.3 Preparation for Shipment

4.3.1 The combustion turbine unit shall be suitably prepared for rail, truck, or sea shipment as applicable, including blocking of the rotor when necessary. The preparation shall be suitable for a minimum period of 6 months of outdoor storage from the time of shipment, such that disassembly is not required, except for bearing and seal inspections, before operation. Any combustion turbine

component, accessory, or instrument not suitable for the extremes of temperatures that can be expected during shipment or storage shall be identified by the Supplier prior to shipment.

4.3.2 Preparation for shipment shall be made after all testing and inspection of the equipment has been accomplished and the equipment has been authorized to ship by the Owner. The preparation shall include as a minimum the steps described in the following paragraphs:

a. All exterior surfaces, with the exception of machined surfaces, shall be given a minimum of one priming coat of paint by the Supplier. This primer must be compatible with the finish paint specified and applied by the Owner.

b. All exterior machined surfaces shall be coated with a suitable rust preventive.

c. The interior of the equipment shall be sprayed, flushed, or fogged with a suitable rust preventive that is removable by solvent. This shall be done through available openings, preferably while the machine is slow rolled.

d. All parts that will be in contact with system oils shall be prepared for shipment in accordance with the following:

1. All internal steel surfaces of components fabricated of carbon steel, such as oil reservoir pumps, bearing housings, and piping, shall be coated with a suitable oil-soluble rust preventive that can be completely removed by flushing with the normal charge oil.

2. Each filter shall be shipped with clean elements installed and shall carry outside a securely affixed all-weather tag stating, "SHIPPED WITH CLEAN ELEMENTS INSTALLED."

e. All flanged openings, except air inlet and exhaust, shall be provided with metal closures, of 3/16 inch minimum thickness with rubber or plastic gaskets and at least four full-diameter bolts. Inlet and exhaust openings shall be provided with substantial gasketed watertight closures.

f. All threaded openings shall be fitted with steel caps or solid-shank steel plugs of metallurgy equal to or better than that of the pressure casing.

g. All openings that have been beveled for field welding shall be provided with closures designed to prevent the entrance of moisture or foreign materials and damage to the bevel.

h. Lifting points and lifting lugs shall be clearly identified along with lifting weight limits if applicable.

i. All combustion turbine units shall be identified with item and serial numbers. All material shipped separately shall be identified with securely affixed, corrosion resistant metal tags indicating the items and serial number for which it is intended.

5. DOCUMENTATION

5.1 Supplier shall supply the type and quantity of drawings and documentation for Owner's authorization or information in accordance with the Seller's Deliverable Schedule (SDS).

6. TESTS AND INSPECTIONS

6.1 Upon receipt of a purchase order, the Supplier will provide the Owner with a detailed inspection and test program (ITP) with an accompanying schedule of activities. The Supplier shall provide the Owner with advance notification of shop inspections and tests so that the Owner can observe testing, dismantling, inspection and reassembly of the equipment.

6.2 Acceptance of shop tests does not constitute a waiver of requirements to meet performance under specified operating conditions, nor does inspection relieve the Supplier of his responsibilities.

END OF SECTION

XCEL ENERGY - WHEATON, WISCONSIN
EDR - COMBUSTION TURBINE GENERATOR

Scope of Supply - If applicable based on Manufacturer's available offerings					
Item	**Description**	**By Mfg.**	**By Purch.**	**Option**	**N / A**
1.0	**General Description**				
1.1	Size Designation				
	Capacity at summer max ambient				
	X 50 MW				
	Shaft Arrangement (if both checked, Mfg's choice)				
	X Single Shaft				
	X Multi-Shaft				
1.2	Quantity of Combustion Turbine Generator Sets				
	4 CTG's				
1.3	Frequency				
	50 Hz				
	X 60 Hz				
1.4	Inlet Filtration System				
	X Self-cleaning				
	Multi-stage				
1.5	Inlet Cooling			X	
	X Evaporative				
	Chiller coil				
1.6	Fuel Type				
	X Natural Gas				
	Fuel Oil				
	Dual Fuel				
1.7	Exhaust Arrangement				
	X Simple Cycle				
	Combined Cycle (with SC Bypass)				
	Combined Cycle (No Bypass)				
	Twin Pac				
1.8	Exhaust Connection				
	Flanged (incl. Expansion Joint only)				
	Flanged - with Expansion Joint and Transition				
	X Vendor Defined				
	NOTE:				
1.9	Location				
	Indoors				
	X Outdoors				
1.10	Combustion Turbine Performance Information Request				
	X Guarantee point indicated with *. Provide performance at MECL, 75% load, and 100% load				

		*						
Ambient DBT	, F	-40	0	30	60	90	105	
Relative Humidity	, %	60	60	60	60	25	20	
Site Elevation	, ft	981	981	981	981	981	981	
NOX Limit	, tons/year	25	25	25	25	25	25	
CO Limit	, ppmvd	L.A.	L.A.	L.A.	L.A.	L.A.	L.A.	L.A.: Lowest Achievable
SCR Pressure Drop Max	, dp							

1.11	Fluid Supply Conditions						
	X See attached data sheet(s)						
	1 **Natural Gas**	**TBD**	psia	**TBD**	F	OEM to advise on temperature, pressure, cleanliness, and superheat requirements at scope interface. Fuel analysis in Appendix A.	
	2 **Steam / Water**	**N/A**	psia	**N/A**	F		
	3 **Fuel Oil**	**N/A**	psia	**N/A**	F		

1.12	Coupling				
	Direct Coupled				
	Synchronized Clutch				
	X Manufacturer Standard				
1.13	Codes and Standards				
	X Local Applicable Laws and Ordinances				
	X Applicable ASME Power Piping and Pressure Vessel Codes				
	X Applicable ANSI Codes and Standards				
	X Applicable PE Stamp				
	X See Attached for List of Codes				
1.14	CTG/Contractor Interface				
	X per ANSI Standards				
	X per IEEE Standards				
	NERC CIP Compliance Requirements				
	Other ____				
1.15	Expected CTG Load Demand				
	X Min Emissions% - 100% With Rapid Daily Cycle				
	100% Base Loaded				
	See Attachment				

Scope of Supply - If applicable based on Manufacturer's available offerings									
Item	**Description**						**By Mfg.**	**By Purch.**	**Option**	**N / A**
1.16	Cooling Water System									
			Open							
		X	Closed							
		X	Propylene Glycol		%					
			Supply Temperature:	32 - 106	degrees F					
			Supply Pressure:	87 - 150	psig					
1.17	Seismic Data per ASCE 7-16									
			Site Class		D					
			Mapped Spectral Response Accelleration Parameters	S_s=	0.045g					
				S_1=	0.032g					
			Site Coefficients	F_a=	1.6					
				F_y=	2.4					
			Occupancy Category		III					
			Seismic Importance Factor for Occupancy Category III	I=	1.25					
			Seismic Design Category		A					
2.0	**Electrical Voltage Levels**									
		345 kV	High Voltage							
			Medium Voltage							
		480 V	Low Voltage							
3.0	**Configuration**									
3.1	Supports						X			
		X	Skid Base							
			Sole Plate							
3.2	Erection / Commissioning Hardware									
			Anchor Bolts and Nuts					X		
			Anchor Bolt Templates				X			
			Foundation Leveling Wedges / Adjustable Support Devices				X			
3.3	Embedments (incl. any specialty anchor bolts like foundation "thru" bolts or support steel unique to the CTG)						X			
3.4	Starting Device						X			
			DC Motor Driven w/Starter							
			Static							
		X	Manufacturer Standard							
		Qty:		1 per CTG	X	1 per Power Block				
3.5	Inlet Air Structure									
			Arrangement: Side Inlet or Over-the-Top Inlet				X			
			Inlet Filter House				X			
			Rain Hood				X			
			Bird Screen				X			
			Self-Cleaning with Air Processing Unit/Air Compressor Assembly				X			
			Multi-stage							X
			Evaporative Cooler				X			
			Chiller Heat Exchanger Grid/Coils							X
			Mist Eliminator				X			
			Inlet Duct and Expansion Joint				X			
			Inlet Duct Silencer (as required)				X			
			Inlet Duct Acoustical Lagging (as required)				X			
			Inlet Air Heating System (as required)				X			
			Inlet Filterhouse and Duct Support Steel/Structure				X			
			Inlet Plenum (with viewing window)				X			
			Inlet Compartment Differential Pressure Alarm				X			
			Thermocouples for Inlet Air Temperature Measurement				X			
			Ladder Access				X			
			Access panels at all filtration maintenance levels				X			
			Manual hoist rated 1/2 ton				X			
			Inlet filter compartment interior lighting				X			
			Inlet air filter support steel drawings				X			
3.6	Compressor									
			Compressor inlet humidity sensor				X			
			Inlet bleed heat manifold for anti-icing				X			
			Inlet bleed heat control valve(s)				X			
			Inlet Guide Vanes and Actuators				X			
			Variable Guide Vanes and Actuators				X			
			Blade and Vane Thermal Coatings				X			
3.7	Combustor									
			Distillate Oil w/ Water Injection							X
			Distillate Oil w/o Water Injection							X
			Dual Fuel w/ Water Injection							X
			Dual Fuel w/ DLN or ULN							X
			Natural Gas w/Water Injection							X
			Natural Gas - DLN with Steam Injection for Power Augmentation							X
			Crossfire flame tubes				X			
			Natural Gas w/ DLN or ULN				X			
			Thermal barrier coatings				X			
			Transition Pieces to Turbine 1st Stage				X			
			SiC flame detectors				X			

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Item	**Description**			**By Mfg.**	**By Purch.**	**Option**	**N / A**
3.8	Fuel System						
	Fuel Gas System - as requried			X			
		X	Unit Fuel Gas Flow Meter				
		X	Fuel Strainer				
		X	Main Fuel Final Filter System				
		X	Pilot Fuel Final Filter System				
		X	Fuel Gas Supply Piping (stainless from final filters)				
		X	Control Valves, Throttle Valves & Instrumentation (Main & Pilot)				
		X	Overspeed Trip Valve (Main & Pilot)				
		X	Vent and State Isolation Valves (as required by NFPA 85 to maintain purge credit)				
		X	Ring Manifolds				
		X	Acoustic Lagging (for piping and valves outside turbine enclosure, as needed)				
	Fuel Oil System						X
			Transfer from Fuel Gas Operation to Fuel Oil Operation during reduced engine load				
			Unit Fuel Oil Flow Meter				
			Fuel Oil Pump Skid (incl. suction filters, pump(s) and on-skid power wiring)				
			Fuel Oil Heater				
			Fuel Oil / Water Injection Skid				
			Water Injection Skid (incl. suction strainer, pump, flow meters, control valves, etc.)				
			Control Valves, Throttle Valves & Instrumentation (Main & Pilot)				
			Overspeed Trip Valve (Main & Pilot)				
			Vent and State Isolation Valves (as required by NFPA 85 to maintain purge credit)				
			Ring Manifolds				
			Acoustic Lagging (for piping and valves outside turbine enclosure, as needed)				
3.9	Turbine						
	Bleed air Cooled Blades and Nozzles			X			
	Nozzle and Blade Thermal Coatings			X			
	Position Switches, Position Transmitters for above			X			
	Turbine Gas and Metal Temperature Monitoring System			X			
	Interconnecting Piping between for Bleed Air Cooling, Lube Oil, etc.			X			
	Journal Bearings with Thermocouples			X			
	Thrust Bearing with Thermocouples			X			
	Rotor Vibration Monitoring			X			
	Turbine Drain System			X			
	Turbine / Generator Coupling Cover			X			
	Blade Cooling Air System & Support Structure (Rotor Air Cooler) (if applicable)			X			
		X	Air-to-Air Forced Draft Type				
			Kettle Boiler Type				
	Purge Air System (for fuel oil operation)						X
	Steam Power Augmentation Nozzles (incl. control valves, instrumentation, flow meter, and pipe)						X
3.10	Exhaust						
	Exhaust Diffuser / Transition Piece			X			
	Exhaust Diffuser Enclosure			X			
	Expansion Joint			X			
	Exhaust Thermocouple Rakes			X			
	Internal Lagging			X			
	Exhaust Frame Blowers			X			
	Galvanized Bolts, Nuts, and Washers			X			
3.11	Cleaning Systems			X			
		X	Portable Compressor Water Wash Skid: Common for both CTG's				
		X	Stainless Steel Tank and Fittings				
		X	Immersion Heater				
		X	On base piping				
		X	Manual ON and OFF line wash capabilities				
		X	Water Wash System Orifice Plates				
3.12	Instrument Air System						X
			Instrument Air Compressor				
			Instrument Air Receiver Tank				
			Instrument Air Tubing				
			Pressure Switch and Gauge Panel				
3.13	Local Gauges			X			
		X	Rack mounted				
			Local				
3.14	Thermal Insulation Material			X			
		X	Including thermal insulation blankets for Combustion Turbine				
3.15	Interconnecting Piping between OEM Supplied Skids			X			
3.16	Insulation and Lagging for OEM Supplied Piping Scope			X			
3.17	Heat Tracing				X		

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Item	**Description**			**By Mfg.**	**By Purch.**	**Option**	**N / A**
3.18	Combustion Turbine Enclosure(s)			X			
		X	Lagging or Enclosure				
			Outdoor Type Sound Proof Cover (85 dBA at 3 ft)				
		X	Sound Proof Cover (85 dBA at 3 ft)				
		X	Enclosure Lighting, Heating and Ventilation				
		X	Modular Construction				
		X	Designed to meet heat tracing requirements				
3.19	Name Plate			X			
3.20	Special Tools			X			
		X	Installation Tools				
		X	Maintenance Tools				
		X	Lifting Beam for Crossover Piping to be Lifted Without Disassembly				
4.0	**Noise Guarantees**						
4.1	Near Field			X			
		X	85 dBA at 3 Ft. Distance and 5 Ft. Above Grade or Platform referred to 20 micropascals				
			Other				
4.2	Far Field (Sound Pressure Levels, A-Weighted)			X			
		TBD	dBA at 400 feet from the equipment/enclosure				
			Other:				
5.0	**Turbine Control Protective Devices**						
5.1	Fuel Control System			X			
		X	Fuel Supply Header to Combustors				
		X	Master Fuel Control Valve				
		X	Fuel Strainers and Filters				
		X	Fuel Gas Separator				
5.2	Speed Control			X			
5.3	Power Control			X			
5.4	Vibration Monitoring			X			
		X	Bentley Nevada				
			Manufacturer Standard				
6.0	**Protective Devices**						
6.1	Overspeed Protection			X			
			Mechanical Overspeed Trip Device (emergency governor)				
		X	Electrical Overspeed Trip Device (2 out of 3)				
6.2	Thrust Protection			X			
			Mechanical Thrust Bearing Wear Trip Device				
		X	Electrical Shaft Position Abnormal Trip System				
6.3	Emergency Manual Trip Device			X			
6.4	Lube Oil Pressure Excessive Low Trip System			X			
6.5	Shaft Vibration Excessive High Trip System (Compatible with Bently Nevada SystemOne)			X			
6.6	Differential Expansion High Trip System			X			
6.7	Shaft Eccentricity Trip System			X			
6.8	Turbine Inlet Temperature High Trip			X			
6.9	Turbine Inlet Differential Temperature High Trip			X			
7.0	**Fire Protection System**						
7.1	Locations						
	Turbine Enclosure(s)			X			
		X	Thermal Detectors				
		X	Combustible Gas Sensors				
		X	Manual Pull Stations at Exits				
		X	Alarm Horns				
		X	Alarm Strobes				
		X	Compartment Warning Signage				
		X	Agent Discharge Nozzles				
		X	Piping (including valves, hangers, insulation and instrumentation)				
		X	Fire Protection Agent				
			CO_2				
			Water Mist				
		X	Inert Gas				

Scope of Supply - If applicable based on Manufacturer's available offerings								
Item	**Description**				**By Mfg.**	**By Purch.**	**Option**	**N / A**
	Electrical Package(s)				X			
		X	Control Panel					
		X	Thermal Detectors					
		X	Smoke Detectors					
		X	Manual Pull Stations at Exits					
		X	Alarm Horns					
		X	Alarm Strobes					
		X	Compartment Warning Signage					
		X	Agent Discharge Nozzles					
		X	Piping (including valves, hangers, insulation and instrumentation)					
		X	Fire Protection Agent					
				CO_2				
			X	Inert Gas (FM200)				
	Lube Oil Package Enclosure(s)				X			
		X	Thermal Detectors					
		X	Smoke Detectors					
		X	Manual Pull Stations at Exits					
		X	Alarm Horns					
		X	Alarm Strobes					
		X	Compartment Warning Signage					
		X	Agent Discharge Nozzles					
		X	Piping (including valves, hangers, insulation and instrumentation)					
		X	Fire Protection Agent					
				CO_2				
				Water Mist				
			X	Inert Gas (FM200)				
8.0	**Lubricating and Hydraulic Oil System**				X			
8.1	General System Design Requirements				X			
			Carbon Steel Tank (sufficient size to include flowback during trips)					
		X	Carbon Steel Double Wall Tank					
		X	AC Motor Driven Main Dual Lube Oil Pumps					
		X	AC Motor Driven Main Dual Hydraulic Oil Pumps: Used for jacking (lift) oil, also					
		X	AC Motor Driven Oil Vapor Fan (2 x 100%) with Mist Eliminators					
		X	DC Motor Driven Emergency Lube Oil Pump					
		X	Duplex Oil Filter (10 microns, parallel)					
		X	Accumulator					
		X	Temperature and Pressure Control Valves					
			Electric Heater with Control System					
		X	Air Cooled or Water Cooled Lube Oil Cooler (2 x 100%) with temp control system					
				90/10 CU-NI				
			X	304 SS				
				Other				
		X	Skid Mounted Piping					
		X	Handrails and Ladder					
8.2	Interconnecting Piping				X			
		X	Manual Valves					
		X	CS Piping return from CTG (Pickled and Passivated)					
		X	SS Oil Pressure Piping (supply to CTG)					
		X	Supply Pipe in High Temp Areas to be Contained Inside Return Oil Pipe					
		X	SS Piping after Oil Filter					
		X	All lube oil piping shall be butt welded, including small bore					
8.3	Oil Conditioner				X			
			Coalescer Type					
			Centrifugal Type					
			Vacuum Type					
		X	Other: Bypass type lube oil purifier sized to process entire contents of the lube oil system in 4 hours					
		X	Interconnecting Piping					
8.4	Lube Oil/Hydraulic Oil Skid Enclosure				X			
		X	Indoor with Soundproof Cover (85 dBA at 3 ft.)					
			Outdoor with Soundproof Cover (85 dBA at 3 ft.)					
			Outdoor					
8.5	Skid Mounted				X			
		X	Combined Lube Oil & Control Oil Systems					
			Separate Lube Oil & Control Oil Systems					
9.0	**Synchronous Generator and Accessories**				X			
9.1	Type							
		X	Totally Enclosed					
			Open					
			Skid Mounted					
			Non-Skid Mounted					

XCEL ENERGY - WHEATON, WISCONSIN
EDR - COMBUSTION TURBINE GENERATOR

Scope of Supply - If applicable based on Manufacturer's available offerings						
Item	**Description**		**By Mfg.**	**By Purch.**	**Option**	**N / A**
9.2	Cooling System					
		Water-to-Air Cooled				
		Hydrogen Cooled				
		Air-to-Air Cooled				
		X Vendor Defined				
9.3	Rotor					
		X Cylindrical Rotor				
		Salient Pole Rotor				
9.4	Excitation (If both checked, Manufacturer's choice)					
		X Brushless				
		X Static				
9.5	Number of Poles					
		X Two (2) Pole				
		Four (4) Pole				
9.6	Terminal Entry Location					
		Bottom				
		Top				
		X Side				
9.7	Location					
		X Indoor				
		Outdoor				
9.8	Generator Frequency					
		50 Hertz				
		X 60 Hertz				
10.0	**Generator Scope**					
10.1	Generator Proper Including Bearing Pedestals & Journal Bearings		X			
10.2	Anchor Bolts and Nuts		X			
10.3	Supports		X			
		X Skid Base				
		Sole Plates				
10.4	Fixators		X			
10.5	Embeds		X			
10.6	Fin-Tube Hydrogen to Water Coolers (if applicable)		X			
10.7	Number of Coolers (vendor to define capacity of each)		X			
		2				
		4				
		X Vendor Defined Standard				
10.8	Cooler Tube Materials					
		90/10 CU-NI				
		304 SS				
		Carbon Steel				
		X Vendor Defined Standard				
10.9	Generator Voltage					
		X 13.8 kV				
		18 kV				
		Other: kV				
10.10	Power Factor					
		0.95 Leading				
		0.85 Lagging				
10.11	Seal Oil System (if applicable)		X			
		X Redundant Seal Oil Pumps				
		X AC/DC Motor Driven Seal Oil Pumps				
		X SS Feed Pipe and CS Drain Pipe				
		X Degassing System				
10.11	Insulation for Prevention Against Shaft Current		X			
10.12	Shaft Guarding Brush		X			
10.13	Shaft Current Monitor		X			
10.14	Air-Gap Flux Probe		X			
10.15	Stator Liquid Cooling System		X			
10.16	Stator Core Condition Monitor		X			
10.17	Space Heater		X			
10.18	Cooling Water Leakage Alarm System		X			
10.19	Main Terminals		X			
10.20	Earth Terminals		X			
10.21	Class F Insulation & Class B Temperature Rise		X			
10.22	Generator Enclosure		X			
		Generator Cover				
		X Sound-Proof Cover (85 dBA at 3 feet)				
		Outdoor-Type Cover (85 dBA at 3 feet)				
		Enclosure Heating and Ventilation				
		Modular Construction				
10.23	Generator Terminal Enclosure		X			

Scope of Supply - If applicable based on Manufacturer's available offerings							
Item	**Description**			**By Mfg.**	**By Purch.**	**Option**	**N / A**
10.24	Contractor Interface						
			At Generator Enclosure Wall				
		X	At Mfg Supplied Equipment				
10.25	Nameplate			X			
10.26	Special Tools			X			
		X	Start-up Tools				
		X	Maintenance Tools				
11.0	**Excitation System**						
11.1	Type (If both checked, Manufacturer's choice)			X			
		X	Permanent Magnet Generator (PMG)				
		X	Bus Fed Static Exciter				
11.2	Rotor Excitation			X			
		X	Slip Ring				
		X	Brushless				
11.3	Automatic Voltage Regulator (AVR)			X			
			Analog Type				
		X	Digital Type				
11.4	Excitation Transformer(s)			X			
11.5	Excitation Cross-Tie Switch (if Applicable)						X
11.6	De-Excitation System with DC Breaker			X			
11.7	Diode Failure Protection System with Cooling Fan and Space Heater			X			
11.8	APR (Automatic Power Factor Regulator)			X			
11.9	Power System Stabilizer			X			
11.10	Excitation Enclosure			X			
12.0	**Electrical Equipment**						
12.1	Generator Main Circuit Breaker			X			
12.2	Generator PT/SA System Class 800, Billing Meter Quality			X			
12.3	Generator Neutral System			X			
			Resistor Type				
		X	Grounding Transformer with Secondary Resistor and Terminals				
12.4	Current Transformer (bushing type, total 7, line side) Class 800			X			
12.5	Current Transformer (bushing type, total 9, neutral side) Class 800			X			
12.6	CT Boxes for the Above (Located in CTG Supplier Housing)			X			
12.7	Low Voltage AC & DC Switchgear			X			
12.8	AC/DC Distribution Panel			X			
12.9	DC Motor Starting Device (only for EOP and Turning Motor)			X			
12.10	Synchronizing Device			X			
			Manual				
		X	Automatic				
12.11	Generator Step-up Transformer				X		
12.12	House Transformer, Starting Transformer				X		
12.13	Non-Segregated Bus Duct (up to Gen. Step-up Transformer)				X		
12.14	Segregated Bus Duct				X		
12.15	Iso Phase Bus Duct				X		
12.16	Motor Type			X			
			TEFC or TENV				
			WPII				
		X	CTG Supplier Define				
12.17	Terminal Boxes or Panels						
			Electric Cubicles	X			
			Auxiliary Motors and Motor Starters	X			
			Local Lube Oil and Hydraulic Fluid Panels	X			
			Control Panel and Junction Boxes	X			
		X	Ring Tongue Terminals				
			Spade Tongue Terminals				
12.18	Wiring Between Instruments or Switches on CTG or manufacturer supplied skids and Junction Boxes			X			
12.19	Wiring from Switchgear to CTG				X		
12.20	Low Voltage Station Service Transformers				X		
12.21	Power Cable for CTG (External Wiring)				X		
12.22	Control Cable for CTG (External Wiring)				X		
12.23	DC Facilities (Batteries, Rack, Battery Charger, etc.)			X			
12.24	UPS				X		
12.25	Electrical Equipment Enclosure			X			
		X	Enclosure Lighting, Heating and Ventilation				
		X	Modular Construction				
		X	Power & Control Wiring				

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Scope of Supply - If applicable based on Manufacturer's available offerings								
Item	**Description**				**By Mfg.**	**By Purch.**	**Option**	**N / A**
13.0	**Control and Monitoring Equipment**							
13.1	Turbine Control and Supervisory				X			
	Interface with Plant BOP				X			
	Ability to Control Remotely				X			
13.2	Digital Turbine/Generator Regulator				X			
			Single MPU					
		X	Double MPU					
			Triple MPU					
13.3	Interlock and Protection System				X			
		X	Auxiliary Control					
		X	Turbine Trip (hard wired)					
		X	Generator Protective Relays					
13.4	ATS Logic with Turbine Stress Evaluator						X	
13.5	Annunciation Device with Annunciation Window						X	
13.6	Monitoring System Cubicle (transducer, conditioner/monitor, etc.)				X			
13.7	Transmitters and Sensors							
	Pressure Inst./Gauge/Switch on Equipment provided by CTG vendor				X			
	Temperature Inst./Gauge/Switch on Equipment provided by CTG vendor				X			
	Level Inst./Gauge/Switch on Equipment provided by CTG vendor				X			
	Speed Measuring Instruments				X			
	Vibration and Monitoring System (Bentley Nevada equivalent)				X			
	Shaft Position Sensor and Monitor						X	
	Flow Measuring Devices on Equipment Provided by CTG vendor				X			
	Key Phaser						X	
	Eccentricity Sensor and Monitor						X	
	Differential Expansion Sensor and Monitor						X	
	Overall Casing Expansion Sensor and Monitor						X	
	Pre-wired from Sensor/Actuators to Junction Boxes				X			
14.0	**Miscellaneous**							
14.1	Performance Testing							
		X	Pressure Taps and Duplicate Temperature Wells Required to Perform Performance Test According to ASME PTC-22		X			
		X	Performance Test Written Procedures		X			
		X	Standard Test Instrumentation		X			
		X	Special Test Instrumentation		X			
		X	Calibration of Test Instrumentation / Equipment		X			
		X	Installation of Test Instrumentation / Equipment		X			
		X	Preliminary Fuel Samples			X		
		X	Testing Fuel Samples			X		
		X	Execution of Performance Tests		X			
		X	Performance Test Reports		X			
14.2	Performance Guarantees with Liquidated Damages, Test Tolerance: 0% Uncertainty: Test quality is to achieve <= 1.0%, however uncertainty is not applied to reults for pass/fail assessment.				X			
		X	Output					
		X	Heat Rate - LHV w/ conversion factor to HHV					
			Exhaust Temperature					
		X	Exhaust Flow					
			Exhaust Energy					
		NOTE:	1. ALL PERFORMANCE DESIGN BASIS CONDITIONS SHALL BE LOCATED AT THE PHYSICAL HARDWARE SCOPE OF SUPPLY. 2. EXHAUST FLOW GUARANTEE IS A NOT-TO-EXCEED FOR THE PURPOSE OF SIZING THE SCR.					
14.2	Performance Guarantees - Make Right				X			
		X	Emission Guarantees (from Minimum Emissions Compliance Load to Full/Base Load)					
				X	NO_x (ppmvd @ 15% O_2, lb/hr as NO_2, lb/MMBtu as NO_2)			
				X	CO (ppmvd @ 15% O2, lb/hr , lb/MMBtu)			
				X	VOC/POC (ppmvd @ 15% O2, lb/hr as CH_4, lb/MMBtu as CH_4)			
				X	PM/PM 10/PM 2.5 (lb/hr, lb/MMBtu)			
					SO_2 (lb/hr, lb/MMBtu)			
					H_2SO_4 (lb/hr, lb/MMBtu)			
					Other			
			Rate of Load Change Emissions Guarantees					
		X	Starting Reliability Guarantee					
		X	Running Reliability Guarantee					
			Ramp Rate Guarantee (while meeting emissions requirements)					
					Increasing (MW/min)			
					Decreasing (MW/min)			
			Ramp Time Guarantee					
		X	Evaporative Cooler Effectiveness (≥ 85%)					
			Heat Input (for Performance Cases)					
		X	Startup Emissions					
		X	Shutdown Emissions					

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Scope of Supply - If applicable based on Manufacturer's available offerings							
Item	**Description**			**By Mfg.**	**By Purch.**	**Option**	**N / A**
14.3	Shop Inspection and Tests - Combustion Turbine						
		Mechanical Balance		X			
		Governor and Control Function Operation		X			
		All Standard Factory Tests		X			
	Shop Inspection and Tests - Generator						
		Mechanical inspection		X			
		Rotor Balance with Rotor at Normal Maximum Operating Temperature		X			
		Rotor Overspeed at 120% Rated		X			
		Measurement of Cold Resistance of Stator and Rotor Windings		X			
		Winding Insulation Resistance Measurement		X			
		Standard IEEE 4 Dielectric Tests on Stator and Rotor		X			
		Resistance Temperature Detector Test		X			
		Lubricating Systems Including Hot Oil Flushing and Bearing Inspection		X			
		Comprehensive tests of all systems and controls to assure proper assembly and connection, including simulation tests of all safety devices		X			
		Test in Workshops for Generator and Excitation		X			
14.4	Dynamic Analysis						
		Foundation			X		
		CTG		X			
		CTG and Foundation Combined		X			
14.5	Sole Plates, Sub Sole Plate, Leveling Plates, Seating Plates, Shims and Liners			X			
14.6	Freeze Protection						
		X	Inside Enclosure	X			
		X	Outside Enclosure	X			
14.7	Lighting						
		X	Inside Enclosures and Panels	X			
		X	Outside Enclosures		X		
14.8	Access Platforms, Stairs and Support Structures			X			
14.9	Applicable Insurance Required Under Combustion Turbine Contract			X			
14.10	Crating for Export (if required) and Suitable Packing for Shipment			X			
	Exhaust Flow Profile Data (raw files) (incl. velocity and temperature)			X			
14.11	As-built design drawings			X			
14.12	O&M Manuals (10 hard copies and 1 electronic copy)			X			
14.13	Controls Instruction Manuals (10 hard copies and 1 electronic copy)			X			
14.14	Software Licenses			X			
14.15	Cleaning and Painting of CTG and Auxiliaries			X			
14.16	Quality Assurance Procedures			X			
14.17	NERC / CIP Requirements			X	X		
14.19	2-Year Operating Spare Parts - Priced					X	
14.20	Start-up and Commissioning Spare Parts			X			

SELLER'S DELIVERABLE SCHEDULE (SDS)

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
BM-01	Preliminary Compiled Bill of Materials (in Excel format) including all subvendor equipment, appurtenances, etc. per Section GR-B	4			
BM-02	Compiled Bill of Materials (in Excel format) including all subvendor equipment, appurtenances, etc. per Section GR-B	8 weeks prior to Delivery			
CA-01	Calculation proving structural design and derivation of loads for Buyer's support structure design. Must be sealed/stamped by a P.E. registered in the jurisdiction of the project.	12			***
CA-02	Calculation proving structural design for all steel components. Must be sealed/stamped by a P.E. registered in the jurisdiction of the project.	12			***
CA-03	ASME Code Calculations. Must be sealed/stamped by a P.E. registered in the jurisdiction of the project.	6	*		***
CN-01	System Control Philosophy Narratives (including Startup and Normal Operating Conditions) with detailed description of all permissives, alarms and trip set points for all devices. Deliverables shall not have network architecture drawings attached	16	*		
DA-01	Data Sheets - Piping Specialties and Inline Components	2			
DA-02	Data Sheets - Safety/Relief Valves including valve type, design code, sizing criteria, set point pressures, and connection sizes	10			
DA-03	Data Sheets - Actuated/Control Valves	10			
DA-04	Data Sheets including: -Solenoid(s) -Positioner -Limit Switch(es)	10			
DA-05	Motor Nameplate Data per Section E1	8			
DA-06	Nameplate drawings including a nameplate voltage connection diagram for all electrical equipment	6			
DA-07	Fill out Cyber Assets Log per Section I3 NERC CIP / Cybersecurity Sensitive	2 weeks prior to FAT		**	

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
DA-08	Motor thermal damage curve including each of the curves listed below and plotted on one graph: 1. Thermal limit curve at cold (ambient temperature) condition for locked rotor 2. Thermal limit curve at hot (operating temperature) condition for locked rotor 3. Thermal limit curve at cold (ambient temperature) condition for running overload 4. Thermal limit curve at hot (operating temperature) condition for running overload 5. Time-current motor acceleration curve at 110% of rated voltage 6. Time-current motor acceleration curve at rated voltage 7. Time-current motor acceleration curve at 90% of rated voltage 8. Time-current motor acceleration curve at 80% of rated voltage	6	*		
DA-09	Motor speed versus torque and current curves indicated at rated voltage, 90% of rated voltage, and 80% of rated voltage	6	*		
DA-10	Consecutive number of starts with the motor at ambient temperature and at operating temperature. Cool down time between starts with the motor at ambient temperature and at operating temperature.	6	*		
DA-11	Superimposed speed-torque curves for each motor driven equipment match. Speed-torque curves shall include the motor speed-torque curves at 80% of rated voltage and at 110% of rated voltage, superimposed on the driven equipment speed-torque curve during acceleration.	6	*		
DA-12	Motor Data - Parameters for relay settings including voltage imbalance limits and current imbalance limits	6	*		
DA-13	Motor Data - Winding and bearing temperature alarm and trip setpoints	6	*		
DA-14	Preliminary Motor Data Sheets per Section GR-B, including data sheets for any motor space heaters.	8	*		
DA-15	Final Motor Data Sheets per Section GR-B, including data sheets for any motor space heaters.	16	*		
DA-16	Start Up Curves and Associated Curve Development Assumptions	10	*		
DA-17	Performance Curves - Generator	6			
DA-18	Performance Correction Curves	8	*		

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
DA-19	Detailed termination connection details for all Buyer wiring terminations (e.g. terminal blocks, breakers, bolted connections, grounding lugs, bus bar, etc.) including, but not limited to: a. Minimum wire size b. Maximum wire size c. Maximum number of wires d. Termination type (e.g. screw clamp, ring lug, spring-cage, push-in, NEMA hole pattern, etc.)	10			
DA-20	Complete and submit the attached White Listed Ports and Services Template per the I3. NERC CIP / Cybersecurity Sensitive	2 weeks prior to FAT		**	
DK-01	Deliver Backup and Recovery capability along with baseline configuration files and software installs per Section I3 NERC CIP / Cybersecurity Sensitive	2 weeks after Delivery	*	**	
EO-01	Electrical one line diagrams including, but not limited to the following: a. Power distribution scheme for all electrical equipment b. Applicable ratings for all electrical equipment c. Applicable notes and standards d. Legend and reference	6	*		
EO-02	Electrical three line diagrams including, but not limited to the following: a. Power distribution scheme for all electrical equipment b. Applicable ratings for all electrical equipment including all CTs and VTs c. Applicable notes and standards d. Legend and reference	6	*		
EO-03	Electrical distribution panelboard schedules including, but not limited to the following: a. Load descriptions b. Load ampacities c. Breaker sizes with number of poles	6	*		
ES-01	Electrical schematic drawings including, but not limited to following: a. All electrical, protection, and control related logic with input/output assignments b. Relay and metering drawings c. Plant interface drawings for alarm and indication d. Terminal information with tag assignments including all auxiliary contact details	10	*		

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
ES-02	All electrical wiring diagrams needed by Buyer to complete electrical and controls design. Wiring diagrams shall include, but not limited to following: a. Interconnecting diagrams for internal and external wiring with termination details for all electrical devices (electrical panels, control panels, lighting, receptacles, control switches, disconnect switches, junction boxes, instruments, valves, actuators, motors, etc.) b. All wiring by Seller, Buyer, or other party shall have clear identification to distinguish installation responsibility	10	*		
ES-03	Electrical drawings to complete power and control interface wiring for instrument, valves, actuators, etc. including, but not limited to following: a. Elementary diagrams showing control logic with input/output assignment b. Terminal designations and termination layout drawings c. Electrical schematics for motor operated valves	10	*		
ES-04	Electrical drawings to complete motor power and control wiring including, but not limited to following: a. Wiring scheme with clearly defined requirement of shield wires for bearing, thermocouple, winding RTDs, etc. b. Wiring diagram with terminal designation c. Motor space heater connections diagram including voltage and power ratings	10	*		
ES-05	Electrical grounding requirements	4	*		
GA-01	Preliminary Outline/General Arrangement Drawings containing the following information at a minimum: -Not to exceed overall dimensions and not to exceed overall weights -Equipment and panel tag numbers -North arrow -All terminal point locations for piping -Access, maintenance, and equipment pull spaces, with dimensions and orientation -Location and overall size dimensions for all electrical equipment (e.g. Devices: motors, instruments, disconnects; Panels: electrical, relay, control, PLC; Wiring Terminal Boxes: motor power, RTD, vibration, heater, MOV; Instrument Junction Boxes; Control Cabinets; etc.) -Ground pad and ground lug locations -Designated clear space under all electrical devices (e.g. panels, terminal boxes, etc.) for conduit access -Electrical working spaces with dimensions and orientation as required by electrical code -Hazardous area classification rating, if applicable -Center of gravity -Not to exceed static and dynamic loads per Section S1 to complete detailed structural and equipment interface designs (+15%/-0%), indicate on drawing margins used -All details related to the attachment of the equipment to the foundation or supporting structure, such as anchor bolt locations and details, skid/frame flange and/or baseplate thickness, grouting requirements, etc. -Platforms/stairs/ladders (if applicable to scope of supply)	8	*		

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
GA-02	Final Outline/General Arrangement Drawings containing the following information at a minimum: -Overall dimensions and overall weights -Equipment and panel tag numbers -North arrow -All terminal point locations for piping -Access, maintenance, and equipment pull spaces, with dimensions and orientation -Location and overall size dimensions for all electrical equipment (e.g. Devices: motors, instruments, disconnects; Panels: electrical, relay, control, PLC; Wiring Terminal Boxes: motor power, RTD, vibration, heater, MOV; Instrument Junction Boxes; Control Cabinets; etc.) -Ground pad and ground lug locations -Designated clear space under all electrical devices (e.g. panels, terminal boxes, etc.) for conduit access -Electrical working spaces with dimensions and orientation as required by electrical code -Hazardous area classification rating, if applicable -Center of gravity -Static and dynamic loads per Section S1 to complete detailed structural and equipment interface designs -All details related to the attachment of the equipment to the foundation or supporting structure, such as anchor bolt locations and details, skid/frame flange and/or baseplate thickness, grouting requirements, etc. -Platforms/stairs/ladders (if applicable to scope of supply)	12	*		
GA-03	Preliminary 3D Model(s) per Section GR-B	6			
GA-04	Updated 3D Model(s) per Section GR-B	Monthly			
GA-05	Detailed arrangement drawings for all electrical equipment (e.g. Devices: motors, analyzers, disconnects; Panels: electrical, relay, control, PLC; Wiring Terminal Boxes: motor power, RTD, vibration, heater, MOV; Instrument Junction Boxes; Control Cabinets; etc.). Drawings shall include but not be limited to the following: a. Layout with front, rear, side, and top view. Shall include dimensions for overall size, cutout locations, cutout sizes, conduit entry locations, and conduit entry sizes. b. Indication of corresponding BOM item c. Internal panel layout including terminal and device arrangement. d. Tags for all terminal blocks, terminal numbers, device tags, etc. e. Electrical device and enclosure hazardous area classification rating, if applicable f. NEMA classification	10	*		
GA-06	Detailed connection drawing for all bolted connections (e.g. bus bar, iso-phase, non-seg, ground pads, lugs, bushing, lightning arrestors, etc.). Drawing shall contain the following information at a minimum: a. Dimensions including location and size of all bolted connections b. Flange details including dimensions for overall size, bolt locations, bolt sizes, etc. c. Clearance requirements with dimensions	10	*		

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
GA-07	Detail/Sectional Drawings with Parts List - Motor General Arrangement and Outline Dimension Drawings showing the following at a minimum: -Motor dimensions -Shaft dimensions -Mounting dimension clearances -Rotor and coupling end float limits -Approximate motor weight -Total motor weight	4			
GA-08	Detail/Section Drawings with Parts List - Turbine	20			
GA-09	Overall Arrangement Drawing - CT Power Train Package including all main and auxiliary equipment	24			
GA-10	Excitation system model	10	*		
HC-01	Electrical Hazard Classification Drawings showing classified drawings per NFPA 70 and NFPA 497. Drawings shall include scaled diagrams showing all classified areas and dimensions measured from the equipment for each area. All code references shall be provided on the drawing.	16	*		
HV-01	Cumulative Equipment Package and Individual Equipment heat rejection/loss to ambient air at maximum operating load (for HVAC sizing purposes)	8	*		
IC-01	As-Built Datalink Communication Reports including "as-built" data point list with addressing and protocol settings in both native file format and PDF format. Potential NERC CIP / Cybersecurity Sensitive	1 week prior to Delivery	*	**	
IC-02	Preliminary network architecture drawing Potential NERC CIP / Cybersecurity Sensitive	12		**	
IC-03	Final network architecture drawing Potential NERC CIP / Cybersecurity Sensitive	30		**	
IN-01	Instrument data sheets for every instrument/device furnished by the Seller, including the following information at a minimum: -Tag numbers -Service description -Calibration range -Instrument range -Length of probes -Manufacturer's make and model number -Serial number Each unique instrument type shall have its own dedicated, project-specific data sheet submitted; generic catalogue cut sheets are not acceptable for the intent of this submittal. Buyer will provide blank data sheets upon Seller request.	16			

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
IN-02	Full versions of cut sheets for each instrument furnished by the Seller that include the model number breakdown	16			
IN-03	Factory Calibration Certificates for Instrumentation	4 weeks prior to Delivery	*		
IN-04	Instrument Installation Details for all shipped-loose instruments	12			
IN-05	Instrumentation Location Plan - both Plan and Elevation views	16			
IV-01	PLC HMI Graphic Screenshots	8			
LT-01	Spare Parts List (in Excel format) including unit pricing per Section GR-B	16			
LT-02	Priced List of Special Tools Required for Installation, Erection and Maintenance	16			
LT-03	Drawing List Categorized by Engineering Discipline and Cross Referenced to the Line Numbers Stated Herein per Section GR-B, including document number and title for each document	4			
LT-04	Updated Drawing List Categorized by Engineering Discipline and Cross Referenced to the Line Numbers Stated Herein per Section GR-B, including document number and title for each document	Monthly			
LT-05	List of Compressed Air Users - to include equipment tag number, usage rate (SCFM), and location (coordinates/elevation)	12	*		
LT-06	Preliminary I/O List (in Excel format) per Section GR-B, including: -Range and engineering units for all signals to DCS -Alarm and Shutdown Levels -DCS Side Terminations	12			
LT-07	Final I/O List (in Excel format) per Section GR-B, including: -Range and engineering units for all signals to DCS -Alarm and Shutdown Levels -DCS Side Terminations	20			
LT-08	Preliminary Mechanical Connection List including at a minimum the following for all terminal/interface points/connections: -All sizes, materials, and interface types/ratings, including pressure classes, connection types, and schedules -Process information such as maximum/minimum/normal design flows, temperatures, and pressures -Coordinates/orientations -Interconnection tag numbers -Pressure drops and heat loads for cooling water	6	*		

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
LT-09	Final Mechanical Connection List including at a minimum the following for all terminal/interface points/connections: -All sizes, materials, and interface types/ratings, including pressure classes, connection types, and schedules -Process information such as maximum/minimum/normal design flows, temperatures, and pressures -Coordinates/orientations -Interconnection tag numbers -Pressure drops and heat loads for cooling water	12	*		
LT-10	Preliminary electrical load list shall include all electrical equipment ratings including, but not limited to the following: a. Nominal operating voltage (AC/DC) b. Phase(s) (3-Phase/1-phase as applicable) c. Efficiency and power factor d. Power requirements (kW/kVA/FLA as applicable)	4	*		
LT-11	Final electrical load list shall include all electrical equipment ratings including, but not limited to the following: a. Nominal operating voltage (AC/DC) b. Phase(s) (3-Phase/1-phase as applicable) c. Efficiency and power factor d. Power requirements (kW/kVA/FLA as applicable)	8	*		
LT-12	PLC Data Link List (in Excel) including point names, descriptions, addresses, scale, ranges, engineering units, and conversion factors	36		**	
LT-13	Sub-Supplier/Fabricator List including addresses and contacts. Updated as suppliers are added.	4			
LT-14	Equipment List (in Excel format) per Section GR-B	10			
LT-15	Line List (in Excel format) per Section GR-B	10			
LT-16	Valve List (in Excel format) per Section GR-B	10			
LT-17	Specialties List (in Excel format) per Section GR-B	10			
LT-18	Instrument List (in Excel format) per Section GR-B	10			
LT-19	Allowable maximum nozzle loads for all pressure piping connections per requirements of Section M1	6	*		
LT-20	Cable Summary/List	16			

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
MA-01	Manufacturer's Comprehensive O&M Documentation/Manual	28	*		
MA-02	Inserts for As-Builts, Test Reports, MTRs, Records produced by ITP, etc for Manufacturer's Comprehensive O&M Documentation/Manual	2 weeks prior to Delivery	*		
MA-03	Manufacturer's Comprehensive O&M Documentation/Manual, excluding the Cyber Security Annex	28	*		
MA-04	Cyber Security Annex for the Manufacturer's Comprehensive O&M Documentation/Manual NERC CIP / Cybersecurity Sensitive	28	*	**	
MA-05	Inserts for As-Builts, Test Reports, MTRs, Records produced by ITP, etc for Manufacturer's Comprehensive O&M Documentation/Manual, excluding the Cyber Security Annex	2 weeks prior to Delivery	*		
MA-06	Cyber Security Annex for the Inserts for As-Builts, Test Reports, MTRs, Records produced by ITP, etc for Manufacturer's Comprehensive O&M Documentation/Manual NERC CIP / Cybersecurity Sensitive	2 weeks prior to Delivery	*	**	
MP-01	Interconnecting Piping Detailed Isometrics	12			
PA-01	Paint/Coating/Lining application procedures with manufacturer's data sheets and inspection forms	8			

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
PA-02	Finish Coat Color Schedule	8			
PA-03	Coating Test Report Results	1 week after Test			
PD-01	Turbine Proper Systems - Piping and Instrumentation Diagrams (P&ID) showing all equipment, piping, instrumentation and controls, connection/interface points, and associated tagging for a complete, code compliant, and ready to operate system.	6	*		
PD-02	Generator Proper Systems - Piping and Instrumentation Diagrams (P&ID) showing all equipment, piping, instrumentation and controls, connection/interface points, and associated tagging for a complete, code compliant, and ready to operate system.	6	*		
PD-03	Lube Oil System - Piping and Instrumentation Diagrams (P&ID) showing all equipment, piping, instrumentation and controls, connection/interface points, and associated tagging for a complete, code compliant, and ready to operate system.	12	*		
PD-04	Hydraulic/Lift Oil System - Piping and Instrumentation Diagrams (P&ID) showing all equipment, piping, instrumentation and controls, connection/interface points, and associated tagging for a complete, code compliant, and ready to operate system.	12	*		
PD-05	All Remaining Systems - Piping and Instrumentation Diagrams (P&ID) showing all equipment, piping, instrumentation and controls, connection/interface points, and associated tagging for a complete, code compliant, and ready to operate system.	16	*		
QC-01	Quality Manual and ISO 9001 Certificate, including all Sub-suppliers	4			
QC-02	Quality Record Matrix per Special Conditions	6			
QC-03	Project Specific Inspection and Test Plan including all Sub-suppliers	4			
QC-04	Supplier Notification Form (SNF) for each Witness and Hold Point identified on the Project Specific Inspection and Test Plan.	21 days prior to Test			
QC-05	Non-Conformance Reports with Proposed Disposition	Within 24 hours of Discovering Non-Conformance			
QC-06	Factory Acceptance Test (FAT) Procedure and Acceptance Criteria	10 weeks prior to FAT			
QC-07	Factory Acceptance Test (FAT) Reports	2 weeks after FAT			
QC-08	Hydrostatic/Pneumatic Leak Test Procedures	8 weeks prior to Hydro Test			
QC-09	Hydrostatic/Pneumatic Leak Test Reports	1 week after Hydro Test			

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
QC-10	AISC Certificate	4			
QC-11	Performance Test Certificate	1 week after Test			
QC-12	Material Test Reports (MTR) traceable to material heat or cast segregated by individual tag numbers, or traceable to material heat by individual components. All MTR shall specify Country of Origin.	16			
QC-13	Welding Procedure Specifications (WPS) / Welding Procedure Qualification Records (PQR) to be utilized. Each WPS and Supporting PQRs shall be submitted as an individual document with WPS Number and Revision Number in the Title.	6			
QC-14	Weld Procedure Matrix	6			
QC-15	Non-Destructive Examination (NDE) and Impact Testing Procedures, including Brinell Hardness Testing Procedure, Positive Material Identification, UT Examination Procedure, RT Examination Procedure, PT Examination Procedure, MT Examination Procedure, etc.	6			
QC-16	Non-Destructive Examination (NDE) and Impact Testing Reports, including Brinell Hardness Testing Report, Positive Material Identification, UT Examination Report, RT Examination Report, PT Examination Report, MT Examination Report, etc.	2 weeks after Test			
QC-17	Deliver certified disclosure letter on corporate letterhead validating DHS cybersecurity compliance or work arounds for all Cyber Assets and embedded devices per Section I3 NERC CIP / Cybersecurity Sensitive	2 weeks after Delivery	*	**	
QC-18	Motor test reports including complete nameplate information and patterned after IEEE Std. 112	12			
QC-19	Structural Steel Material Test Reports (MTR) - consistent with approved fabricator identification procedures and in accordance with AISC 303, Section 6.1. At a minimum each MTR shall specify Country of Origin.	2 Weeks After Delivery to Site			

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
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Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
RE-01	Recommended Maintenance Schedule, which shall include (but not be limited to) the following: -Predictive or preventative maintenance program -Servicing procedures for dismantling and/or replacing components -Routine electrical and mechanical procedures -Any tests/checks for cleaning, lubricating, and otherwise caring for the Equipment -Instrument calibration -Maintenance of interlocks and other applicable safety features	12			
RE-02	Digital photographs of all Buyer termination points clearly showing both the Buyer's side and Seller's side wiring, terminal block labels, terminal labels, and wiring labels. Photographs shall be submitted before equipment is shipped.	6 weeks prior to Delivery	*		
RE-03	Freeze protection requirements (min allowable ambient temperature, max exposure temperatures, min maintained process temperature, etc.) for any Seller provided equipment. Note acceptable type of freeze protection system.	8			
RE-04	Heat Tracing quantities: List of Components on equipment skid, lines including piping size and approximate lengths, class and size for all flanges and valves, factory routed tubing lengths, and inline items: specialties, instrumentation, etc. Note acceptable type of freeze protection system. Any information not available during initial submittals shall be submitted on as-built drawings before shipment including pictures of completed skids.	8			
RE-05	Pre-Operational Cleaning Guidelines	2 weeks prior to Delivery			
RE-06	Calibration certificates for all safety/pressure relief valves provided in the Seller's scope (both on-skid or shipped-loose) with set pressure greater than 15 psig [100 kPa]	4 weeks prior to Delivery			
RE-07	All requirements for Unloading, Receiving, Handling, and Long and Short Term Storage per Section GR-B	12			
RE-08	Cut Sheets - all manual and control valves	8			
RE-09	Cut Sheets - Pipe Supports	10			
RE-10	Cut Sheets - Silencers	10			
RE-11	Cut Sheets - Start-up Vent Valves including Cv or capacity/DP information	8			
RE-12	Cut Sheets - Ignition Transformer	10			
RE-13	Cut Sheets - Motor and Drive Components	4			
RE-14	Insulation Details/Specifications for all Seller-provided equipment and piping	12			
RE-15	Station Designer's Handbook	2			
RE-16	Generator requisition summary sheets	6			
RE-17	Line/Neutral cubicle drawings	8			
RE-18	Generator Protection Studies and Relay Settings	36			

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
RE-19	Technical Feasibility Exceptions (TFEs) NERC CIP / Cybersecurity Sensitive	4 weeks prior to Delivery		**	
RE-20	Preliminary door hardware information	4			
RE-21	Final door hardware information	8			
RE-22	Complete Logistics and Transportation Plan detailing all of the steps EXW factory, including a detailed Method Statement when any of the following modes of transportation are applicable: (i) Air; (ii) Barge; (iii) Ocean; (iv) Rail; and (v) Over the Road (Heavy Haul).	8	*		
RE-23	List of cleared personal for access to sensitive documentation; first/last name and email only per Section I3	4			
RE-24	Notification of employee separation from project or company; first/last name and email only	4 hours after separation	*		
RE-25	Resumes for TFA Candidates (TFA must be qualified to commission the communication links between the equipment PLC and the plant DCS)	6			
SH-01	Engineering/Procurement/Production/Fabrication/Shipping Schedule per Section GR-B.	2			
SH-02	Updated Engineering/Procurement/Production/Fabrication/Shipping Schedule per Section GR-B.	Monthly			
SH-03	Notify Buyer of all shipments	4 weeks prior to Delivery			
ST-01	Dimensions, weights, configurations, and details of steel construction/fabrication for overall structure and all steel members and connections including but not limited to: -Structural framing members -Base plates -Anchor bolts -Stairs -Ladders -Guard rails -Metal grating -Metal deck -Fall restraint systems. Must be sealed/stamped by a P.E. registered in the jurisdiction of the project.	12			***

SELLER'S DELIVERABLE SCHEDULE (SDS)

Combustion Turbine Generator		For specific dates associated with the durations specified herein, see the Material Contract section.			
		Kiewit Spec:	94.03.36.100		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
ST-02	Joint Details, Material of Construction for Structural Welds, and Installation Requirements for Structural Bolted Connections	60 days prior to Delivery of Structural Steel			

*Liquidated Damages apply
**Cyber Security applies
***P.E. Stamp required from a P.E. licensed in the jurisdiction of the project

APPENDIX A

GAS ANALYSIS

Performance Guarantee Guidance

The following provides performance guarantee guidance for the Combustion Turbine Generator (CTG) and Selective Catalytic Reduction (SCR).

Performance Guarantees

The following parameters are recommended to be guaranteed. The approach of guarantees with no tolerance is preferred over guarantees with a test tolerance.

- CTG Net Power Output in kW
- CTG Net Heat Rate in Btu/kWh (indicate LHV or HHV)
- CTG Exhaust Flow in lb/h
- SCR Performance

Guarantee Basis Conditions

The following are recommended guarantee basis conditions.

- All guarantees shall be based on the boundary of the scope of supply
- Guarantees shall be based on 200 operating or equivalent operating hours
- Barometric pressure shall be used (not elevation)
- Exhaust pressure basis shall be at the boundary of the scope of supply. A measurement point must exist at the physical location corresponding to the guarantee basis location.
- Power factor - 0.85
- Grid frequency - 60 Hz
- Fuel gas temperature to CTG equipment terminal point - 50 °F
- CTG exhaust pressure - 12” H_2O

Recommended Liquidated Damages

Below is a summary of recommended liquidated damages.

CTG Net Power Output - $1,500 per kW

CTG Net Heat Rate - $20,000 - $50,000 per Btu/kWh (indicate LHV or HHV)

CTG Maximum Exhaust Flow – Tune machine to make right for SCR sizing and performance.

SCR Performance – Make right.

Auxiliary Power for Other Equipment - $1800 per kW

Line #	Description	Detailed Engineering	Supply of Equip, Material or Service	Constr/Erect Test/Implement	Comments
1	**Permits**				
2	Municipal Development Permit	OWNER	OWNER	N/A	Information and support may be required from Contractor as identified by OWNER
3	Stormwater Construction Permit	ENGINEER	CONTRACTOR	N/A	As required to do work
4	Building permits	ENGINEER	CONTRACTOR	N/A	As required to do work
5	Road Construction	ENGINEER	CONTRACTOR	N/A	As required to do work
6	Utility Crossing Agreements	ENGINEER	CONTRACTOR	N/A	As required to do work
7					
8	**General Conditions and Services**				
9	Site Offices, Phone/Utilities Hookup, Hi-Speed Lines, Satellite	N/A	CONTRACTOR	CONTRACTOR	
10	Site Office Eqt./Supplies, Furn., Phone/Fax Svc	N/A	CONTRACTOR	CONTRACTOR	
11	OWNER Site Offices, Phone/Fax/Utility Hookup, Hi-Speed Lines	N/A	CONTRACTOR	CONTRACTOR	
12	Temporary & Permanent Storage/Warehouse	N/A	CONTRACTOR	CONTRACTOR	
13	Construction Electric Power System	N/A	CONTRACTOR	CONTRACTOR	Distribution system and transformer within the construction site supplied by Contractor.
14	Construction Sanitary Facilities	N/A	CONTRACTOR	CONTRACTOR	Temporary system by Contractor.
15	Construction Water (NOT potable)	N/A	CONTRACTOR	CONTRACTOR	
16	Construction Water Treatment	N/A	CONTRACTOR	CONTRACTOR	
17	Construction Potable Water	N/A	CONTRACTOR	CONTRACTOR	Contractor to supply bottle service.
18	Temporary Fire Fighting System	N/A	CONTRACTOR	CONTRACTOR	
19	Personal Protection Equipment (PPE)	N/A	OWNER/CONTRACTO	OWNER/CONTRACTOR	Each pays own.
20	Safety Training Program	N/A	CONTRACTOR	CONTRACTOR	
21	First Fills	N/A	CONTRACTOR	N/A	
22	Start-up Consumables through Substantial Completion, including;				
23	Lubricating Oil	N/A	CONTRACTOR	N/A	Meet or Exceed OEM requirement
24	Ammonia	N/A	CONTRACTOR	N/A	
25	Natural gas	N/A	OWNER	N/A	
26	Operation Consumables, including;				
27	Lubricating Oil	N/A	OWNER	OWNER	After Substantial Completion
28	Ammonia	N/A	OWNER	OWNER	After Substantial Completion
29	Nitrogen	N/A	OWNER	OWNER	After Substantial Completion
30	Natural gas	N/A	OWNER	OWNER	After Substantial Completion
31	Start-up and operations process waste disposal				
32	Oil drains, flushes	N/A	CONTRACTOR	CONTRACTOR	Contractor hauls offsite until Substantial Completion.
33	First Aid Station	N/A	CONTRACTOR	CONTRACTOR	
34	Drug Testing of Crafts and CM	N/A	CONTRACTOR	CONTRACTOR	
35	Site Vehicles	N/A	CONTRACTOR	CONTRACTOR	
36	Owner & Consultant Vehicles	N/A	OWNER	OWNER	
37	Start-up and operation manual	ENGINEER	CONTRACTOR	CONTRACTOR	
38	Turnover packages	ENGINEER	CONTRACTOR	CONTRACTOR	
39	Commissioning supervision	N/A	CONTRACTOR	CONTRACTOR	Owner provides Operators
40	Commissioning craft & support	N/A	CONTRACTOR	CONTRACTOR	Contractor to supply supervision and labor
41	Stack testing	N/A	CONTRACTOR	CONTRACTOR	Subcontract
42	Performance testing, testing equipment, labor	ENGINEER	CONTRACTOR	CONTRACTOR	
43	Factory testing and shop inspections	N/A	CONTRACTOR	CONTRACTOR	Owner/Rep may witness.
44	Project management, including invoicing	N/A	CONTRACTOR	CONTRACTOR	
45	Construction management	N/A	CONTRACTOR	CONTRACTOR	
46	Bonds	N/A	CONTRACTOR	CONTRACTOR	
47	O&M Training	N/A	CONTRACTOR	CONTRACTOR	
48	Start-up and Operations Operators	N/A	OWNER	OWNER	
49	Start-up Maintenance	N/A	CONTRACTOR	CONTRACTOR	Prior to Substantial Completion
50	Operations maintenance	N/A	OWNER	OWNER	After Substantial Completion
51	Startup Spares	N/A	CONTRACTOR	CONTRACTOR	
52	Capital Spares	N/A	OWNER	OWNER	
53	Site Security - Overall Facility	N/A	CONTRACTOR	CONTRACTOR	Prior to Substantial Completion
54	Material Receiving	N/A	CONTRACTOR	CONTRACTOR	
55	Temporary Warehousing	N/A	CONTRACTOR	CONTRACTOR	
56	Stored Equipment Maintenance	N/A	CONTRACTOR	CONTRACTOR	
57	Equipment and Materials Transportation to Site	N/A	CONTRACTOR	CONTRACTOR	Included with Owner Supplied Equipment
58	Customs Clearance including Fees	N/A	N/A	N/A	
59	Special Tools	N/A	CONTRACTOR	CONTRACTOR	By vendors of Contractor or Contractor.

Line #	Description	Detailed Engineering	Supply of Equip, Material or Service	Constr/Erect Test/Implement	Comments
60	Heavy Haul	N/A	CONTRACTOR	CONTRACTOR	
61	Site clean-up and disposal of trash	N/A	CONTRACTOR	CONTRACTOR	
62	Project labor agreement	N/A	CONTRACTOR	CONTRACTOR	If Required
63	Hazardous Waste Removal and Disposal	N/A	CONTRACTOR	CONTRACTOR	Waste generated by Contractor
64	Project and Interface Schedules	N/A	CONTRACTOR	CONTRACTOR	
65	Project Controls, Resource Management, Reporting	N/A	CONTRACTOR	CONTRACTOR	
66	Monthly Progress Reports and Owner Interface Meetings	ENGINEER	CONTRACTOR	CONTRACTOR	
67	3D Model Reviews	ENGINEER	N/A	N/A	
68	Constructability Review	ENGINEER	N/A	N/A	
69	**Civil/Sitework**				
70	Site Clearing	N/A	CONTRACTOR	CONTRACTOR	
71	Process Site survey (except property limits)	N/A	CONTRACTOR	CONTRACTOR	Including topographical survey.
72	Property limits survey	N/A	OWNER	OWNER	
73	Permanent Site Benchmarks	N/A	CONTRACTOR	CONTRACTOR	
74	Soil survey, including borings	OWNER	OWNER	OWNER	Owner to provide geotechical report with bid documents. Any additional testing shall be by Contractor.
75	Construction laydown area and maintenance	N/A	CONTRACTOR	CONTRACTOR	
76	Construction Parking area and maintenance	N/A	CONTRACTOR	CONTRACTOR	
77	Temporary roads and maintenance	N/A	CONTRACTOR	CONTRACTOR	
78	Erosion/Sediment Control	ENGINEER	CONTRACTOR	CONTRACTOR	
79	Storm Drainage	ENGINEER	CONTRACTOR	CONTRACTOR	
80	Asphalt/Concrete Paving	ENGINEER	CONTRACTOR	CONTRACTOR	
81	Perimeter Fencing/Gates	ENGINEER	CONTRACTOR	CONTRACTOR	Construction and permanent fencing by Contractor.
82	Signage	ENGINEER	CONTRACTOR	CONTRACTOR	
83	Final roads and paving	ENGINEER	CONTRACTOR	CONTRACTOR	
84	Underground Piping Systems	ENGINEER	CONTRACTOR	CONTRACTOR	
85	Existing topsoil removal and storage	ENGINEER	CONTRACTOR	CONTRACTOR	
86	Final Grading of Site	ENGINEER	CONTRACTOR	CONTRACTOR	
87	Landscaping (Sidewalks, Stone, Shrubs, Trees, Sod, etc.)	ENGINEER	CONTRACTOR	CONTRACTOR	
88					
89	**Concrete Work**				
90	Excavation, Backfill & Compaction for Buildings, foundations	ENGINEER	CONTRACTOR	CONTRACTOR	Includes backfill import as necessary
91	Excavation, Backfill & Compaction for Utilities	ENGINEER	CONTRACTOR	CONTRACTOR	
92	Piling	ENGINEER	CONTRACTOR	CONTRACTOR	As Required
93	Building Foundations	ENGINEER	CONTRACTOR	CONTRACTOR	
94	Equipment Foundations	ENGINEER	CONTRACTOR	CONTRACTOR	
95	Steel Structures Foundations	ENGINEER	CONTRACTOR	CONTRACTOR	
96	Pipe Rack Foundations	ENGINEER	CONTRACTOR	CONTRACTOR	
97	Tank Foundations	ENGINEER	CONTRACTOR	CONTRACTOR	
98	Storm Water and Other Manholes and Lift stations	ENGINEER	CONTRACTOR	CONTRACTOR	
99	Retaining walls	ENGINEER	CONTRACTOR	CONTRACTOR	If Required
100	Underground Ductbanks	ENGINEER	CONTRACTOR	CONTRACTOR	
101					
102	**Structural Work**				
103	Buildings				
104	Weather Enclosures	ENGINEER	CONTRACTOR	CONTRACTOR	
105	Pipe Rack Structural Steel	ENGINEER	CONTRACTOR	CONTRACTOR	
106	Miscellaneous Pipe/Cable Tray Support Steel	ENGINEER	CONTRACTOR	CONTRACTOR	
107	Crane & Support Steel	ENGINEER	CONTRACTOR	CONTRACTOR	
108	Platforms, Stairs, Ladders, Handrails	ENGINEER	CONTRACTOR	CONTRACTOR	
109	Equipment Support Steel	ENGINEER	CONTRACTOR	CONTRACTOR	
110	Cranes				
111	Misc. Hoists	N/A	CONTRACTOR	CONTRACTOR	
112	Combustion Turbine Bridge Crane	ENGINEER	CONTRACTOR	CONTRACTOR	If Required
113	Special tools for Combustion Turbine Generator	N/A	OWNER	CONTRACTOR	
114					

Line #	Description	Detailed Engineering	Supply of Equip, Material or Service	Constr/Erect Test/Implement	Comments
115	**Mechanical/Process Equipment**				
116	Combustion Turbine Generator (CTG), including:				
117	CTG Mechanical Package	N/A	OWNER	CONTRACTOR	
118	CTG Electrical Package	N/A	OWNER	CONTRACTOR	
119	Lube Oil System	N/A	OWNER	CONTRACTOR	
120	Control Oil System	N/A	OWNER	CONTRACTOR	
121	Fuel Gas System				
122	Fuel Gas Valves for Purge Credit to Meet NFPA 85	N/A	N/A	N/A	Not required for simple cycle
123	Final Filter/Separator	N/A	OWNER	CONTRACTOR	
124	CT Inlet Cooling Modules - onboard CT/Gen coolers	N/A	OWNER	CONTRACTOR	
125	Fire Protection/Detection System	N/A	OWNER	CONTRACTOR	
126	Inlet Air System				
127	Evaporative Cooler System (with moisture separator)	N/A	OWNER	CONTRACTOR	
128	Inlet Support Structure	N/A	OWNER	CONTRACTOR	
129	Inlet Access Ladders	N/A	OWNER	CONTRACTOR	
130	Exhaust Transition	N/A	OWNER	CONTRACTOR	
131	Static Start System	N/A	OWNER	CONTRACTOR	
132	Turning Gear	N/A	OWNER	CONTRACTOR	
133	Line Termination Enclosure with CTs, VTs, Surge Arrestors, and Surge Capacitors	N/A	OWNER	CONTRACTOR	
134	Neutral Cubicle with CT, Neutral Tie Bus, Grounding Transformer, and Secondary Resistor	N/A	OWNER	CONTRACTOR	
135	CTG Isolated Phase Duct	ENGINEER	CONTRACTOR	CONTRACTOR	
136	CTG Generator Breaker	ENGINEER	CONTRACTOR	CONTRACTOR	
137	Interconnecting Cable, Cable Tray and Conduit	N/A	CONTRACTOR	CONTRACTOR	
138	Interconnecting Piping between Package Skids	N/A	CONTRACTOR	CONTRACTOR	
139	Water Wash System/Skid	N/A	OWNER	CONTRACTOR	
140	CTG Drain Tanks	N/A	CONTRACTOR	CONTRACTOR	
141	Access Platforms, Walkways and Ladders	N/A	OWNER	CONTRACTOR	
142	Anchor Bolts, Embedded Plates and Reinforcing Steel	ENGINEER	CONTRACTOR	CONTRACTOR	
143	Bed Plates, Sole Plates, Adjusting Screws, Shims	N/A	OWNER	CONTRACTOR	
144	Module/Compartment Ventilation Ductwork Connecting to Modules	ENGINEER	CONTRACTOR	CONTRACTOR	Includes ductwork from enclosures to outdoors
145	Unloading at Jobsite	N/A	CONTRACTOR	CONTRACTOR	
146	Technical Direction during Installation, Start Up & Testing	N/A	OWNER	CONTRACTOR	CTG TFA Service by OWNER only
147	Training of Operating & Maintenance Personnel	N/A	OWNER	CONTRACTOR	
148	O&M Manuals	N/A	OWNER	CONTRACTOR	
149	NOx Reduction System				
150	Aqueous Ammonia Vaporizing Skid	ENGINEER	OWNER	CONTRACTOR	
151	Dilution Air Blower	ENGINEER	OWNER	CONTRACTOR	
152	Ammonia Injection Grid	ENGINEER	OWNER	CONTRACTOR	
153	Ammonia Valves for Purge Credit to Meet NFPA 85	ENGINEER	OWNER	CONTRACTOR	
154	CTG Exhaust Expansion Joint	ENGINEER	OWNER	CONTRACTOR	
155	Stack	ENGINEER	OWNER	CONTRACTOR	
156	Transition Duct to Stack	ENGINEER	OWNER	CONTRACTOR	
157	Expansion Joint in Transition Duct to Stack	ENGINEER	OWNER	CONTRACTOR	
158	EPA Test Connections and Access Platforms	ENGINEER	OWNER	CONTRACTOR	
159	Continuous Emissions Monitoring System	ENGINEER	OWNER	CONTRACTOR	
160	FAA Lighting and Obstruction Marking for Stack	ENGINEER	OWNER	CONTRACTOR	
161	Lightning Protection	ENGINEER	OWNER	CONTRACTOR	
162	CO Reduction System	ENGINEER	OWNER	CONTRACTOR	
163	Access Platforms, Walkways and Ladders	ENGINEER	OWNER	CONTRACTOR	
164	Anchor Bolts, Embedded Plates and Reinforcing Steel	ENGINEER	OWNER	CONTRACTOR	
165	Bed Plates, Sole Plates, Adjusting Screws, Shims	ENGINEER	OWNER	CONTRACTOR	
166	Unloading at Jobsite	ENGINEER	OWNER	CONTRACTOR	
167	Technical Direction during Installation, Start Up & Testing	ENGINEER	OWNER	CONTRACTOR	
168	Training of Operating & Maintenance Personnel	ENGINEER	OWNER	CONTRACTOR	
169	Heat Rejection Systems, including;				
170	Air Cooled Heat Exchanger	ENGINEER	CONTRACTOR	CONTRACTOR	If not supplied as part of CTG package
171	Water Supply Systems				
172	Demin Water Supply	OWNER	OWNER	OWNER	Leased system
173	Demin Water Storage Tank	ENGINEER	CONTRACTOR	CONTRACTOR	

Line #	Description	Detailed Engineering	Supply of Equip, Material or Service	Constr/Erect Test/Implement	Comments
174	Plant Drains and Waste Water System				
175	Wastewater Sump	ENGINEER	CONTRACTOR	CONTRACTOR	
176	Wastewater Transfer Pumps	ENGINEER	CONTRACTOR	CONTRACTOR	
177	Drain Sump Pumps	ENGINEER	CONTRACTOR	CONTRACTOR	
178	Oil / Water Separator	ENGINEER	CONTRACTOR	CONTRACTOR	
179	Aqueous Ammonia System				
180	Ammonia Storage Tank	ENGINEER	CONTRACTOR	CONTRACTOR	
181	Ammonia Forwarding Pumps	ENGINEER	CONTRACTOR	CONTRACTOR	
182	Ammonia Unloading Station	ENGINEER	CONTRACTOR	CONTRACTOR	
183	Compressed Air system - Instrument and Service Air				
184	Air Compressors	ENGINEER	CONTRACTOR	CONTRACTOR	
185	Air Dryers and filters	ENGINEER	CONTRACTOR	CONTRACTOR	
186	Air Receivers	ENGINEER	CONTRACTOR	CONTRACTOR	
187	Compressed Gas System				
188	Carbon Dioxide Bottle Rack and Manifold	N/A	N/A	N/A	
189	Carbon Dioxide Bottles	N/A	N/A	N/A	
190	Hydrogen Bulk Storage Tank	N/A	N/A	N/A	
191	Hydrogen Gas	N/A	N/A	N/A	
192	Nitrogen Generator	N/A	N/A	N/A	
193	Fuel Gas System				
194	Natural Gas Custody Transfer Metering Station	OWNER	OWNER	OWNER	
195	Natural Gas Piping From Custody Transfer to Site Boundary	OWNER	OWNER	OWNER	
196	Natural Gas Check Metering Station	ENGINEER	CONTRACTOR	CONTRACTOR	
197	Dew Point Heater	ENGINEER	CONTRACTOR	CONTRACTOR	
198	Gas Compressors w/ Building	N/A	N/A	N/A	
199	Knock Out Tank	ENGINEER	CONTRACTOR	CONTRACTOR	
200	Drain Tank(s)	ENGINEER	CONTRACTOR	CONTRACTOR	
201	Coalescing Filters	ENGINEER	CONTRACTOR	CONTRACTOR	
202	Performance Heaters	N/A	OWNER	CONTRACTOR	
203	Gas Turbine Final Filters	N/A	OWNER	CONTRACTOR	
204	Pressure Control Stations	ENGINEER	CONTRACTOR	CONTRACTOR	
205	Pulsation Studies and Mitigation	N/A	N/A	N/A	
206					
207	**Piping**				
208	Control Valves	ENGINEER	CONTRACTOR	CONTRACTOR	
209	Motor and Air Operated Small Bore and Large Bore Valves	ENGINEER	CONTRACTOR	CONTRACTOR	
210	Large and Small Bore Piping, Valves, Devices	ENGINEER	CONTRACTOR	CONTRACTOR	
211	Pipe Supports (all Large Bore and Small Bore)	ENGINEER	CONTRACTOR	CONTRACTOR	
212	Balance of Piping, All Other Valves, Devices, and Specialties	ENGINEER	CONTRACTOR	CONTRACTOR	
213					
214	**Piping & Equipment Insulation**				
215	Piping Insulation	ENGINEER	CONTRACTOR	CONTRACTOR	Permanent and temporary
216	Mechanical Equipment Insulation	ENGINEER	CONTRACTOR	CONTRACTOR	Permanent and temporary
217					
218	**Fire Protection**				
219	Standpipes, Risers, Hose Stations, Branches, Devices (sprinkler heads,	ENGINEER	CONTRACTOR	CONTRACTOR	
220	Fire Protection				
221	Motor-driven Main, Diesel driven Back-up, and Jockey Pumps/Controllers	ENGINEER	CONTRACTOR	CONTRACTOR	
222	Underground piping to shutoff valves or hydrants	ENGINEER	CONTRACTOR	CONTRACTOR	
223	ALL Aboveground complete systems	ENGINEER	CONTRACTOR	CONTRACTOR	
224					
225	**Painting/Coatings**				
226	Structural Steel	ENGINEER	CONTRACTOR	CONTRACTOR	
227	Mechanical Equipment/Tanks	ENGINEER	CONTRACTOR	CONTRACTOR	
228	Piping	ENGINEER	CONTRACTOR	CONTRACTOR	
229					
230	**Electrical & Instrumentation**				
231	Plant Substation/Switchyard	OWNER	OWNER	OWNER	
232	HV transmission lines to nearest substation	OWNER	OWNER	OWNER	

Line #	Description	Detailed Engineering	Supply of Equip, Material or Service	Constr/Erect Test/Implement	Comments
233	Dead End Structure at highside of GSU	ENGINEER	CONTRACTOR	CONTRACTOR	
234	High Voltage System				
235	Relay Protection Control Cabinets and Metering	ENGINEER	CONTRACTOR	CONTRACTOR	
236	Main GSU Transformers	ENGINEER	CONTRACTOR	CONTRACTOR	
237	Station Service Transformers	ENGINEER	CONTRACTOR	CONTRACTOR	
238	Disconnect Switches	ENGINEER	CONTRACTOR	CONTRACTOR	
239	Iso-Phase Bus Duct	ENGINEER	CONTRACTOR	CONTRACTOR	
240	Medium Voltage Electrical Systems				
241	Relay Protection Control Cabinets and Metering	ENGINEER	CONTRACTOR	CONTRACTOR	
242	Station Service Transformers	ENGINEER	CONTRACTOR	CONTRACTOR	
243	Non-Seg Bus Duct	ENGINEER	CONTRACTOR	CONTRACTOR	
244	Switchgear, Secondary Substations, and Dry Transformers	ENGINEER	CONTRACTOR	CONTRACTOR	
245	Conduit/Cabletray/Other Raceway	ENGINEER	CONTRACTOR	CONTRACTOR	
246	Cable	ENGINEER	CONTRACTOR	CONTRACTOR	
247	Low Voltage Electrical Systems				
248	Diesel Emergency Genset	ENGINEER	CONTRACTOR	CONTRACTOR	
249	Transformers	ENGINEER	CONTRACTOR	CONTRACTOR	
250	Substations and Motor Control Centers	ENGINEER	CONTRACTOR	CONTRACTOR	
251	Load Centers	ENGINEER	CONTRACTOR	CONTRACTOR	
252	Raceway/Conduit/Cabletray/Receptacles	ENGINEER	CONTRACTOR	CONTRACTOR	
253	Instrumentation & Controls				
254	DCS	ENGINEER	CONTRACTOR	CONTRACTOR	
255	Control Panels/Desks, CRTs, Printers, etc. (Non-DCS)	ENGINEER	CONTRACTOR	CONTRACTOR	
256	Instruments/Devices (balance)	ENGINEER	CONTRACTOR	CONTRACTOR	
257	Transmitters and Process Controllers, PLC's	ENGINEER	CONTRACTOR	CONTRACTOR	
258	Control/Signal, Instrument, Phone, Data, and Fiber Optic Wiring	ENGINEER	CONTRACTOR	CONTRACTOR	
259	Instrument and Sampling System Tubing	ENGINEER	CONTRACTOR	CONTRACTOR	
260	Calibration	ENGINEER	CONTRACTOR	CONTRACTOR	
261	Uninterruptible Power Supply & 125V DC	ENGINEER	CONTRACTOR	CONTRACTOR	
262	Lighting				
263	Lighting	ENGINEER	CONTRACTOR	CONTRACTOR	
264	Pre-Eng. Steel building lighting	ENGINEER	CONTRACTOR	CONTRACTOR	
265	Outdoor/Site Lighting	ENGINEER	CONTRACTOR	CONTRACTOR	
266	Cathodic Protection	ENGINEER	CONTRACTOR	CONTRACTOR	
267	Heat Tracing	ENGINEER	CONTRACTOR	CONTRACTOR	
268	Grounding	ENGINEER	CONTRACTOR	CONTRACTOR	
269	Lightning Protection	ENGINEER	CONTRACTOR	CONTRACTOR	
270	Security and In-Plant Communications Systems				
271	Closed Circuit TV System	ENGINEER	CONTRACTOR	CONTRACTOR	
272	Gate Opener and Card Reader System	ENGINEER	CONTRACTOR	CONTRACTOR	
273					
274	**Other Construction**				
275	Construction Phase Testing, Inspection, and Check-out	N/A	CONTRACTOR	CONTRACTOR	Includes all construction phase QA testing
276	Small tools and consumables	N/A	CONTRACTOR	CONTRACTOR	Including welding rod, rags, sheet gasket, etc…
277	On-Site Quantity Surveying	N/A	CONTRACTOR	CONTRACTOR	Contractor responsible for maintaining record of actual quantities installed on the project, including materials and direct labor.
278	Contaminated Soil Testing	N/A	CONTRACTOR	CONTRACTOR	
279	Instrument Calibrations	N/A	CONTRACTOR	CONTRACTOR	
280	On-site Housekeeping, Maintenance and Rubbish Removal	N/A	CONTRACTOR	CONTRACTOR	
281	Snow Removal	N/A	CONTRACTOR	CONTRACTOR	
282	Dust Suppression	N/A	CONTRACTOR	CONTRACTOR	
283	Fall Arrest Prevention Systems	N/A	CONTRACTOR	CONTRACTOR	
284	Construction Turnover Packages (to Startup)	N/A	CONTRACTOR	CONTRACTOR	
285					
286	**Commissioning & Start-up**				
287	System Definitions/Descriptions	ENGINEER	N/A	N/A	
288	System Function Test/Commissioning Procedures	ENGINEER	CONTRACTOR	CONTRACTOR	
289	Startup Turnover Packages and Execution	N/A	CONTRACTOR	CONTRACTOR	

Line #	Description	Detailed Engineering	Supply of Equip, Material or Service	Constr/Erect Test/Implement	Comments
290	Pressure Test/Flushing	N/A	CONTRACTOR	CONTRACTOR	
291	Temporary Demin Water Supply	N/A	CONTRACTOR	CONTRACTOR	
292	DCS Check-out	N/A	CONTRACTOR	CONTRACTOR	
293	High Voltage and Other Electrical Testing	N/A	CONTRACTOR	CONTRACTOR	
294	Boiler Degreasing/Chemical & Acid Cleaning	N/A	CONTRACTOR	CONTRACTOR	
295	Systems Start-up and Commissioning (Labor, Ops, & Labor Mgmt)	N/A	CONTRACTOR	CONTRACTOR	
296	Systems Start-up and Commissioning (Technical Oversight)	N/A	CONTRACTOR	CONTRACTOR	
297	Lube Oil Flush	ENGINEER	CONTRACTOR	CONTRACTOR	
298	Noise Testing	N/A	CONTRACTOR	CONTRACTOR	
299	As-Built Drawings	N/A	CONTRACTOR	CONTRACTOR	
300	Instruction Books / Manuals	N/A	CONTRACTOR	CONTRACTOR	
301	Owner Training/Operator Training	N/A	CONTRACTOR	CONTRACTOR	Included with Owner Supplied Equipment
302	Manufacturer's Field Services	N/A	CONTRACTOR	CONTRACTOR	Included with Owner Supplied Equipment

NOTES:

1.) Contractor's detailed engineering shall incorporate basic engineering data provided in this specification.

2.) This list is not meant to be an all inclusive list of all Materials and Work for the project, but has been used to clarify scope for major items and activities.

TECHNICAL SPECIFICATIONS FOR SELECTIVE CATALYTIC REDUCTION (SCR)

94.03.30.175.02

XCEL ENERGY

KIEWIT PROJECT NO. 20038657

ISSUED: DECEMBER 11, 2020

REVISION A – ISSUED FOR REVIEW

KIEWIT
8900 Renner Blvd., Lenexa, KS 66219
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TECHNICAL SPECIFICATIONS
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TS1	Selective Catalytic Reduction	TS1-1 – TS1-21	A
EDR	Engineering Design Requirements	EDR-1 – EDR-5	A
SDS	Seller's Deliverable Schedule	SDS-1 – SDS-8	A
APPENDIX A			
	Gas Turbine Performance	LATER	A
APPENDIX B			
	SCR Performance Guarantees	2 pages	A
APPENDIX C			
	CTG Interface Details	LATER	A
APPENDIX D			
	CTG Fuel Specification	LATER	A

TECHNICAL SPECIFICATION 94.03.30.175.02

SELECTIVE CATALYTIC REDUCTION (SCR)

1. SCOPE: The scope of Seller supply includes equipment, materials, and services for the quantity specified in the Engineering Design Requirements (EDR) of Selective Catalytic Reduction and CO Catalytic Reduction system(s), each downstream of one simple cycle combustion turbine(CT), referred to herein as SCR systems. This Section stipulates the major design and performance criteria for the SCR systems and their associated Equipment.

1.1 Each SCR system shall include, but not limited to, the following items. The Seller shall be responsible for providing all equipment as required to provide a complete system as required to meet all guarantees. Interconnecting piping between the ammonia flow control skid and the ammonia distribution header will be by others. Foundations and erection will be by others. Erection supervision shall be offered as an option by Seller.

a. SCR and CO Catalyst.
b. SCR and CO Catalyst housing, internal supports, and seals.
c. Support framing from the combustion turbine exhaust diffuser flange up through and including the exhaust stack.
d. Exhaust stack.
e. Inlet and outlet transition ducts and all expansion joints within the Seller's scope of supply. See EDR for expansion joints between the CTG Exhaust and the SCR inlet duct.
f. Tempering air / purge air fan skid complete with accessories.
g. Interconnecting tempering air ductwork from fans to casing.
h. Tempering air distribution within the SCR system casing.
i. Ammonia flow control and vaporization skids complete with accessories.
j. Ammonia injection grid and support structure.
k. Ammonia distribution header adjacent to the ammonia injection grid including flow control valves, flow orifices, and manometers. Header(s) shall be routed vertically up the side of the SCR with the flow control valves and associated instrumentation located as near as practical to their respective connection points to the SCR grid. Header(s) shall be equipped with expansion joints as required.
l. Silencing equipment for the SCR system and stack necessary to meet noise guarantees.
m. Access platforms, stairs and ladders for SCR system and test ports. These shall meet OSHA requirements.
n. Piping shall be shop fabricated to the maximum extent possible, i.e. 40-foot sections.
o. All instrumentation as required for a complete functioning system capable of fully remote operation, including remote startup and shutdown.
p. Test ports consisting of 2-1/2 inch pipe connections for the CEMS and for performance testing that allow traverse testing upstream and downstream of each

layer of catalyst and upstream of ammonia injection in a grid arrangement. Sampling grid(s) may be provided as an alternative.

q. Provisions shall be made such that catalytic element sampling coupons or catalyst elements can be readily accessible without disturbing other equipment and by the use of common tools.

r. All piping, valves and components in contact with aqueous ammonia shall be stainless steel upstream of the Ammonia Vaporizer and carbon steel downstream of the Ammonia Vaporizer.

1.2 The base bid shall be based on the design and materials detailed herein. Alternate design and materials submitted by the Seller will be considered.

2. DESIGN AND PERFORMANCE CRITERIA:

2.1 Seller shall design the systems and equipment in accordance with the design data and operating cases listed in the EDR. Seller shall design the systems and equipment, including selecting materials of construction to provide a minimum 30-year operating life at all operating conditions specified. It is understood that Equipment provided will require routine maintenance, major overhauls, and possible replacement during the life of the facility.

2.2 SCR systems shall be designed to ensure that stack emissions remain in compliance with the limits set forth in the EDR throughout the firing range represented by the cases in Appendix A.

2.3 The SCR, accessories, and all equipment furnished shall be capable of meeting performance guarantees continuously at any load point in the EDR and Appendix A, across the full range of ambient design conditions. The SCR shall operate in a safe, reliable and stable mode under all listed conditions without exceeding the design temperatures.

3. OPERATING CONDITIONS:

3.1 The system shall be suitable for withstanding the transient and steady state operating conditions for all gas turbine operations including starting, loading, unloading and shutdown as well as abnormal conditions including emergency shutdown or sudden full load rejection. The normal operating range of the SCR will be as stated in the EDR. Reference the information included in Appendix A for combustion turbine exhaust conditions at various site ambient conditions and operating loads. The design of equipment shall incorporate appropriate measures for the thermal stresses and metal fatigue associated with the cyclic activity of a peaking power plant.

3.2 The combustion turbines and SCR systems will be located outdoors and shall be designed for both continuous and cycling operation during any ambient conditions presented in these specifications. Each SCR system will receive and process exhaust gases from the make and model of combustion turbine shown in Table EDR. The Seller recognizes the combustion turbine model and acknowledges that the Seller is fully abreast and knowledgeable of the range of exhaust characteristics and velocity profiles and has accounted for these conditions in the Seller's offering.

3.3 The catalysts and other equipment shall be capable of withstanding short-term temperature spikes during tempering air fan failures. All material in the exhaust gas path, or otherwise subjected to exhaust temperature shall be acceptable for the design maximum gas temperature presented in Table EDR.

3.3.1 Fuel: The combustion gas turbine will burn natural gas fuel that meets the requirements listed in Appendix D – Fuel Gas Composition Analysis. The supplied fuel information shall be used for the equipment design and the performance guarantees.

4. GUARANTEES: Seller equipment shall meet the performance guarantees specified in the EDR. The guarantees for emissions, pressure drop, and noise shall be met in everyday operation under all specified operating conditions. The Contractor will conduct tests per agreed upon procedures to determine all guarantees are met.

5. FLOW MODEL(S):

5.1 Computational Fluid Dynamics (CFD) Flow Model

5.1.1 A computational fluid dynamics (CFD) flow model study based on the specific gas turbine exhaust profile data shall be provided. The study shall be conducted at a minimum of two (2) operating conditions (CT MECL and CT Full-Load) to ensure a uniform gas flow profile at the inlet to the catalyst sections. The gas velocity profile entering each catalyst module and the maximum temperature stratification shall be as required by the catalyst manufacturer. Sampling ports shall be provided to verify these parameters.

5.1.2 This CFD flow model shall be conducted, and the results shall be provided to Buyer prior to release for fabrication. If CFD flow model is not completed before fabrication, Seller will take responsibility for any modifications needed due to flow model results.

5.2 Physical Flow Model:

5.2.1 Provide a physical flow model for any new SCR reactor design or on a combustion turbine for which the supplier does not have and SCR that has been in operation for at least six months. The physical model shall be tested in the turbulent flow regime with an air flow rate with proper similitude to the gas flow rates of the full-scale installation. The modeled pressure drop shall be corrected for air/gas density to reflect full-scale conditions. The model shall incorporate or account for all internal structures of the equipment and ductwork including such items as beams, cross struts, stiffeners, and other incidental obstructions to gas flow. A detailed description of the physical model test procedures be developed and submitted to the Buyer for acceptance.

5.2.2 The physical model(s) shall be geometrically identical to the full-scale installation. The model(s) shall be constructed of clear plexiglass to permit observation during flow studies. The model shall be no smaller than $1/12^{th}$ scale. The model shall be tested with air velocity of proper similitude to the flue gas velocity in the full-scale installation. The model shall take into account the effect of the flow patterns and temperature gradients from upstream equipment.

5.2.3 The Seller shall give notice to the Buyer prior to performing physical flow modeling tests. The Seller shall allow Buyer to witness all testing including the final flow model testing. The Seller shall contact the Buyer seven (7) days prior to the final testing period. The

model shall be maintained in assembled condition and prepared for further testing until Buyer is in full acceptance of the flow model study report. The model shall be retained by the Seller for the life of the Project or until expiration of the warranty period. Final disposition of flow model after project completion or warranty period expiration shall be at the Buyer's discretion.

5.2.4 Flow Modeling Objectives and Requirements: CFD and/or Physical Flow Modeling Objectives:

a. Optimize the tempering air system
b. Optimize Pressure drop at all load conditions
c. Recommend duct configurations, turning vanes and other gas distribution devices
d. Achieve the level of distribution and mixing of gas and ammonia, including temperature to support the guaranteed performance.
e. Minimize non-uniform flow distribution, turbulence, and swirl by proper duct geometry and the use of gas distribution devices.

6. FUNCTIONAL TESTING: All controls, instruments, valves, dampers, control panels and auxiliaries shall be function tested prior to delivery.

7. CODE REQUIREMENTS: The equipment shall be designed and constructed in accordance with the latest applicable requirements of the applicable codes and standards, except where modified or supplemented by these Specifications.

7.1.1 The proper stamps shall be affixed to denote conformance to the appropriate codes. All data reports and inspection certificates required by the codes shall be "Engineer-Owner" type documented on a master data report provided and distributed by the Seller.

7.1.2 The Seller shall prepare a written statement of exception to any portion of the applicable codes and standards. The statement shall be submitted to Contractor for review and comment. The statement shall: 1) identify the applicable code or standard section; 2) describe what they cannot or will not do; and 3) describe what they will do in lieu of the code or standard requirement. Failure of the Seller to submit the written statement of exception to Contractor shall be understood to mean that the Seller is complying in all respects to the applicable codes and standards.

8. FOUNDATION LOAD CHART: The Seller shall provide a foundation load chart that clearly shows the vertical and horizontal design loads acting at each load point. The magnitude, direction and location of the design loads shall correspond to each load condition. Load conditions for seismic, thermal, snow and wind shall be given for both the negative and positive coordinate directions. The coordinate axes shall be relative to the equipment axes and occurrences of uplift shall be identified by the coordinate sign convention.

9. GUARANTEE CORRECTION CURVES: The Seller's guarantee correction curves will be used to determine compliance with contract guarantees at the guarantee conditions if they are not achievable during the performance test. The following curves, at a minimum, shall

be included. Provide curves for at least two representative operating condition cases (or state curve is applicable at all conditions). One curve should be at the guarantee condition and one at the governing case that sizes the catalyst. Provide each NOx reduction curve, with at least three ammonia slip concentrations in ppmvd @ 15% O_2 (if applicable). One ammonia slip should be the design slip with two curves below the design. All curves should list the case that they apply to, including key operating conditions (e.g., flue gas flow, flue gas temperature, inlet NOx concentration, ammonia slip, flue gas temperature, time in hours on the catalyst life deactivation curve). If applicable, all curves should indicate a method to correct the curves to the current time with respect to the catalyst life.

a. NOx Reduction v. Inlet NOx (ppmvd @ 15% O_2)
b. NOx Reduction v. Flue Gas Flow Rate
c. NOx Reduction v. Temperature
d. NOx Reduction v. NO/NO_2 Ratio (NO_2 content as percent of NOx)
e. Pressure Drop v. Flue Gas Flow Rate
f. Ammonia slip (ppmvd @ 15% O_2) v. Operating Time (i.e., catalyst life / deactivation curve)
g. NOx Reduction v. RMS of the NH3/NOx molar maldistribution
h. Ammonia slip (ppmvd @ 15% O2) v. RMS of the NH3/NOx molar maldistribution

10. CONSTRUCTION: The design shall be based on factory-built modules with as many shop-assembled components as possible. The design shall include provisions necessary to allow ease of construction, maintenance, and accessibility.

10.1 The Seller shall incorporate the following construction details to minimize the amount of time required to erect the SCR systems and equipment.

a. Factory installed permanent lifting lugs and guy wire lugs on all panels and duct assemblies. Lifting lugs shall not penetrate internal insulation. Internal lifting lugs and guy wire lugs shall be noted in the drawings to be removed in the field. Lifting lugs location shall be clearly identified in Seller's drawings and shall be submitted for Contractor's approval.
b. Factory installed permanent stack erection trunnions or lifting lugs.
c. Shop modularize upper support steel sub assemblies as much as possible. Seller will not be back-charged for interferences with piping or other structural steel caused by Contractor's chosen installation sequence; however, Seller shall be ultimately responsible for interferences that result from design or manufacturing errors.
d. Field-assembled connections for the stack platforms, stairs and ladders shall be bolted connections, not field-welded connections.
e. Field-assembled connections for all other platforms, stairs, and ladders shall be bolted connections.
f. Provide tension control (Lajune-type or equal) bolts in lieu of hex head bolts for

the inlet duct, stair tower, and other components except where installation of TC bolts is not possible such as handrails. Seller will not be back-charged for the installation of hex head bolts where TC bolts and/or installation tools will not fit.

g. Any joints designated as slip-critical by Seller shall be indicated on Seller's installation drawings.

h. Prefabricate upper elevation platforms in sections as large as possible to accommodate standard shipping means.

i. Erection drawings shall indicate that lifting lugs, guy wire lugs, erection trunnions, etc. located on the exterior of the casing or stack may be left in place after erection except where an interference is caused with other permanent components.

j. Seller and Contractor shall mutually approve field weld profiles (moments) in a timeframe to support Seller's engineering and delivery schedule. The field welds (moments) will be designed to be a full penetration weld in accordance with AWS standards.

k. Provide roof access holes to accommodate the use of sky climbers for construction, inspection and maintenance.

11. TEMPORARY AND SHIPPING STEEL:

11.1 Design and install temporary/shipping steel for ease of removal in the field.

11.2 All temporary/shipping steel bolting details shall be clearly shown on the Seller's drawings.

11.3 Temporary bolts used to secure temporary/shipping steel shall not be welded to their respective nuts. Nuts shall be secured to the bolts using lock washers, double nuts, "punching" the bolt threads or by using a welded tab design as required so as to not damage the bolt threads and to allow the use of impact wrench/sockets for quick removal of nuts/bolts.

11.4 Casing shall not be welded onto the truck bed. It shall be tied down with chains or bolted to the truck bed.

11.5 Seller shall furnish one (1) horizontal lifting device and/or one (1) strongback as required for erection. Seller shall provide an option to supply a second horizontal lifting device and/or a second strongback (total of two (2) each) for erection.

12. PIPE WELDING: Field welding shall be minimized as much as practical. Contractor shall have the opportunity to review and revise field weld locations shown on Seller's piping.

13. SHOP COATING: Large bore piping and fittings which will not be insulated shall be delivered to the site shop blasted in accordance with SSPC-SP6 and primed with an inorganic zinc rich primer. Engineered components such as valves, pumps, silencers, etc. shall be delivered to the site finish painted in accordance with the manufacturer's standard finish suitable for the site conditions. Seller's standard finish coating systems shall be submitted to Contractor for review and approval.

14. ACCESS PLATFORMS:

14.1 All ammonia balancing valves shall be accessible by manlift. If manlift accessibility cannot be provided, alternate means shall be provided such as davit for sky climber, etc. Davit arm shall be accessible from an SCR catalyst housing.

14.2 The SCR and CO catalyst modules will be loaded by hand and shall not require An internal monorail or hoist.

15. SHUTDOWN/MAINTENANCE DRAIN AND VENTS: Casing drains shall be provided to drain any condensation from the exhaust gas.

16. NOx CATALYST:

16.1 The NOx catalyst shall be of the low-dust type. The catalyst shall be designed to minimize pressure loss. The direction of gas flow through the catalyst shall be horizontal.

16.2 The catalyst shall be either a homogenous extruded honeycomb or corrugated type. The catalyst modules shall not be subject to de-lamination or permanent deformation of the catalyst or support material due to stresses induced by the seismic conditions, vibration, pressure and thermal conditions or combinations thereof.

16.3 The volume of NOx catalyst supplied shall be designed to control NOx and ammonia slip to the values guaranteed without requiring cleaning, regeneration, or replacement during the catalyst life guarantee period, except that vacuuming may be necessary to remove insulation or debris deposits on the catalyst face prior to placing the catalyst in service. The NOx and ammonia slip limits shall be met simultaneously and corrected to the catalyst life ammonia slip v. time correction curve. The end of catalyst life guarantee period is when the catalyst activity reaches the minimum acceptable level and requires a catalyst layer replacement as measured by the ammonia slip. The end of catalyst life NOx and ammonia slip limits specified in the EDR shall take precedence over the RFP or air permit limits when the values in the EDR are lower.

16.4 The catalyst shall be designed and sized for an NH_3/NOx molar maldistribution of 15% RMS. However, the AIG and any gas distribution devices shall be designed for the SCR and catalyst supplier's standard RMS. RMS is the Root-Mean-Square of the Deviations expressed as a percentage of the mean:

$$RMS = \frac{\sqrt{\frac{1}{(n-1)}\sum_{i=1}^{n}(x_i - \bar{x})^2}}{\bar{x}} \times 100\%$$

Where n = number of data points
$\bar{x}$ = mean of NH_3/NOx ratios
x_i = NH_3/NOx ratio of point i

16.5 The catalyst shall be designed and sized for a bypass/leakage rate of gases around the catalyst per the EDR.

16.6 The NOx catalyst shall be of modular design to facilitate installation and removal of the catalyst. The catalyst modules shall be the maximum practical size to facilitate and minimize field maintenance. Any special tools required to facilitate the removal or installation of catalyst modules shall be provided. Any special tools or handling fixtures for the proper handling or unloading of the catalyst modules from a truck or rail car shall be provided. Internal tie-off lugs shall be provided for use during catalyst installation and replacement.

16.7 The NOx catalyst modules shall include sealing frame and frame steel to improve the ease of catalyst replacement and installation. The frame materials shall be compatible with the catalyst material. The sealing system shall be designed to limit exhaust gas leakage past each layer of catalyst. The sealing mechanism and materials shall provide a service life equal to or greater than the catalyst. SCR catalyst sealing system shall have tongue and groove seals. Catalyst seals shall consist of at least three adjacent, overlapping sealing surfaces in the areas where thermal expansion occurs. Blinding plates and simple pillow seals are not acceptable as the primary seal unless specifically approved by the Buyer.

16.8 The SCR shall be designed to accept future additional layers of catalyst as specified in the EDR.

16.9 Design shall incorporate sufficient catalyst to treat the exhaust gas to meet emissions levels specified without requiring cleaning, rejuvenation or replacement for the catalyst life guarantee period.

16.10 Seller shall supply testing penetrations consisting of 2-½ inch pipe connections located in each side of the casing to permit performance testing of each row of catalyst cells in the system. The test ports shall have blind flanges. The design and configuration of the test ports shall allow traverse testing before and after each row of catalyst in a grid arrangement. No permanent access provisions are required to these test ports.

17. TEMPERING/PURGE AIR SYSTEM:

17.1 A tempering air system shall ensure the catalyst operating temperatures are controllable within the range required for long life of the catalyst. The tempering air system shall inject ambient air to reduce the exhaust temperature. Seller is responsible to engineer this system to provide effective mixing of the air with exhaust gas and to ensure that the cross sectional variations in flow, velocity, temperature and concentration of NOx, CO, VOC and ammonia do not cause emissions to exceed their guaranteed values.

17.2 The tempering air skid shall be furnished pre-assembled and pre-wired to the extent practical. As a minimum, the skid shall include the following equipment.

a. Two (2) 100% tempering air fans.

b. Two (2) inlet air silencer/filters.
c. Acoustical enclosures as required.
d. System to prevent hot gas backflow into a non-operating fan.
e. Ductwork damper system to provide tempering air flow control.
f. Seller shall provide an option to include Variable Frequency Drive (VFD) Motors (Motor starter by others) and remove ductwork control damper system.

18. AMMONIA INJECTION SYSTEM:

18.1 The ammonia vaporization system shall be designed to deliver an ammonia flow that results in a sufficient volumetric ammonia to NOx ratio at the highest exhaust flow and NOx level. The ammonia feed to the vaporizer chamber shall be filtered to prevent clogging of the atomizing nozzles.

18.2 The system shall include the items below and shall be provided pre-piped and pre-wired to the maximum extent possible.

a. Two (2) 100% ammonia vaporizers with an air atomizing nozzle, or packed tower.
b. See EDR for Type of Vaporization System
   - Electric: Air Heaters (n+1 design for redundancy) and heater power panel. The maximum watt density on electric air heaters shall be 30-w/sq.in. to minimize heater burnout.
   - Hot flue gas recirculation.
c. Two (2) 100% capacity dilution air blowers or hot flue gas fans with motors. The blowers (fans) shall be skid-mounted electric motor driven centrifugal fans. The capacity shall be sufficient to dilute the ammonia at the highest flow requirement to ensure adequate mixing and so that the ammonia/air (gas) mixture is not flammable.
d. Contractor's supplied starters for the dilution air blower motors will be supplied with standard Class 20 overload relays. If the Class 20 relays are not sufficient for starting the blower motors (at any ambient temperature conditions with or without the combustion turbine in operation) due to the long motor acceleration time, the Seller will be responsible for providing the required starters for the dilution air blower motors
e. Actuated valve on the outlet of each blower (fan).
f. Actuated valve on the inlet of each blower (fan) for a hot gas recirculation system only.
g. Aqueous ammonia flow control valves.
h. All piping and support structure from ammonia injection manifold to the ammonia injection grid (AIG).
i. Flow meters or flow orifices with transmitters for aqueous ammonia flow and dilution gas flow.
j. Strainers, including differential pressure gauge, upstream of the flow control valves.
k. Manual isolation valves
l. Actuated shut-off valve(s) or solenoid valve(s) for the aqueous ammonia and atomizing air (when applicable).

m. Local instrumentation.

n. Electric junction box where all field wiring termination points will be located.

18.3 The minimum exit temperature of the vaporizer at any load condition is 450 °F.

18.4 The ammonia injection grid shall consist of multiple, manifold pipes with holes configured and spaced for uniform distribution of the ammonia/air mixture throughout the exhaust gas flow. The AIG shall have at least two horizontal zones for the SCRs wider than 15 and with each vertical zone no larger than 7 feet. The location of the ammonia injection grid shall be such that thorough mixing of the ammonia and NOx can be achieved prior to passing through the NOx catalyst. The ammonia injection grid shall be located upstream of the NOx catalyst and shall be fabricated of stainless steel.

18.5 The ammonia injection gird shall include a permanent sample grid at the catalyst exit to be used for AIG tuning with sample lines terminating near grade or a platform.

18.6 The AIG tuning process shall be submitted to the Buyer and shall include the methodology on determining the NH_3/NOx molar maldistribution RMS.

18.7 The interconnect piping between the ammonia vaporization skid and the ammonia injection system shall be designed for insulation by others. The vaporizer skid components shall be shop-insulated by the Seller.

18.8 The sparger pipes exiting the ammonia header shall be equipped with valves and flow elements to allow balancing of the ammonia flow into the duct. The Seller shall define the control capability as part of the proposal.

18.9 The ammonia injection piping shall have local temperature and pressure indication including differential pressure gauge for each header valve.

18.10 The ammonia piping shall have a condensate drain.

18.11 Ammonia/Air Mixing Chamber.

18.11.1 The ammonia/air mixing chamber shall thoroughly mix the ammonia and air so that the gas mixture is safe and non-flammable.

18.11.2 The ammonia vaporization chamber shall have a maximum inlet temperature of the heated dilution air of 800 ˚F.

18.11.3 For systems that use hot flue gas for vaporization, provide means to cool the dilution gas fan with ambient air.

19. CO CATALYST:

19.1 The Seller shall provide a CO catalyst system to meet the air emission guarantees as stated in the EDR for CO and VOCs. The CO catalyst shall be designed and located to meet the guarantees over the full range of operation from Peak Load to Minimum Load shown in Appendix A and the full range of design ambient temperature.

19.2 The design inlet CO and VOC concentration shall be equal to 100% of the combustion turbine exhaust CO and VOC levels as given in Appendix A.

19.3 Provide access manways and catalyst loading openings in the casing sufficient to facilitate removal and installation of the catalyst modules without the need for cutting or welding of any casing components. Internal tie-off lugs shall be provided for use during catalyst installation and replacement.

20. CATALYST WARRANTY: All catalyst shall be designed to meet all emissions guarantees for a minimum catalyst life guarantee period specified in the EDR. The catalyst life guarantee is defined as the duration from initial operation until the catalyst activity reaches the minimum acceptable level and requires a catalyst layer replacement. Any failed module caused by defects in workmanship and materials shall be repaired or replaced at Contractor's option, at Seller's expense.

21. CASING:

21.1 The exhaust gas path shall be enclosed by the casing. The casing shall be furnished with steel liner from the SCR inlet up to the exhaust stack. The exhaust gas path shall be completely gas tight to prevent leakage and bypassing of hot gases within the casing, except that expansion bellows located at floor penetrations may be provided with a 3/16" maximum weep hole to allow draining of condensation from the bellows. Casing panels shall be fabricated with lifting lugs and guy wire lugs installed to minimize erection time.

21.2 The casing shall be designed to withstand the maximum combustion turbine exhaust pressure and flow rate. Unless otherwise specified in the EDR, the SCR outer casing shall be fabricated of A36 carbon steel plate at least 1/4" thick with stiffening for an internal design pressure of 20 in. w.c. in addition to wind loadings specified below.

21.3 A complete walkway layout for maintenance, accommodations for catalyst installation, sampling and replacement, adequate access doors upstream and downstream of the catalyst sections, and adequate test ports for traverse emissions testing upstream and downstream of the SCR catalyst. All flow distribution equipment, if required, shall be provided by Seller.

21.4 The catalyst modules and frame shall be designed to allow for thermal expansion without damaging the catalyst.

21.5 Design shall allow the removal of NOx catalyst through top of casing by mobile crane.

21.6 Housing structural support members, columns, and casing stiffener bars shall be external to the casing to prevent exposure to hot exhaust gases.

21.7 Internal insulation on the sides and top of the system housing shall be covered with a minimum of 14 gauge 409 stainless steel liner. Internal insulation on the floor of the housing shall be covered with a minimum of 10 gauge 409 stainless steel liner. The liner panels shall be overlapped in the direction of the flow.

21.8 Penetrations of the casing required for piping or other pressure parts shall be sealed to retain the pressure tight integrity of the casing.

21.8.1 Access manway doors shall be 18” x 24” in size, and shall be internally insulated, hinged or davited and pressure tight, with bolted closure. Seller shall provide a grab bar for each casing manway door. Penetrations shall be installed on each side of the roof panel to accommodate the use of sky climbers for construction, inspection, and maintenance. The number and location of access doors shall be acceptable to Contractor. Three (3) extra gaskets shall be provided for each manway.

21.9 Seller shall minimize the size of full penetration buttwelds on casing vertical joints. The welds shall be sized for structural integrity as required by Seller’s design.

22. DUCTS:

22.1 Duct Sections: The Seller shall provide insulated and lined duct sections. Access manways and openings as required for replacement and/or maintenance of the SCR and CO catalysts without the need for cutting or welding of any casing components shall be provided.

22.2 Transition Duct Arrangement: The expansion joint / transition duct from the combustion turbine (CT) outlet flange to the casing proper shall be provided by the Seller and shall have a transition angle as required to promote an even distribution of exhaust gas. The transition duct angle shall not exceed a 45º angle between floor and roof of transition. The Seller shall design the inlet to mate with the CT outlet flange.

22.3 Materials: Materials shall be in accordance with the requirements of the EDR.

22.4 Ductwork: The connection to the CT outlet shall be in accordance with the requirements of the EDR. All ductwork, hardware, and gaskets required for the interconnection of the CT outlet, SCR, and the exhaust stack shall be furnished by the Seller. See Appendix C for specific requirements at the CT-SCR interface. Seller shall comply with all details, recommendations and requirements from the CT supplier for this interface. Distribution vanes or perforated plate shall be provided (if required) in the SCR inlet transition section to allow uniform flow distribution to the SCR. The distribution vanes (if required) shall be constructed of 304 stainless steel.

22.5 Ducts shall be constructed of steel plate in accordance with the requirements of the EDR. Field joints shall be flanged and designed for bolting and seal welding. Angles or plates used to form flanges shall be joined to the ducts by continuous fillet welds. Templates shall be used for drilling bolt holes in flanges. Ducts shall be designed to prevent pulsations and noise generation. Each low point shall be furnished with drains. Casing drains for each low point shall be provided and shall be capped.

22.6 The floor of the ducts shall be designed to provide a rugged surface for ladders, scaffolding, etc.

22.7 All ductwork and transition sections shall be provided with an internal insulation and lagging system as specified in below. SCR outlet transition ducts, EPA ports, stacks, and in general any area accessible to personnel shall be provided with an expanded mesh barrier or thermal insulation from their bases to a height of at least eight (8) feet above grade, as required for personnel protection from temperatures exceeding 140ºF.

22.8 Ductwork shall be designed to withstand the maximum combustion turbine exhaust pressure, as measured at the combustion turbine exhaust connection, shown as "stack outlet temperature" in the EDR and Appendix A.

22.9 Turning vanes shall be provided in ductwork as required to minimize gas side pressure loss and optimize proper gas distribution.

23. MAIN EXHAUST STACK:

23.1 The Seller shall furnish one Main Exhaust Stack constructed per all requirements listed in the EDR. The stacks shall be furnished complete with supporting steel, expansion joints, interconnecting ductwork, grounding lugs, and hardware. The stacks shall be self-supporting without guying. The concrete foundation and anchor bolts for the stack will be furnished by the Buyer.

23.2 Design and construction of exhaust stack steel shall be in accordance with Section GR-A, Section S1, the EDR, and with the following codes and standards:

a. ASME/ANSI STS-1, Steel Stacks
b. AISC 360, Specification for Structural Steel Buildings

23.3 The steel exhaust stacks and supports shall be capable of enduring specified normal and abnormal design operating conditions in combination with wind and seismic loads for the design life of the facility. Effects of wind shall include along-wind and across-wind response.

23.4 Design values for yield strength and moduli of elasticity of the stack material shall depend on the composition of the material and the maximum temperature of the metal at design operating conditions, and shall be as prescribed by the ASME Pressure Vessel Code, Section VIII, Division 2, Part AM. A stack liner shall only be supplied if necessary to meet the design life for the stack.

23.5 Design calculations and design drawings of the stack(s) shall be in accordance with Section S1 Documentation and submitted to the Buyer for review prior to release for fabrication. The drawings shall indicate the size, shape, and location of all structural members and elements; specific details of connections between the members and elements; the materials of construction including protective linings and coatings; and the forces and moments imposed by the stacks on the supports for each design load condition.

23.6 The main stack shall be provided with an expanded mesh barrier for personnel protection from temperatures exceeding 140 °F at any location that is accessible from any ladder or platform around the stack.

23.7 Any stack low point, which may collect condensation, shall be furnished with a stainless steel drainpipe and 3" drain valve.

23.8 The stack shall include one: (1) clean out door not less than 2' by 2' located at the bottom of the inner wall. Access shall be provided through the outer wall to the clean out door.

23.9 The exhaust stack shall be cleaned, prepared, and the outer stack wall material shall be primed painted by the Seller with inorganic zinc primer appropriate for temperature conditions. Equipment, materials and structures shall have protective coating furnished in accordance with the Painting and Coating Specifications. In the event of a conflict in requirements, the more stringent shall apply.

23.10 Stack height and exit velocity shall be as listed in the EDR at the Guarantee Performance Case.

23.11 The Seller shall provide a bolted fit-up flanged connection (angle to angle) for the upper stack section where it attaches to the lower stack section at the damper housing connection. This bolted connection will be externally seal welded gas tight by the Buyer in the field. See additional shipping details in the Construction Article

23.12 Stack Welds: The Seller's stack design for stack field welds shall be designed with a bevel such that open-root short circuit processes (RMD, STT) can be used instead of backing bar joint details wherever possible.

23.13 There shall be no stack field welded joints with differing shell plate thickness. All welds with differing plate thickness shall be done in the shop.

23.14 CEMS and EPA Ports: Port quantities and sizes are listed in the EDR. Ports shall be evenly spaced. All ports shall be provided with ANSI Class 150 flanges with matching blind flanges, bolting hardware and gaskets. The flange bolt hole orientation shall be coordinated with Buyer's CEMS vendor. Buyer will be allowed to change the size of the ports to a smaller size at no additional cost, if such change is requested prior to or during the Buyer's review of the stack drawings. CEMS ports shall comply with all EPA requirements including those for spacing relative to disturbances.

23.15 A port for inlet NOx measurement shall also be provided and located per manufacturer's recommendations, and be as far as possible upstream of the SCR catalyst and ammonia injection location. The port shall be a 4" diameter, ANSI Class 150 flanged connection.

23.16 A caged ladder per ANSI 14.3, OSHA standards shall be provided for access to a 360º EPA platform. The platform minimum width shall be as listed in Section 1 of the EDR. The CEM and EPA sample connections shall be accessible (chest level) from this platform. The platform shall provide sufficient clearance to walk around CEMS equipment without having to climb over or under any components including electronics. Expanded metal mesh for personnel protection shall be located at the base of the stack to a height of not less than 8' above grade. Personnel protection shall also be placed at the EPA ports to a height of not less than 8' above the platform. A davit arm with a minimum capacity of 500 lbs. shall be provided to allow the attachment of a chain hoist at the EPA platform ring. The davit arm shall be positioned to allow for ease of installation and removal of CEMS probes.

23.17 Stack Base Template: The Seller shall provide a carbon steel template of the stack base plate, match marked, orientation marked, match drilled to the base plate for use in aligning and setting anchor bolts.

23.18 Welding: A detailed procedure identifying the sequence and methods for field fit up and welding of each section shall be submitted for review to Contractor. This procedure shall address distortion control of continuously welded circular sections.

24. EXPANSION JOINTS:

24.1 Expansion joints shall be provided for the interface between the SCR casing outlet and the main stack connection, and at all other locations as required to accommodate thermal expansion. Expansion joints shall be specifically designed for use in combustion turbine service.

24.2 Expansion joints shall be sized and designed by the expansion joint manufacturer to meet the conditions specified and the arrangement of the ductwork with respect to expansion, contraction, and offsets.

24.3 The nonmetallic expansion joints shall be of gas tight construction except that expansion bellows located at floor penetrations may be provided with a 3/16” maximum weep hole to allow draining of condensation from the bellows. Nonmetallic expansion joint shall be of low noise design.

24.4 The expansion joint belts shall be designed to withstand full system operating temperatures and pressures, including excursions.

24.5 Duct Connections: The Seller shall ensure that the expansion joints furnished are designed and fabricated such that the internal opening and bolt pattern lines up with the casing outlet and stack inlet flange connections. Gaskets shall be factory cut and shipped ready for installation.

24.6 Construction: The expansion joints shall be constructed in accordance with the requirements specified herein. Expansion joints shall be shipped to the Site fully assembled, where size permits, and ready for bolting to the mating flanges. The expansion joint between the casing outlet and the stack breech may require a fused joint to be completed in the field.

25. HANGERS AND SUPPORTS: All necessary hanger assemblies, miscellaneous hanger steel, and support steel for supporting all ducts shall be furnished. Hangers shall be designed for attachment to supporting framework using suitable welding brackets. Special attention shall be given to hangers around transition sections, openings, and access doors. Hanger assemblies shall be prefabricated in the Seller's shop to the greatest extent practical allowing for field adjustment during installation. Bulk supply of hanger components for field assembly is not acceptable.

26. BEARING PLATES: All low friction (greased) bearing plates required for the accommodation of duct expansion shall be furnished as required by Seller’s design.

27. TRIM AND PIPING:

27.1 General: This Article covers the design and construction requirements for piping, valves, and other miscellaneous trim Equipment for the SCR system.

27.2 The Seller shall provide all supports required for the installation of all piping, valves, and piping accessories furnished by the Seller. Piping, valves, valve stations, and piping accessories furnished under these Specifications shall be supported from structural steel furnished as part of the SCR system. Valve stations shall be located on platforms to provide for adequate access.

27.3 Seismic bumpers, including all supports and restraints shall be provided by Seller where required.

27.4 Design pressure of piping systems shall be a minimum of 25 psig above the maximum pressure anticipated during operation plus 10% or 50 psig, whichever is greater. Where piping is directly or indirectly connected to the discharge of a pump, the maximum operating pressure shall be based on the pump shutoff head plus maximum suction pressure (including static head) at the pump suction connection, at a specific gravity of 1.0. Design temperature of piping systems shall be a minimum of 10 deg. F above maximum temperatures anticipated during operation, rounded to the next 5 deg. F. All carbon steel piping shall include a corrosion allowance of 0.020" minimum. All stainless steel piping shall include a corrosion allowance of 0.000" minimum.

27.5 Minimum pipe size shall be ½ inch, except for connections to equipment. Pipe sizes 1-1/4 inch, 3-1/2 inch, 5, 7 and 9 inch shall be not used except for connections to equipment.

27.6 Trim piping protruding from any pressure vessel or module shall have a shop installed coupling, or nipple.

27.7 All large bore pipe risers will be cut to length and properly machined for field welding. No random ends shall be furnished except as agreed by Contractor.

27.8 Pipe Supports: Seller shall completely detail design and furnish all pipe supports for all pipe provided under this Contract. The support locations and loads shall be accurately noted on the drawings. Contractor shall have the opportunity to review and revise field weld locations. Pipe supports shall be shop fabricated as much as possible without exceeding shipping limitations. Unistrut shall not be used for pipe supports. Small bore support pipe support restraints shall be Anvil Figure 244 or Contractor approved equal as applicable.

27.9 Seller shall palletize and clearly identify pipe supports by drawing number.

28. INSULATION:

28.1 General: The SCR casing and ductwork shall be insulated in the shop to the maximum feasible extent. All surfaces, which will be inaccessible during erection, shall be shop insulated and lagged.

28.2 Internal Insulation: The inlet ductwork, inlet transition section, the entire reactor casing, and the exhaust stack shall be internally insulated to minimize heat loss and to prevent the high combustion turbine exhaust temperatures from reaching the external surface. In addition, the insulation system shall be designed to limit the exterior skin temperature to an average of 140 deg F at all operating conditions with an ambient air temperature of 94 deg F, an emissivity of 0.09, no incident solar heating, and 1 ft/sec air velocity, or as required by OSHA,

whichever is more stringent. The insulation shall be attached to the internal wall and protected by an internal liner.

28.3 The internal liner shall be provided throughout the casing, inlet ductwork, and inlet transition section. The liner material and thickness shall be adequate for the design conditions. The liner shall be attached by standoff studs and washer, or other acceptable method that permits expansion of the liner relative to the ductwork. Washers shall be the same material as the Liner. The internal liner at the seams shall be overlapped in the direction of gas flow. Seller shall provide threaded liner pins at the field seams. Seller shall not be liable for any damage to the liner and pin caused by Contractor. The internal insulation shall be designed to withstand normal maintenance without incurring damage. Insulation and liner on upward facing horizontal and semi-horizontal surfaces shall be designed to carry a concentrated 250 pound personnel walking load without crushing insulation or permanently deforming the liner. The internal insulation shall be designed to withstand water-washing operations. The insulating wall panels shall be of a lap joint design. Wall panels of the "butt-fit" design are not acceptable due to their poor fit-up characteristics. Outlet transition ducts and stack shall be provided with thermal insulation barriers or expanded metal for personnel protection.

28.4 External Insulation: Seller shall provide all required thermal insulation specifications to Contractor for all external surfaces of piping or equipment that cannot be shop insulated. Insulation and lagging for Seller supplied equipment (except as indicated below) and piping shall be supplied and installed by Contractor. Seller shall identify insulation requirements on piping and equipment drawings.

28.5 Seller shall identify all equipment access openings, inspection openings, removable heads, etc., which must be removed periodically for inspection and repairs. Seller shall provide all clearances required for thermal movement of supplied piping and equipment.

28.6 Insulation for personnel protection shall be supplied on surfaces above 140°F within three (3) feet of walkways, ladders and platforms.

28.7 Seller shall provide metal personnel protection shields or other suitable personnel protection devices at each access platform and anywhere else on the system where temperatures exceed OSHA limits.

28.8 Materials: All insulation materials shall be asbestos free and non-corrosive.

28.9 Equipment Insulation:

28.9.1 Seller shall provide removable insulation blankets for SCR Dilution Air Blowers and any other auxiliary equipment as required. The removable insulation blankets shall be sewn to fit the shapes of the individual components and shall be designed to be securely laced in place. Removable jackets may utilize hog ring sewing. The insulation core shall be in compliance with ASTM C553 for temperatures up to 850°F and ASTM C1086 for temperatures from 850°F to 1200°F. Lacing hooks and lacing wire shall be 304SS material. The outer surface of the blankets shall consist of waterproof silicon rubber impregnated glass fiber fabric, shall be gray in color, and suitable for outdoor service. The blankets shall be easily removed and reinstalled without damage to the blanket. Blankets shall be installed in accordance with the blanket manufacturer's recommendations.

28.9.2 The blankets shall also be tagged with a permanent stainless steel tag (2.5” x 0.75”) with ½” lettering and the unique equipment number identifier stamped on the tag.

29. STRUCTURAL AND MISCELLANEOUS STEEL:

29.1 General: Design and construction requirements for casing, ductwork, SCR system, and platform support steel, grating, guardrails and handrail, shall be as noted herein. Scope of supply for structural and miscellaneous steel shall be as specified herein.

29.2 Normal maintenance and operation of the SCRs shall be provided by a system of walkways, platforms, ladders, and stairs, all provided by the Seller. Platforms shall be a minimum of three (3) feet wide unless otherwise noted, with a minimum overhead clearance of seven (7) feet. Handrails, platforms, and stair tower shall have bolted connections and shop fabricated to the greatest extent possible via standard truck or ocean shipment. Speed rail and field welding are not allowed.

29.3 Ladders, handrails, handrail posts, toe plates, platform grating, and stair treads will be constructed of galvanized steel. Platforms, stairs, ladders, and handrails shall be fabricated as specified above and shall attach to the stack or casing as specified above. Seller will not be back-charged for interferences that result from an accumulation of field tolerances provided that the components are manufactured to applicable code tolerances. Seller shall be ultimately responsible for interferences that result from design or manufacturing errors.

29.4 Provide structural and miscellaneous steel required to frame and support all component parts and equipment. Provide structural steel supports for flues, ductwork, transitions, casing and stack as required.

29.5 Seller shall install all grating penetrations for large bore pipe and structural steel. Grating penetrations shall meet OSHA requirements. Seller will not be back-charged for interferences that result from an accumulation of field tolerances provided that the components are manufactured to applicable code tolerances. Seller shall be ultimately responsible for interferences that result from design or manufacturing errors.

29.6 Contractor shall supply and install electrical cable tray on the side of the casing as required to support Seller-supplied equipment located at or near the top of the casing. Seller and Contractor shall mutually agree to the location of the electrical cable trays such that the cable tray supports will be connected to and supported from the casing structure. Seller shall allocate a space 2’-0” wide x 3’-0” long from the top of concrete to the top of the casing for Contractor-supplied cable tray.

29.7 Welding: Welding of structural and miscellaneous steel shall be in accordance with all applicable codes and Seller’s standard practice. Seller shall submit structural welding details if required.

30. ELECTRICAL:

30.1 General: The SCR and auxiliaries shall conform to the requirements in the General Electrical Work Sections.

30.2 Three phase power wiring will be by others and terminated by others at the motor junction box. Seller shall furnish cable tray where cable routing to the motor crosses Seller supplied equipment.

30.2.1 Other electric wiring shall be installed in rigid galvanized conduit or liquid-tight where required, and shall be suitable for environmental conditions specified. Wiring assembly shall be in accordance with NFPA 70 requirements for area classification noted.

30.3 All instrumentation or control devices provided as part of a pre-manufactured skid assembly shall be wired to common NEMA 4 junction boxes located on the skid. Each device shall terminate on a numbered terminal block. Junction boxes shall be uniquely identified and shall be located on general arrangement plans. Terminals and wiring shall be indicated in the Seller's wiring diagrams and schematics.

30.4 All electrical instruments and components supplied shall be UL listed.

31. INSTRUMENTATION:

31.1 General: The Seller shall include all primary elements, sensors, transmitters, actuators and valves required for system control, sequencing, protection and monitoring.

31.2 Instrument List: Seller shall furnish a comprehensive instrument list that contains the instrument tag number, manufacturer, model number, calibration range, installation detail reference and design conditions as a minimum submittal.

31.3 Electronic Instrument Location Plan: An electronic list identifying the instrument tap location (X, Y and Z coordinates) for all instrumentation furnished by the Seller shall be provided.

31.4 Instruments: The following instruments shall be provided, as a minimum, for connection to the Plant DCS, or local indication as indicated. It shall be the Seller's responsibility to ensure the type and quantity of instruments provided meets code requirements.

a. CT exhaust temperature indicators with wells
b. CT exhaust gas absolute pressure indicators
c. Differential pressure transmitter - CO catalyst
d. Differential pressure transmitter - NOx catalyst
e. Differential pressure transmitter – Total, SCR Inlet to CO Catalyst outlet
f. Tempering air duct temperature indicator
g. Tempering air duct damper position indicator
h. CTG trip request
i. CTG start interlock
j. SCR purge in progress
k. SCR common alarm
l. Dilution air fan status
m. Ammonia filter differential pressure indicator
n. Ammonia inlet pressure switch

o. Ammonia flow transmitter
p. Ammonia flow shut off valve position indicator
q. Ammonia flow control valve position indicator
r. Ammonia heater temperature transmitter
s. Ammonia mixer temperature transmitter
t. Ammonia-air injection temperature transmitter
u. Dilution air flow indicator
v. Dilution air pressure switch
w. Dilution air temperature indicator

31.5 NOx Inlet Probe: One (1) NOx inlet probe that can be moved to three vertical locations with umbilical lengths sufficient for the furthest location shall be provided.

31.6 Temperature Measurement: All necessary connections for installation of temperature measuring devices shall be furnished as required. All thermocouples shall be ISA Type K and RTDs shall be 100 ohm platinum with a 0.385 alpha.

31.7 Thermocouples: A system of permanently installed thermocouples shall be provided for monitoring critical metal temperatures throughout the SCR. Thermocouples shall be ungrounded and shall be Type K, stainless steel sheathed, and spring loaded. A system of wiring and rigid aluminum conduit shall be installed to connect all thermocouples to a junction box or boxes at locations acceptable to the Engineer. Junction boxes shall contain marked terminal blocks that denote the position of the thermocouple.

31.7.1 Thermocouples shall have weatherproof heads, with terminal blocks extending beyond the casing. For tube skin thermocouples, Seller shall supply sufficient wiring to allow termination of the thermocouples exterior to the casing.

31.7.2 Local Thermometers: Local indicating thermometers supplied with auxiliary Equipment shall be bimetallic type with 5 inch dials minimum. Local thermometers shall have adjustable angle dials. For high temperatures, or for remote mounting, thermometers shall be minimum 5 inch dial gas actuated thermometers.

31.7.3 Skid mounted instruments shall be furnished and installed as specified herein, including instrument valves, tubing, and enclosures as required. Instruments to be installed by Contractor shall be furnished loose. Pressure and differential pressure transmitters shall be furnished with manifolds and mounting brackets.

31.7.4 Instrument root valves tapped off the primary piping shall be provided by the Seller. Tubing, fittings, blowdown valves and heated instrument enclosures will be furnished by Contractor.

31.7.5 HART compatible transmitters shall be configured with a software tag compatible with the Contractor's asset management system.

31.7.6 Calibration: All instrumentation shall be provided with a factory calibration. Certificates of calibration shall be submitted to Contractor for each instrument.

32. CONTROL SYSTEM:

32.1 The Seller shall provide a control system that will safely operate the SCR through all plant operating conditions. This control system will seamlessly integrate: tempering/purge air, ammonia vaporization/injection system, and system sequencing.

32.2 The SCR will be controlled from the plant Distributed Control System (DCS) furnished by the Contractor. The Seller shall provide documentation indicating the recommended methods for control and the system components. The documentation shall include all alarms, set points, trips, interlocks and directions for automatic sequencing of ramp rates required to achieve the life expectancy requirements identified in other sections of the contract.

32.3 Seller shall incorporate the following external inputs into the SCR control system:

a. SCR start-stop
b. Purge required
c. CEMS not in service
d. Stack NOx corrected to 15% O2
e. CTG fuel flow

32.4 Logic Diagrams: The documentation described above shall be furnished in the form of digital logic diagrams and analog SAMA diagrams. Both digital and analog logic diagrams shall be submitted for review. The logic diagrams shall be designed to provide automated startup, operation and shutdown of the SCR system. The Seller shall initiate detailed discussions with the Contractor in order to understand the control objectives, documentation format, and overall plant operation prior to initiating work on the digital and analog logic diagrams.

32.4.1 The digital and analog logic diagrams submitted shall be of a sufficient level of detail to provide programming instructions to the Plant DCS vendor for programming. All costs associated with supporting DCS factory acceptance testing at the DCS vendor's facility of the Seller furnished logic shall be included in the contract price.

32.5 Control Narrative: In addition to the digital and analog logic diagrams described above, the Seller shall furnish a written description of the digital and analog logic diagrams. The written description shall be of a sufficient level of detail to allow the reader to understand the control philosophy of each controlled component.

END OF SECTION

SELECTIVE CATALYTIC REDUCTION

Engineering Design Requirements (EDR)

Description	Units	Quantity/Entry
1. General		
Quantity of SCR Systems = No. of CTs)	--	4
Fuel Sulfur	gr/100 dscf	
Fuel Sulfur of ULSD	ppmw	
Site Elevation	ft ASL	981
Seismic Data per ASCE 7-16		
Site Class	--	D
Mapped Spectral Response Accelleration Parameters	S_s=	0.045g
	S_1=	0.032g
Site Coefficients	F_a=	1.6
	F_y=	2.4
Occupancy Category	--	III
Seismic Importance Factor for Occupancy Category III	I=	1.25
Seismic Design Category	--	A
2. COMBUSTION TURBINE		GE LM6000
3. CT EXHAUST CONDITIONS AT MAX LOAD, NATURAL GAS FUEL		
Mass Flow	lb/hr	4,600,000
Gas Temperature	°F	1146
NOx	ppmvd @ 15% O2	9.0
CO	ppmvd @ 15% O2	4.0
VOC (as CH_4)	ppmvd @ 15% O2	1.0
SO_2	lb/hr	1.3
PM10/PM2.5 (front and back halves, USEPA Method 5/202 or 201A/202)	lb/hr	8.8
H_2SO_4	lb/MMBtu	TBD
CO_2	lb/hr	TBD
HCHO	ppbvd @ 15% O2	TBD
4. CT EXHAUST CONDITIONS AT MIN OPERATING LOAD, NATURAL GAS FUEL		
Mass Flow	lb/hr	2,800,000
Gas Temperature	°F	1160
NOx	ppmvd @ 15% O2	9.0
CO	ppmvd @ 15% O2	10.0
VOC (as CH_4)	ppmvd @ 15% O2	3.0
SO_2	lb/hr	0.8
PM10/PM2.5 (front and back halves, USEPA Method 5/202 or 201A/202)	lb/hr	8.0
5. CT EXHAUST CONDITIONS AT MAX LOAD, LIQUID FUEL - ULSD		
Mass Flow	lb/hr	NA
Gas Temperature	°F	NA
NOx	ppmvd @ 15% O2	NA
CO	ppmvd @ 15% O2	NA
VOC (as CH_4)	ppmvd @ 15% O2	NA
SO_2	lb/hr	NA
PM10/PM2.5 (front and back halves, USEPA Method 5/202 or 201A/202)	lb/hr	NA

Description	Units	Quantity/Entry
H_2SO_4	lb/MMBtu	TBD
CO_2	lb/hr	TBD
HCHO	ppbvd @ 15% O2	TBD
6. CT EXHAUST CONDITIONS AT MIN OPERATING LOAD, LIQUID FUEL - ULSD		
Mass Flow	lb/hr	NA
Gas Temperature	°F	NA
NOx	ppmvd @ 15% O2	NA
CO	ppmvd @ 15% O2	NA
VOC	ppmvd @ 15% O2	NA
SO_2	lb/hr	NA
PM10/PM2.5 (front and back halves, USEPA Method 5/202 or 201A/202)	lb/hr	NA
7. OPERATING CONDITIONS:		
CT Exhaust Gas Temperature Ramp Rate	°F/min	
CT Exhaust Gas Temperature Variation at Catalyst Inlet	°F	
Exhaust Gas Flow Variation at Catalyst Inlet	% RMS	
Ammonia to NOx Ratio Variation at Catalyst Inlet for catalyst design	% RMS	15%
Ammonia to NOx Ratio Variation at Catalyst Inlet for SCR design	% RMS	by Seller
Alkali Metals in Fuel	ppmw	
Alkali Metals in DeNOx/turbine Water	ppmw	
Alkali Metals in Ammonia Reagent	ppmw	
8. EXPECTED OPERATING PROFILE		
Annual Operation	hrs/yr	877
Annual Starts	starts/yr	100
CT operating on Natural Gas	% of generation	100%
CT operating on Liquid Fuel	% of generation	0%
Typical dispatch mode	Daily / Long Term	Daily
9. GUARANTEED MAXIMUM EMISSIONS - NATURAL GAS (1-hour running average for CEMS measured pollutants)		
Minimum CT load where emissions gurantees are applicable	%	60%
NOx (USEPA Method 7E)	ppmvd @ 15% O2	2.0
CO (USEPA Method 10)	ppmvd @ 15% O2	3.0
VOC (as CH4) (USEPA Method 25A and 18)	ppmvd @ 15% O2	2.0
Ammonia (NH_3) Slip - Steady state operation (USEPA Method CTM-027 or 320)	ppmvd @ 15% O2	5.0
Ammonia (NH_3) Slip - Non Steady state operation (USEPA Method CTM-027 or 320))	ppmvd @ 15% O2	TBD
PM (front half filterable only, USEPA Method 5)	lb/hr	TBD or delete
PM10/PM2.5 (front and back halves, USEPA Method 5/202 or 201A/202)	lb/hr	10.0
H_2SO_4 (USEPA Method 8 or CTM-013)	lb/MMBtu	TBD
CO_2 (USEPA Method 3A or 40CFR98)	lb/hr	TBD
HCHO (USEPA Method 320)	ppbvd @ 15% O2	TBD
NOx Reduction Efficiency (based on inlet loading below)	%	78%

Description	Units	Quantity/Entry
Time to reach compliance (after CT reaches min load below)	minutes	15
10. GUARANTEED MAXIMUM EMISSIONS - ULSD (1-hour running average for CEMS measured pollutants)		
Minimum CT load where emissions gurantees are applicable	%	50%
NOx (USEPA Method 7E)	ppmvd @ 15% O2	TBD
CO (USEPA Method 10)	ppmvd @ 15% O2	TBD
VOC (as CH4) (USEPA Method 25A and 18)	ppmvd @ 15% O2	TBD
Ammonia (NH_3) Slip - Steady state operation (USEPA Method CTM-027 or 320)	ppmvd @ 15% O2	TBD
Ammonia (NH_3) Slip - Non Steady state operation (USEPA Method CTM-027 or 320))	ppmvd @ 15% O2	TBD
PM (front half filterable only, USEPA Method 5)	lb/hr	TBD
PM10/PM2.5 (front and back halves, USEPA Method 5/202 or 201A/202)	lb/hr	TBD
H_2SO_4 (USEPA Method 8 or CTM-013)	lb/MMBtu	TBD
CO_2 (USEPA Method 3A or 40CFR98)	lb/hr	TBD
HCHO (USEPA Method 320)	ppbvd @ 15% O2	TBD
Time to reach compliance (after CT reaches min load below)	minutes	TBD
11. GUARANTEED CATALYST LIFE		
Catalyst life performance guarantee period	hours	24,000
12. GUARANTEED STATIC PRESSURE DROP (SCR inlet to stack pressure drop port)		
Pressure drop without future catalsyst	in. w.c.	9
Pressure drop with future catalsyst	in. w.c.	
13. GUARANTEED NOISE REQUIREMENTS:		
Near Field Limit (3 ft distance and 5 ft above grade)	dBA	85
Far Field Limit (at 400 ft and 5 ft above grade) per casing	dBA	55
Far Field Limit (at 400 ft and 5 ft above grade) per stack	dBA	52
14. AIR DUCT DESIGN:		
Duct Material	--	A36 C.S
Duct Minimum Thickness	in	0.25
Finish paint/coating	--	Seller's Standard
15. GAS DUCT DESIGN:		
Casing Material	--	A36 C.S
Casing Minimum Thickness	in	0.25
Casing maximum external temperature	°F	140
Liner Material	--	409 SS
Liner Minimum Thickness - floor	ga	11
Liner Minimum Thickness - other	ga	14
Casing insulation thickness	in	6
Casing insulation type	--	8 lb/ft3 ceramic fiber
Maximum Exhaust Gas Temperature	°F	1200
Finish paint/coating	--	Seller's Standard
Expansion Joint between CTG Exhaust Duct and SCR inlet duct	--	By Purchaser
Expansion Joint between SCR and Stack	--	Included
Duct Material (by gas temperature)	≥ 750°F	409 SS
Duct Material (by gas temperature)	< 750°F	A36 CS (1/4" min)
16. SCR DESIGN:		
Catalyst design basis: NH3/NOx Distribution	% RMS	15%

Description	Units	Quantity/Entry
Catalyst design basis: Bypass/leakage of gases around catalyst	%	1%
Orientation of SCR Reactor	Horizontal/Vertical	Horizontal
Construction type (Modular, C-Section, Harps)	--	Sellers Option
Location	Indoors/Outdoors	Outdoors
Casing Material	--	A36 C.S
Casing Minimum Thickness	in	0.25
Casing maximum external temperature	°F	140
Liner Material	--	409 SS
Liner Minimum Thickness - floor	ga	11
Liner Minimum Thickness - other	ga	14
Casing insulation thickness	in	4
Casing insulation type	--	8 lb/ft3 ceramic fiber
Maximum Exhaust Gas Temperature	°F	1200
Finish paint/coating	--	Seller's Standard
Number of catalyst future layers	--	
17. AMMONIA VAPORIZATION AND INJECTION SYSTEMS		
Ammonia type	Aqueous / Anhyd.	Aqueous
If Aqueous, concentration	%	19%
Type of vaporization	--	Hot Flue Gas
Quantity of hot gas or dilution air fans	--	2 x 100%
Quantity of inlet valves for gas or air fans	--	2
18. TEMPERING AIR SYSTEM		
Quantity of tempering air fans	# x %	3 x 50%
Location of termpering air fans	--	Outdoors
Motor Voltage/Phase/Hertz	--	
17. STACK DESIGN		
Stack damper to store residual heat	Yes/No	No
Height	ft	200
Diameter	ft	By Seller
Maximum Exhaust Gas Temperature	°F	1200
Minimum Stack Gas Temperature	°F	180
Stack Shell Material	--	A36 C.S
Stack Shell Minimum Thickness	in	0.25
Stack Shell Corrosion Allowance	in	0.125
Stack Shell maximum external temperature	°F	130
Liner Material	--	409 SS
Liner Minimum Thickness - floor	ga	11
Liner Minimum Thickness - other	ga	14
Stack Shell insulation thickness	in	4
Stack Shell insulation type	--	8 lb/ft3 ceramic fiber
Minimum Exit Velocity	ft/sec	60
Stack Damper	--	N/A
CEMS Platform	--	included
CEMS Platform minimum width	ft	3.5
CEMS Ports	--	
Number	--	2
Diameter	in	4
EPA Ports	--	
Number	--	4

Description	Units	Quantity/Entry
Diameter	in	6
Spare Monitoring Ports	--	
Number	--	2
Diameter	in	6
Port Location	--	
Minimum Distance from Downstream Disturbance	stack diameters	2.0
Minimum Distance from Upstream Disturbance	stack diameters	0.5
FAA Lighting	--	N/A
8. Field Services (option price)		
Erection Support	man-days	60
Commissioning / Startup	man-days	10
Operator Training	man-days	2

SELLER'S DELIVERABLE SCHEDULE (SDS)

Selective Catalytic Reduction (SCR)		For specific dates associated with the durations specified herein, see the Contract.			
		Kiewit Spec:	94.03.30.175.02		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
BM-01	Compiled Bill of Materials (in Excel format) including all subvendor equipment, appurtenances, etc.	8 weeks prior to Delivery			
CA-01	Exhaust Stack Design Calculations	8			
CN-01	System Control Philosophy Narratives (including Startup and Normal Operating Conditions) with detailed description of all permissives, alarms and trip set points for all devices. Deliverables shall not have network architecture drawings attached	14	*		
DA-01	Data Sheets - Catalyst	4			
DA-02	Motor Nameplate Data	8			
DA-03	Nameplate drawings including a nameplate voltage connection diagram for all electrical equipment	6			
DA-04	Motor thermal damage curve including each of the curves listed below and plotted on one graph: 1. Thermal limit curve at cold (ambient temperature) condition for locked rotor 2. Thermal limit curve at hot (operating temperature) condition for locked rotor 3. Thermal limit curve at cold (ambient temperature) condition for running overload 4. Thermal limit curve at hot (operating temperature) condition for running overload 5. Time-current motor acceleration curve at 110% of rated voltage 6. Time-current motor acceleration curve at rated voltage 7. Time-current motor acceleration curve at 90% of rated voltage 8. Time-current motor acceleration curve at 80% of rated voltage	6	*		
DA-05	Motor speed versus torque and current curves indicated at rated voltage, 90% of rated voltage, and 80% of rated voltage	6	*		
DA-06	Consecutive number of starts with the motor at ambient temperature and at operating temperature. Cool down time between starts with the motor at ambient temperature and at operating temperature.	6	*		
DA-07	Superimposed speed-torque curves for each motor driven equipment match. Speed-torque curves shall include the motor speed-torque curves at 80% of rated voltage and at 110% of rated voltage, superimposed on the driven equipment speed-torque curve during acceleration.	6	*		
DA-08	Motor Data - Parameters for relay settings including voltage imbalance limits and current imbalance limits	6	*		
DA-09	Motor Data - Winding and bearing temperature alarm and trip setpoints	6	*		
DA-10	Preliminary Motor Data Sheets per Section GR-B, including data sheets for any motor space heaters.	8	*		
DA-11	Final Motor Data Sheets per Section GR-B, including data sheets for any motor space heaters.	16	*		

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Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
DA-12	Preliminary Stack Foundation Load Table/Requirements (Dead/Live Weight, COG, Wind, Thermal, Seismic), Anchor Bolts, and Baseplate Details. Must be sealed/stamped by a P.E. registered in the jurisdiction of the project.	8	*		***
DA-13	Final Stack Foundation Load Table/Requirements (Dead/Live Weight, COG, Wind, Thermal, Seismic), Anchor Bolts, and Baseplate Details with Seismic Calculations for foundation design. Must be sealed/stamped by a P.E. registered in the jurisdiction of the project.	12	*		***
DA-14	Detailed termination connection details for all Buyer wiring terminations (e.g. terminal blocks, breakers, bolted connections, grounding lugs, bus bar, etc.) including, but not limited to: a. Minimum wire size b. Maximum wire size c. Maximum number of wires d. Termination type (e.g. screw clamp, ring lug, spring-cage, push-in, NEMA hole pattern, etc.)	10			
ES-01	Electrical schematic drawings including, but not limited to following: a. All electrical, protection, and control related logic with input/output assignments b. Relay and metering drawings c. Plant interface drawings for alarm and indication d. Terminal information with tag assignments including all auxiliary contact details	10	*		
ES-02	All electrical wiring diagrams needed by Buyer to complete electrical and controls design. Wiring diagrams shall include, but not limited to following: a. Interconnecting diagrams for internal and external wiring with termination details for all electrical devices (electrical panels, control panels, lighting, receptacles, control switches, disconnect switches, junction boxes, instruments, valves, actuators, motors, etc.) b. All wiring by Seller, Buyer, or other party shall have clear identification to distinguish installation responsibility	10	*		
ES-03	Electrical drawings to complete power and control interface wiring for instrument, valves, actuators, etc. including, but not limited to following: a. Elementary diagrams showing control logic with input/output assignment b. Terminal designations and termination layout drawings c. Electrical schematics for motor operated valves	10	*		
ES-04	Electrical drawings to complete motor power and control wiring including, but not limited to following: a. Wiring scheme with clearly defined requirement of shield wires for bearing, thermocouple, winding RTDs, etc. b. Wiring diagram with terminal designation c. Motor space heater connections diagram including voltage and power ratings	10	*		
ES-05	Electrical grounding requirements	4	*		

SELLER'S DELIVERABLE SCHEDULE (SDS)

Selective Catalytic Reduction (SCR)		For specific dates associated with the durations specified herein, see the Contract.			
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Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
GA-01	Preliminary Outline/General Arrangement Drawings containing the following information at a minimum: -Not to exceed overall dimensions and not to exceed overall weights -Equipment and panel tag numbers -North arrow -All terminal point locations for piping -Access, maintenance, and equipment pull spaces, with dimensions and orientation -Location and overall size dimensions for all electrical equipment (e.g. Devices: motors, instruments, disconnects; Panels: electrical, relay, control, PLC; Wiring Terminal Boxes: motor power, RTD, vibration, heater, MOV; Instrument Junction Boxes; Control Cabinets; etc.) -Ground pad and ground lug locations -Designated clear space under all electrical devices (e.g. panels, terminal boxes, etc.) for conduit access -Electrical working spaces with dimensions and orientation as required by electrical code -Hazardous area classification rating, if applicable -Center of gravity -Not to exceed static and dynamic loads per Section S1 to complete detailed structural and equipment interface designs (+15%/-0%), indicate on drawing margins used -All details related to the attachment of the equipment to the foundation or supporting structure, such as anchor bolt locations and details, skid/frame flange and/or baseplate thickness, grouting requirements, etc. -Platforms/stairs/ladders (if applicable to scope of supply)	4	*		
GA-02	Final Outline/General Arrangement Drawings containing the following information at a minimum: -Overall dimensions and overall weights -Equipment and panel tag numbers -North arrow -All terminal point locations for piping -Access, maintenance, and equipment pull spaces, with dimensions and orientation -Location and overall size dimensions for all electrical equipment (e.g. Devices: motors, instruments, disconnects; Panels: electrical, relay, control, PLC; Wiring Terminal Boxes: motor power, RTD, vibration, heater, MOV; Instrument Junction Boxes; Control Cabinets; etc.) -Ground pad and ground lug locations -Designated clear space under all electrical devices (e.g. panels, terminal boxes, etc.) for conduit access -Electrical working spaces with dimensions and orientation as required by electrical code -Hazardous area classification rating, if applicable -Center of gravity -Static and dynamic loads per Section S1 to complete detailed structural and equipment interface designs -All details related to the attachment of the equipment to the foundation or supporting structure, such as anchor bolt locations and details, skid/frame flange and/or baseplate thickness, grouting requirements, etc. -Platforms/stairs/ladders (if applicable to scope of supply)	10	*		
GA-03	Erection/Installation Drawings for all equipment, including shipped-loose components such as piping isometrics, etc. Must be sealed/stamped by a P.E. registered in the jurisdiction of the project.	16			***
GA-04	Preliminary 3D Model(s) per Section GR-B	6			

Selective Catalytic Reduction (SCR)		For specific dates associated with the durations specified herein, see the Contract.			
		Kiewit Spec:	94.03.30.175.02		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
GA-05	Updated 3D Model(s) per Section GR-B	Monthly			
GA-06	Detailed arrangement drawings for all electrical equipment (e.g. Devices: motors, analyzers, disconnects; Panels: electrical, relay, control, PLC; Wiring Terminal Boxes: motor power, RTD, vibration, heater, MOV; Instrument Junction Boxes; Control Cabinets; etc.). Drawings shall include but not be limited to the following: a. Layout with front, rear, side, and top view. Shall include dimensions for overall size, cutout locations, cutout sizes, conduit entry locations, and conduit entry sizes. b. Indication of corresponding BOM item c. Internal panel layout including terminal and device arrangement. d. Tags for all terminal blocks, terminal numbers, device tags, etc. e. Electrical device and enclosure hazardous area classification rating, if applicable f. NEMA classification	10	*		
GA-07	Detailed connection drawing for all bolted connections (e.g. bus bar, iso-phase, non-seg, ground pads, lugs, bushing, lightning arrestors, etc.). Drawing shall contain the following information at a minimum: a. Dimensions including location and size of all bolted connections b. Flange details including dimensions for overall size, bolt locations, bolt sizes, etc. c. Clearance requirements with dimensions	10	*		
GA-08	Detail/Sectional Drawings with Parts List - Motor General Arrangement and Outline Dimension Drawings showing the following at a minimum: -Motor dimensions -Shaft dimensions -Mounting dimension clearances -Rotor and coupling end float limits -Approximate motor weight -Total motor weight	4			
GA-09	Detail/Section Drawings with Parts List - Stack assembly with elevation view	16	*		
HV-01	Cumulative Equipment Package and Individual Equipment heat rejection/loss to ambient air at maximum operating load (for HVAC sizing purposes)	4	*		
IN-01	Instrument data sheets for every instrument/device furnished by the Seller, including the following information at a minimum: -Tag numbers -Service description -Calibration range -Instrument range -Length of probes -Manufacturer's make and model number -Serial number Each unique instrument type shall have its own dedicated, project-specific data sheet submitted; generic catalogue cut sheets are not acceptable for the intent of this submittal. Buyer will provide blank data sheets upon Seller request.	16	*		
IN-02	Full versions of cut sheets for each instrument furnished by the Seller that include the model number breakdown	16			
IN-03	Factory Calibration Certificates for Instrumentation	4 weeks prior to Delivery	*		

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		Kiewit Spec:	94.03.30.175.02		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
IN-04	Instrumentation Location Plan - both Plan and Elevation views	16			
LT-01	Spare Parts List (in Excel format) including unit pricing per Section GR-B	24			
LT-02	Drawing List Categorized by Engineering Discipline and Cross Referenced to the Line Numbers Stated Herein per Section GR-B, including document number and title for each document	4			
LT-03	Updated Drawing List Categorized by Engineering Discipline and Cross Referenced to the Line Numbers Stated Herein per Section GR-B, including document number and title for each document	Monthly			
LT-04	List of Compressed Air Users - to include equipment tag number, usage rate (SCFM), and location (coordinates/elevation)	8	*		
LT-05	I/O List (in Excel format) per Section GR-B, including: -Range and engineering units for all signals to DCS -Alarm and Shutdown Levels -DCS Side Terminations	12			
LT-06	Mechanical Connection List including at a minimum the following for all terminal/interface points/connections: -All sizes, materials, and interface types/ratings, including pressure classes, connection types, and schedules -Process information such as maximum/minimum/normal design flows, temperatures, and pressures -Coordinates/orientations -Interconnection tag numbers -Pressure drops and heat loads for cooling water	4	*		
LT-07	Preliminary electrical load list shall include all electrical equipment ratings including, but not limited to the following: a. Nominal operating voltage (AC/DC) b. Phase(s) (3-Phase/1-phase as applicable) c. Efficiency and power factor d. Power requirements (kW/kVA/FLA as applicable)	4	*		
LT-08	Final electrical load list shall include all electrical equipment ratings including, but not limited to the following: a. Nominal operating voltage (AC/DC) b. Phase(s) (3-Phase/1-phase as applicable) c. Efficiency and power factor d. Power requirements (kW/kVA/FLA as applicable)	8	*		
LT-09	Equipment List (in Excel format) per Section GR-B	4			
LT-10	Line List (in Excel format) per Section GR-B	12			
LT-11	Valve List (in Excel format) per Section GR-B	12			
LT-12	Specialties List (in Excel format) per Section GR-B	12			
LT-13	Instrument List (in Excel format) per Section GR-B	16			

SELLER'S DELIVERABLE SCHEDULE (SDS)

Selective Catalytic Reduction (SCR)		For specific dates associated with the durations specified herein, see the Contract.			
		Kiewit Spec:	94.03.30.175.02		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
MP-01	Piping - Plan View (Including Customer Connections)	18			
MP-02	Piping - Right Side Elevation (Including Customer Connections)	18			
MP-03	Piping - Left Side Elevation (Including Customer Connections)	18			
MP-04	Interconnecting Piping Detailed Isometrics	12			
PA-01	Paint/Coating/Lining application procedures with manufacturer's data sheets and inspection forms	8			
PA-02	Finish Coat Color Schedule	8			
PA-03	Coating Test Report Results	1 week after Test			
PD-01	Piping and Instrumentation Diagrams (P&ID) showing all equipment, piping, instrumentation and controls, connection/interface points, and associated tagging for a complete, code compliant, and ready to operate system.	6	*		
QC-01	Quality Manual and ISO 9001 Certificate, including all Sub-suppliers	4			
QC-02	Quality Record Matrix per Special Conditions	6			
QC-03	Project Specific Inspection and Test Plan including all Sub-suppliers	4			
QC-04	Supplier Notification Form (SNF) for each Witness and Hold Point identified on the Project Specific Inspection and Test Plan.	21 days prior to Test			
QC-05	Non-Conformance Reports with Proposed Disposition	Within 24 hours of Discovering Non-Conformance			
QC-06	AISC Certificate	4			
QC-07	Material Test Reports (MTR) traceable to material heat or cast segregated by individual tag numbers, or traceable to material heat by individual components. All MTR shall specify Country of Origin.	8			
QC-08	Motor test reports including complete nameplate information and patterned after IEEE Std. 112	6			
QC-09	Structural Steel Material Test Reports (MTR) - consistent with approved fabricator identification procedures and in accordance with AISC 303, Section 6.1. At a minimum each MTR shall specify Country of Origin.	2 Weeks After Delivery to Site			
RE-01	Manufacturer's Standard O&M Manual(s) per Section GR-B	8			

Selective Catalytic Reduction (SCR)		For specific dates associated with the durations specified herein, see the Contract.			
		Kiewit Spec:	94.03.30.175.02		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
RE-02	Recommended Maintenance Schedule, which shall include (but not be limited to) the following: -Predictive or preventative maintenance program -Servicing procedures for dismantling and/or replacing components -Routine electrical and mechanical procedures -Any tests/checks for cleaning, lubricating, and otherwise caring for the Equipment -Instrument calibration -Maintenance of interlocks and other applicable safety features	12			
RE-03	Digital photographs of all Buyer termination points clearly showing both the Buyer's side and Seller's side wiring, terminal block labels, terminal labels, and wiring labels. Photographs shall be submitted before equipment is shipped.	6 weeks prior to Delivery	*		
RE-04	Freeze protection requirements (min allowable ambient temperature, max exposure temperatures, min maintained process temperature, etc.) for any Seller provided equipment. Note acceptable type of freeze protection system.	4			
RE-05	Heat Tracing quantities: List of Components on equipment skid, lines including piping size and approximate lengths, class and size for all flanges and valves, factory routed tubing lengths, and inline items: specialties, instrumentation, etc. Note acceptable type of freeze protection system. Any information not available during initial submittals shall be submitted on as-built drawings before shipment including pictures of completed skids.	4			
RE-06	Pre-Operational Cleaning Guidelines	2 weeks prior to Delivery			
RE-07	All requirements for Unloading, Receiving, Handling, and Long and Short Term Storage per Section GR-B	24			
RE-08	Preliminary Field Erection Procedure Manual	6 months prior to Delivery			
RE-09	Final Field Erection Procedure Manual with detailed Erection Drawings	4 months prior to Module Delivery			
RE-10	Cut Sheets - Control Valves (Steam, Feedwater, Motor Operated Valves, Level Control Valves, etc.)	10			
RE-11	Cut Sheets - all manual and control valves	8			
RE-12	Insulation Details/Specifications for all Seller-provided equipment and piping	12			
RE-13	Complete Logistics and Transportation Plan detailing all of the steps EXW factory, including a detailed Method Statement when any of the following modes of transportation are applicable: (i) Air; (ii) Barge; (iii) Ocean; (iv) Rail; and (v) Over the Road (Heavy Haul).	8	*		
RE-14	Final O&M Manual (including but not limited to Final As-Builts, Test Reports, MTRs, Records produced by ITP, etc.) for the entire scope of the Seller's design.	4 weeks after Delivery	*		
RE-15	Dynamic Thermal Analysis	20	*		
RE-16	Gas Side CFD Flow Model Study Results	20	*		

SELLER'S DELIVERABLE SCHEDULE (SDS)

Selective Catalytic Reduction (SCR)		For specific dates associated with the durations specified herein, see the Contract.			
		Kiewit Spec:	94.03.30.175.02		
Line No.	**Engineering Submittal Description/Title**	**Date Due Weeks After Award**	**LD**	**Cyber Security**	**P.E. Stamp**
SH-01	Engineering/Procurement/Production/Fabrication/Shipping Schedule per Section GR-B.	2			
SH-02	Updated Engineering/Procurement/Production/Fabrication/Shipping Schedule per Section GR-B.	Monthly			
ST-01	Dimensions, weights, configurations, and details of steel construction/fabrication for overall structure and all steel members and connections including but not limited to: -Structural framing members -Base plates -Anchor bolts -Stairs -Ladders -Guard rails -Metal grating -Metal deck -Fall restraint systems	6			
ST-02	Joint Details, Material of Construction for Structural Welds, and Installation Requirements for Structural Bolted Connections	60 days prior to Delivery of Structural Steel			
ST-03	Module Lifting Sled Drawing/Detail	6 weeks prior to Initial Delivery			

*Liquidated Damages apply
**Cyber Security applies
***P.E. Stamp required from a P.E. licensed in the jurisdiction of the project

APPENDIX A

GAS TURBINE PERFORMANCE

APPENDIX B

SCR SYSTEM PERFORMANCE GUARANTEES

SCR SYSTEM PERFORMANCE GUARANTEES

1. EMISSIONS: The Seller shall guarantee emissions of the SCR/CO system in accordance with the SCR Engineering Design Requirements (EDR). Stack testing or the certified CEMS monitoring equipment will be used to verify emissions. The Seller shall correct, at the Seller's expense, Equipment that does not meet the specified guarantees due to reasons caused by the Seller.

The Seller is responsible for providing SCR and CO catalysts such that stack emissions will remain in compliance with the emissions guarantees as stated in the SCR EDR. The stack emissions shall remain in compliance at all combustion turbine loads shown in Appendix A at any site ambient condition from minimum to maximum.

Guarantees shall be based upon the combustion turbine exhaust data given in Appendix A.

VOC emissions are defined as total hydrocarbons excluding methane and ethane and are expressed in terms of methane.

Seller shall not be responsible for start-up emissions when post combustion air pollution control equipment is not able to be in operation. Seller shall be responsible for start-up emissions when the SCR catalyst temperature is greater than the minimum catalyst temperature required for ammonia injection.

2. PRESSURE DROP: Total pressure drop is defined as the static gas-side pressure loss from the SCR ductwork inlet to the exhaust stack inlet, including the inlet duct, distribution grid, CO catalyst Bay, SCR catalyst, and exhaust stack. The SCR stack temperature will be measured utilizing a stack traverse at or near the stack outlet. Ports for the stack traverse shall be supplied by Seller.

The total pressure drop corrected to the guarantee point volumetric flow shall not exceed the value specified in the SCR EDR.

END OF SECTION

APPENDIX C

CTG INTERFACE DETAILS

APPENDIX D

CTG FUEL SPECIFICATION

MASTER SPECIFICTION
FOR

600 Volt Non-Segregated Phase Bus Duct

Revision 1.0

REVISION HISTORY

Date	Revision	Change Description
12-10-2014	1.0	New

****
In addition to revising this spec to correspond to project-specific requirements, update all highlighted areas with project-specific data.
****

GENERAL

DESCRIPTION

****
Insert project-specific description items (i.e. new construction project, replacement project, project location, etc.). Revise the following *example* as required:
****

The 600 V non-segregated phase bus duct shall be designed and constructed for use on a 480 V, 3-phase, 60 hertz, high-resistance grounded, delta system.

Bus duct provided under these Specifications shall include all fittings, bus-to-equipment terminations, supports, flexible connectors, accessories, connection hardware and any special tools required for a complete installation.

SUMMARY

Reference Drawings

The following drawings, included in Appendix 4, contain additional scope requirements as part of this specification:

- General Arrangements
- One-Line Diagrams
- Bus Duct Layouts
- Transformer Connection Details
- Switchgear Connection Details

Technical Proposal Documentation

See Appendix 2 for technical proposal requirements.

APPLICABLE CODES AND STANDARDS

- State and local codes, laws, ordinances, rules and regulations
- ANSI – American National Standards Institute
- ASTM – American Society for Testing and Materials
- ICEA – Insulated Cable Engineers Association
- IEEE – Institute of Electrical and Electronic Engineers
- NEMA – National Electrical Manufacturer's Association

- NFPA – National Fire Protective Association
- OSHA – Occupational, Health and Safety Administration
- UL – Underwriter's Laboratories

In the event of conflict or disagreement between codes and standards, the more stringent conditions shall govern.

TECHNICAL REQUIREMENTS

DESIGN & CONSTRUCTION FEATURES

1. **Environmental**

   Non-segregated bus duct shall be manufactured to withstand site environmental conditions. See Appendix 4 for site specific environmental conditions.

2. **Ratings**

Non-segregated bus duct ratings shall be as specified in Appendix 2 Data Sheets.

BUS CONSTRUCTION

1. Bus duct construction shall be in accordance with IEEE C37.23.

2. Bus duct shall be furnished as a complete assembly of rigidly supported conductors, housed in a 3-phase enclosure without barriers between the phase conductors.

3. The bus conductors shall be copper and shall be designed to carry rated continuous current without exceeding the temperature rise requirements specified by IEEE and NEMA standards.

4. The current carrying capacity shall be based on actual service conditions including skin and proximity effects, the effects of the bus insulation, the bus duct enclosure, and ambient temperature.

5. The bus shall be installed with rigid, non-tracking, fire-resistant, and non-hygroscopic insulating supports capable of withstanding the mechanical forces imposed by short-circuit currents equal to the momentary current.

6. All bus duct shall have fully insulated conductors and conductor joints. All phase conductors shall be insulated via fluidized bed epoxy coating except at bolted terminations and connection points. Insulating materials shall be water resistant, flame retardant and rated for continuous operation at 105°C. The insulation level of the combined system shall meet or exceed IEEE C37.23 requirements.

7. All bolted joints, expansion joints, and bus connections shall have insulated, removable boots with nylon fasteners. Removable boots shall overlap bus bar insulation on each conductor insulated by the boot. The length of overlap on each conductor shall not be less than 2 inches at expansion joints and not less

than 1 inch at other connections.

8. All bus conductor connections shall be bolted with silver-plated connection surfaces having minimum contact resistance.

9. Expansion joints shall be furnished, where required, to prevent mechanical stress in bus supports and connections throughout the ambient temperature range listed in Appendix 4.

EQUIPMENT TERMINATIONS

1. Braided flexible connectors and bus duct termination enclosures/fittings shall be provided for bus-to-equipment terminations.
2. Removable, flexible, braided connectors shall be supplied to provide electrical insulation between bus duct and equipment, to isolate equipment vibration and to facilitate equipment removal.
3. Flexible connectors shall have a continuous current rating equal or greater than bus conductors.

BUS ENCLOSURE

1. Indoor sections of bus duct shall be furnished with non-ventilated dust-tight enclosures. Outdoor sections of bus duct shall be furnished with non-ventilated weatherproof enclosures with gasketed, peaked top covers.
2. Bus enclosures shall be fabricated from aluminum not less than 1/8-inch thick.
3. Wall flanges and airtight vapor barriers shall be furnished at each transition from indoor to outdoor bus duct.
4. Fire barriers shall be provided in accordance with NFPA. As a minimum, 2-hour rated fire barriers shall be provided where bus duct penetrates firewalls and building walls.
5. Enclosure finish shall be light gray per ASTM D1535.

SPACE HEATERS

1. Outdoor bus duct sections shall be furnished with space heaters to prevent condensation of moisture within the bus duct.
2. Space heater capacity shall be as required to maintain the compartment and the bus duct internal temperature above the dew point shown in Appendix 4.
3. Heaters shall be located and thermally insulated to prevent painted surface or bus insulation damage, degradation or discoloration.
4. Heaters shall be rated at 240 VAC and be rated for operation at 120 VAC.
5. Space heaters shall be controlled by an adjustable thermostat, factory set to account for site conditions listed in Appendix 4.

GROUND BUS

1. An integral ground bus shall be furnished in accordance with IEEE C37.23.
2. Provisions to ground the ground bus to the station grounding system shall be provided at every terminal end of bus duct runs, at each indoor-to-outdoor transition and at every equipment termination.

INFRARED INSPECTION VIEWING PANES

1. Infrared (IR) inspection viewing panes (ports) shall be installed to permit thermography inspection of equipment connections. IR ports shall be oriented to allow inspection from ground level.
2. IR ports shall provide a NEMA rating equal to, or greater than, that of the enclosure in which it is installed.
3. IR ports shall be NFPA 70E compliant.
4. IR ports shall be 3” minimum diameter and shall consist of reinforced polymeric optic material with removable protective covers.

OUTDOOR BUS DUCT SUPPORTS

1. Supports shall be ASTM A36 carbon steel and shall be designed to withstand environmental loads (wind, snow, seismic, etc.) listed in Appendix 4.
2. Support spans shall be 12 feet or less.
3. Finish
    a. Supports shall be galvanized by the hot dip process in accordance with ASTM A-123 except that all shapes shall receive 3.0 ounces of zinc per square foot of surface area. Supports are to be galvanized both inside and out after all cutting, punching, welding and cleaning have been completed.
    b. Finished galvanized surfaces must be uniform in color, appearance and texture and must be free of excessive roughness, pimples, lumpiness and runs.
4. Each support shall have a NEMA 2-hole ground pad located at its base.
5. Support locations shall meet NEC working clearance requirements and shall be at least 3 feet from equipment to allow maintenance access.
6. Support locations shall be reviewed with Company to ensure unobstructed clearance for doorways, forklift access, roadway access, personnel egress and headroom prior to installation.

INDOOR BUS SUPPORTS

1. Indoor supports shall be galvanized steel and designed to be supported from overhead building steel.
2. Support spans shall be 12 feet or less.
3. Support locations shall meet NEC working clearance requirements and shall be at least 3 feet from equipment to allow maintenance access.
4. Support locations shall be reviewed with Company to ensure unobstructed clearance for doorways, forklift access, personnel egress and headroom prior to installation.

TESTING

Testing requirements are defined in Appendix 6.

DELIVERABLES

Deliverable requirements are defined in Appendix 1.

PROPOSAL DATA REQUIREMENTS

Seller shall provide proposed equipment data in accordance with Appendix 2.

SITE CONDITIONS

Site conditions are defined in Appendix 4.

QUALITY ASSURANCE

QA/QC requirements are defined in Appendix 5.

PACKAGING STORAGE & SHIPPING

Packing, shipping storage requirements are defined in Appendix 7.

PERFORMANCE GUARANTEES

****
Fill in Appendix 3 as required
****

SOUND CONTROL REQUIREMENTS

****
Fill in as required
****

INSTRUMENTATION & CONTROL REQUIREMENTS

****
Fill in as required
****

MATERIALS & WELDING

****
Fill in as required and revise Appendix 5 accordingly.
****

CLEANING, PAINTING & COATING

****
Fill in as required and revise Appendix 5 accordingly.
****

SPARE PARTS

****
Fill in as required
****

APPENDICES TO SPECIFICATION

****

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.

****

1. DELIVERABLES
2. PROPOSAL DATA REQUIREMENTS
3. PERFORMANCE GUARANTEES
4. SITE CONDITIONS AND REFERENCE MATERIALS
5. QA/QC (Including Inspection Test Plans)
6. STARTUP, TESTING, AND COMMISSIONING
7. PACKAGING, SHIPPING, AND STORAGE
8. ACCEPTABLE MANUFACTURERS

APPENDIX 1

DELIVERABLES

****

The following is a list of minimum suggested deliverables and deliverable information. Revise per project requirements as required:

****

Manufacturer drawings:

1. Bus duct plan and elevation drawings showing phasing arrangement, weights and detailed dimensions.
2. Bus duct connection details.
3. Schematics and wiring diagrams showing customer connections for bus duct heaters.
4. Bus duct support types, details, anchor bolt plan, and support locations.
5. Bus duct nameplate data.

Test data:

1. Factory and field test data/test report. See Appendix 6 for details.

Operation and Maintenance Manuals:

1. Operation and maintenance (O&M) manuals shall include the following minimum information:
   a. Installation instructions.
   b. Operating instructions.
   c. Maintenance instructions.
   d. Nameplate data.
   e. Assembly drawings.
   f. Bill of Material with vendor part numbers.
   g. Recommended spare parts list.
   h. Certified (final) test reports
   i. Storage and Handling instructions.
   j. Special tools required for installation, operation and/or maintenance.
   k. Warranty Information

QA/QC:

Seller's QA/QC Inspection and Test Plan (ITP)

****

Include project-specific requirements for the following:

****

- Seller Deliverable Schedule
- Deliverable Format
- Deliverable Quantities

APPENDIX 2

PROPOSAL DATA REQUIREMENTS

600V NON-SEGREGATED BUS DUCT DATA SHEET

Seller shall provide the following minimum technical data applicable to the equipment in the proposed scope of supply.

****

In addition to revising this spec to correspond to project-specific requirements, update all highlighted areas with project-specific data.

****

600V NON-SEGREGATED BUS DUCT	UNITS	REQUIREMENTS	SELLER RESPONSE
Manufacturer		Seller	
City & Country of Manufacture		Seller	
Duty Cycle		Continuous	
ELECTRICAL PARAMETERS:			
Bus Conductor Material		Copper	
Enclosure Material		Aluminum	
Rated Nominal Voltage	kV	0.48	
Rated Maximum Voltage	kV	0.635	
Operating Frequency	Hz	60	
Rated Continuous Current at Max Ambient	A	3000	
Power Frequency Withstand (1 min., dry)	kV, RMS	2.2	
Rated Momentary Current (10 cycle, asym.)	kA, RMS	78	
Rated Short-Time Current (1 sec, sym.)	kA, RMS	69	
Rated Temp Rise Above Max Ambient	°C	65	
Total Electrical Loss at Rated Current	Watts/3-phase foot	Seller	
FINISH			
Color		ASTM D1535, Light Gray	

APPENDIX 2

PROPOSAL DATA REQUIREMENTS

600V NON-SEGREGATED BUS DUCT

****

The following additional information shall also be included with proposals:

1. Seller variances or exceptions to the specification.
2. Itemization of proposed estimated materials.
3. Add/deduct pricing for bus duct cost per lineal foot, each type of bus duct fitting, and flexible connectors.

****

APPENDIX 3

PERFORMANCE GUARANTEES

****
Typically, non-segregated phase bus systems do not have performance guarantees associated with them. However, consider all project-specific requirements to determine the applicability of this Appendix.
****

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

****

In addition to revising this spec to correspond to project-specific requirements, update all Appendix highlighted areas with project-specific data.

****

SITE CONDITIONS

LOCATION

Xcel Energy's Cherokee Station site is located in Adams County, CO at 6198 Franklin St. Denver, CO 80216.

METEOROLOGICAL DATA

Table 1 below lists the major site conditions which are based on ambient weather conditions taken from several data references. The following abbreviations apply to this table:

DBT:	Dry Bulb Temperature
MCWB:	Mean coincident wet bulb for a given dry bulb temperature
AMSL:	Above Mean Sea Level

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

TABLE 1 – MAJOR SITE CONDITIONS

PARAMETER	DATA
Site Elevation	5131 feet AMSL
Site Ambient Conditions	
Record low dry bulb temperature: MCWB for record low DBT:	-29°F -29°F
99% winter design dry bulb temperature: MCWB for 99% winter design DBT:	-5°F -8°F
Average winter dry bulb temperature: MCWB for average winter DBT:	-35°F -29°F
Annual average dry bulb temperature: MCWB for annual average DBT:	50°F 39°F
Summer 1% dry bulb temperature: MCWB for summer design 1% DBT: (Comparable to ASHRAE cooling, 0.4% occurance)	95°F 70°F
Record high dry bulb temperature: MCWB for record high DBT:	105°F 72°F
Dry bulb temperature for ISO System Accrediation: MCWB for ISO System Accrediation DBT:	95°F 70°F
Relative Humidity Range	0% to 100%
Annual Average Percipitation	18 inches
Maximum 24 Hour Rainfall Total	3 inches
Annual Average Snowfall	60 inches
Maximum 24 Hour Snowfall Total	48 inches

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

WIND LOADING

Wind loads shall be in accordance with the IBC. Basic wind design parameters are as follows:

DESCRIPTION	CHEROKEE	NOTES
Classification of Structure Category	III	Ref. ASCE 7-05, Section 1.5
Exposure	C	Ref. ASCE 7-05, Section 6.56
Wind Importance Factor	1.15	
Reference Wind Velocity, V	90 mph	3 sec. gust @ 33 ft. above ground. Ref. ASCE 7-05

SEISMIC CRITERIA

Structures shall be designed using the seismic criteria in the IBC as applicable to Colorado. Basic seismic parameters, per the IBC, are as follows:

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration at a short period (0.2 seconds), S_s = 0.217g.

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration a 1 second period), S_s = 0.056g.

Seismic Importance Factor, I_E = 1.25.

Based on the information presented in the Geotechnical Report, the project site has been assigned to Site Class D, to be verified by a site-specific geotechnical report.

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

REFERENCE MATERIALS

The following drawings contain additional scope requirements as part of this specification:

- General Arrangements
- One-Line Diagrams
- Bus Duct Layouts
- Transformer Connection Details
- Switchgear Connection Details

APPENDIX 5

QA/QC (Including Inspection Test Plans)

****

Revise this Appendix accordingly per project-specific requirements.

****

QA/QC

INSPECTION AND TEST PLANS

Seller shall submit their standard Inspection and Test Plan (ITP) for approval in accordance with Appendix 1 requirements.

QA/QC INSPECTIONS/REPORTING

****

Determine frequency of Xcel inspections of Seller's facilities during fabrication, prior to delivery, etc. and add requirements to this section as required. Review Xcel Intranet QA/QC Toolbox for various tools and templates for the following, as project requirements dictate:

- Shop inspection reports
- Non-conformance reports
- Release for shipment, etc.

Add these documents to this Appendix as required.

****

APPENDIX 6

STARTUP, TESTING AND COMMISSIONING

****
The following are minimum suggested testing requirements. Revise per project requirements as required:
****

Factory Testing:

1. Perform standard factory tests in accordance with IEEE C37.23.
2. Submit test data/test reports in accordance with Appendix 1.

Shop Tests:

1. Perform standard shop tests in accordance with IEEE standards.

****
Depending on project requirements, determine whether factory field support is required to startup/commission non-seg bus systems. Minimum commissioning considerations are as follows:

- Construction/installation inspections
- International Electrical Testing Association (NETA) standard field tests (e.g. bus high potential testing, etc.)
- Anti-condensation system/controls commissioning

****

APPENDIX 7

PACKAGING, SHIPPING AND STORAGE

PACKAGING, SHIPPING AND STORAGE

Seller shall prepare equipment for shipment following successful completion of factory testing and resolution of QA/QC non-conformances (see Appendix 5 for additional details.

Seller shall prepare equipment to withstand any possible damage or loss due to rough handling or exposure to weather during transit or extended outdoor storage (up to two (2) years).

Seller shall install all required covers to protect equipment from rain, hail, wind, dust, snow and environmental conditions detrimental to the equipment.

Equipment shall be adequately sealed and protected during shipment to prevent corrosion, foreign matter egress and freeze damage which could result from the presence of residual water.

Lifting points and centers of gravity shall be clearly marked on the shipped equipment.

Shipping structural bracing shall be installed as required to allow for field handling, skidding and hoisting.

Equipment supplied with space heaters shall have heater leads accessible without requiring disassembly of shipping containers.

Threaded outlets shall have plugs or caps installed prior to shipping.

Ancillary materials which are “shipped loose” shall be in separately boxed and re secured to the main equipment containers.

Seller shall provide the following minimum unloading/handling information:

- Shipping weight and dimensions of each article
- Pick points
- Rigging requirements
- Weight distribution
- Center of gravity
- Sensitivities
- Hazards

A QA/QC inspection certification, signed by the Seller shall be issued to the company prior to shipment. A copy of this certificate shall be included with the Bill of Lading.

APPENDIX 7

PACKAGING, SHIPPING AND STORAGE

Shipping documentation shall include the following minimum information:

- Company Destination (Plant, Unit)
- Company Agreement number
- Sellers order number
- Date shipped
- Shipping origin
- Company equipment tag information
- Seller's equipment identification information
- Shipment tracking information
- Shipment description
- Shipment quantity
- Gross weight
- Special handling requirements
- Identification of spare equipment
- Barcode, RFID, or similar material control information

Seller shall coordinate all deliveries with Company prior to shipment. Coordination shall include resolution of QA/QC non-conformances, delivery schedule, unloading/handling requirements, and storage requirements.

APPENDIX 8

ACCEPTABLE MANUFACTURERS

****
The following list contains the typically preferred manufacturers. Coordinate with Xcel Sourcing to determine final bid list:
****

Acceptable manufacturers are as follows:

- Azz-Calvert
- Eaton Cutler-Hammer
- Delta-Unibus
- Technibus

MASTER SPECIFICTION
FOR

4160 Volt Non-Segregated Phase Bus Duct

Revision 1.0

REVISION HISTORY

Date	Revision	Change Description
12-5-2014	1.0	Enhancements; Required Format

4160 Volt Non-Segregated Phase Bus Duct

GENERAL

DESCRIPTION

The 4160V non-segregated phase bus duct shall be designed and constructed for use on a 4160V, 3-phase, 60 Hertz, 3-wire, resistance grounded (2.4 ohm) system.

All indoor and outdoor bus duct, including fittings, bus duct supports, and conductor flexible conductors shall be furnished in accordance to these Specifications.

One 4160V bus duct shall be required from each auxiliary power transformer secondary flange connection of each unit auxiliary power transformer to a Switchgear lineup or Secondary Unit Substation, etc.

SUMMARY

Bus Duct Layout

Refer to the site layout and powerhouse layout drawings for location and orientation of powerhouse and auxiliary power transformer equipment.

The following estimated bus duct lengths, number of supports, and fittings may be used for bidding purposes (per bus duct run).

- Outdoor bus duct length/run –
- Indoor bus duct length/run –
- Fittings (quantity) –
- Outdoor supports (quantity) / run –

Include separate additional add/deduct pricing in proposal for elbows and a cost per foot of bus for final price adjustments.

Reference Drawings

The following drawings are being submitted as part of this specification:

- Bus Layout
- One-Line Diagram
- Three-Line Diagram
- Site Layout
- Aux Transformer Outline
- 5kV Non-Seg Bus Auxiliary Transformer

Technical Proposal Documentation

The following information shall be included with the bid proposal:

- Any variances or exceptions which the Manufacturer has to the specifications
- Attached data sheets to be filled-out as completely as possible
- Estimated materials
- Manufacturer's literature pertinent to proposed equipment.

Approved Manufacturers

- Delta-Unibus
- Calvert/AZZ
- Cutler-Hammer
- ABB
- Square D

APPLICABLE CODES AND STANDARDS

- State and local codes, laws, ordinances, rules and regulations
- ANSI – American National Standards Institute
- ASTM – American Society for Testing and Materials
- ICEA – Insulated Cable Engineers Association
- IEEE – Institute of Electrical and Electronic Engineers
- NEMA – National Electrical Manufacturer's Association
- NFPA – National Fire Protective Association
- OSHA – Occupational, Health and Safety Administration
- UL – Underwriter's Laboratories

In case of conflict or disagreement between codes and standards, the most stringent conditions shall govern.

TECHNICAL REQUIREMENTS

Design & Construction Features

1. **Environmental**
   The following ambient and site conditions shall be used in the design of all furnished equipment:
   - Site Location
   - Site Elevation, Feet (above mean sea level)
   - Atmospheric Pressure (psia)
   - Maximum Design Temperature, degrees F
   - Minimum Design Temperature, degrees F
   - Design Wind Speed, per ANSI C2 (mph)
   - Snow Load (pounds per square foot)
   - Seismic Zone (UBC)
   - Electrical Classification
   - Exposure to solar heat in the areas of outdoor installation

2. **Ratings**

Bus duct shall be furnished with the following voltage ratings:

- Nominal voltage: 4.16 kV rms
- Rated maximum voltage: 4.76 kV rms
- Rated power frequency dry one-minute withstand voltage: 19 kV rms
- Rated impulse withstand voltage: 60 kV peak

Bus duct shall be furnished with the following current and short-circuit ratings:

- Continuous rated current: 2,000 amps rms
- Short-circuit current withstand, asymmetrical (10 cycle rating): 65,000 amps rms or greater

Bus Construction

1. Bus duct construction shall be in accordance with ANSI Standard C37.23, and other applicable requirements of Codes and Standards stated in these Specifications.
2. Bus duct shall be furnished as a complete assembly of rigidly supported conductors, housed in a 3-phase enclosure without barriers between the phase conductors.
3. The bus conductors shall be copper or aluminum alloy and shall be designed to carry rated continuous current without exceeding temperature rise requirements specified in IEEE and NEMA standards. The current carrying capacity shall be based on actual service conditions including skin and proximity effects, and the effects of the bus insulation, the bus duct enclosure, and the ambient temperature.
4. The bus shall be installed with rigid, non-tracking, fire-resistant, and non-hygroscopic insulating supports capable of withstanding the mechanical forces imposed by short-circuit currents equal to the momentary current.
5. All bus conductor connections shall be completed by bolting. These connections shall be silver-plated for copper bus and tin-plated for aluminum. Provisions shall be made for bus expansion, to prevent undesirable or destructive mechanical strains in the bus supports and connections, through the ambient temperature range from 20ºF to 100ºF. Expansion joints shall be furnished where required.
6. Except at bolted terminations and connection points, all phase conductors in bus duct shall have a “Noryl” or equal sleeve type insulating material. All bolted joints; expansion joints; and bus connections, factory or field; and connections between the bus conductors and transformer terminals shall be insulated with removable boots. Removable boots shall be designed to overlap permanent insulation on each conductor in the connection insulated by the boot. The length of overlap on each conductor shall not be less than 2 inches at expansion joints, and not less than 1 inch at other connections. The insulating rating of bus, joint, connection, and termination insulation shall be not less than the voltage rating of the equipment.
7. Taps or connections shall be provided, as required, to accommodate auxiliary equipment such as lightning and surge protection, generator controls, metering and relaying, and current and potential transformers.
8. Removable covers shall be provided to permit access to the interior of the enclosure.

BUS ENCLOSURE

1. Indoor sections of bus duct shall be furnished with non-ventilated dust-tight enclosures. Outdoor sections of bus duct shall be furnished with non-ventilated weatherproof enclosures.
2. The bus enclosures shall be fabricated from aluminum not less than 1/8-inch thick.
3. Wall flanges and airtight vapor barriers shall be furnished at each transition from indoor to outdoor bus duct. In addition, a fire barrier, with 2-hour rating, shall be provided when penetrating firewalls.
4. After fabrication, all metal work of the enclosures shall be thoroughly cleaned and any steel work shall be phosphorized, or equivalent, and shall be painted with gray ANSI 61, or equivalent, gray paint.

SPACE HEATERS

1. Outdoor bus duct sections shall be furnished with space heaters to prevent condensation of moisture within the bus duct.
2. The heaters shall be located and thermally insulated such that no painted surface or bus insulation shall be damaged or discolored. Space heater capacity shall be as required to maintain the compartment and the bus duct internal temperature above the dew point. Voltage normally applied to the space heaters will be 120 V. Space heater voltage rating shall be 240 V.
3. Space heaters shall be controlled by an adjustable thermostat, factory set at manufacturer's recommended setpoints.

GROUND BUS

1. A ground bus shall be furnished which will electrically connect together all equipment connected to the bus duct. The ground bus shall be capable of carrying rated bus short-circuit current.
2. Provisions shall be made at each transition from indoor to outdoor bus duct to connect the enclosure to the station grounding system.

OUTDOOR BUS DUCT SUPPORTS

1. Supports shall be designed to withstand all environmental loads (wind, seismic, etc.). Support spans shall be 12 feet or less.
2. Finish
    a. Supports shall be galvanized steel in accordance with ASTM A36.
    b. Structures shall be galvanized by the hot dip process in accordance with ASTM A-123 except that all shapes shall receive 3.0 ounces of zinc per square foot of surface area. Structures are to be

galvanized both inside and out after all cutting, punching, welding and cleaning have been completed.

c. Finished galvanized surfaces must be uniform in color, appearance and texture and must be free of excessive roughness, pimples, lumpiness and runs.

3. Each support shall have a standard NEMA (2 hole) ground pad located at its base.
4. Manufacturer shall consider equipment maintenance access when locating supports. Support locations shall be at least 3 feet from equipment to allow room for equipment maintenance.

INDOOR BUS SUPPORTS

1. Indoor supports shall be galvanized steel and designed for hanging supports from building overhead steel. Support spans shall be 12 feet or less.

EQUIPMENT TERMINATIONS

1. Manufacturer shall furnish all flexible connectors and bus termination fittings for equipment terminations, for the termination of the busbars to the transformers and switchgear.

SEISMIC REQUIREMENTS

[Fill in as required]

SOUND CONTROL REQUIREMENTS

[Fill in as required]

ELECTRICAL REQUIREMENTS

[Fill in as required]

INSTRUMENTATION & CONTROL REQUIREMENTS

[Fill in as required]

MATERIALS & WELDING

[Fill in as required]

CLEANING, PAINTING & COATING

[Fill in as required]

PACKAGING & SHIPPING

[See Appendix 7]

STORAGE & HANDLING PROCEDURES

[See Appendix 7]

SPARE PARTS

[Fill in as required] Commissioning spares to be included/supplied with the equipment.

QUALITY ASSURANCE

[See Appendix 5]

DELIVERY REQUIREMENTS

[Fill in as required]

FIELD SERVICE

[Fill in as required]

TESTING

Material Testing & Inspection

1. **Factory Tests**
   a. Perform standard factory tests in accordance with ANSI C37.23.
   b. Include certified test reports in instruction books.

2. **Shop Tests**
   Routine shop tests shall be performed in accordance with IEEE Standards.

   The Manufacturer is responsible for all costs associated with the tests and for correcting deficiencies and retesting in the event of a test failure.

3. **Field Testing**
   [Fill in as required]

INSTALLATION

1. Contractor shall install bus duct and outdoor supports in accordance with Manufacturer's instructions and drawings.
2. Install power wiring to bus duct space heater circuits from 120/208 or 120/240 volt distribution panel.

MANUFACTURER'S DATA SUBMISSION SCHEDULE

General

Provide Company address and responsible individual.

[Fill in as required]

Drawings / Manuals

1. Submittals

Submit approval drawings, final drawings, instruction books, and technical proposal per Factory Tests, above.

a. Perform standard factory tests in accordance with ANSI C37.23.
b. Include certified test reports in instruction books.

2. Approval Drawings

Shop approval drawings shall include at least the following:

a. Bus duct layout and arrangement showing phasing arrangement, weight, and detailed dimensions.
b. Bus duct support details, anchor bolt plan, and support locations.
c. Bus duct ratings
d. Schematics and wiring diagrams showing customer connections for bus duct heaters.
e. Bus duct connection details.
f. Bus duct grounding details.
g. Complete information for tightening of all electrical connections secured with bolts of studs shall be included on erection and assembly drawings. The information furnished shall include torque wrench settings or complete details of other tightening procedures recommended for bus joints and connector attachments.

3. Final Drawings and Manuals

Submit final "as-built" drawings and manuals.

[Specify format for drawings and the number of manuals required.]

The instruction books shall include, but not be limited to:

a. Complete service and repair manuals.
b. Complete parts list with vendor part numbers and a recommended spare parts list.
c. Bill of materials
d. Certified test reports
e. Storage and Handling instructions
f. Installation instructions

g. Complete set of as-built drawings
h. Contact information for warranty issues or service on equipment.

4. Technical Proposal Documentation

The following information shall be included with the bid proposal:

a. Any variances or exceptions which the Manufacturer has to this and referenced Specifications.
b. Attached data sheets to be filled out as completely as possible.
c. Estimated materials
d. Manufacturer's literature pertinent to proposed equipment.

TECHNICAL DATA

Site Data

[See Appendix 4]

Technical Data by Company

[See Appendix 4]

Technical Data by Manufacturer

[See Appendix 2]

APPENDICES TO SPECIFICATION

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.
****

1. **DELIVERABLES**
2. **PROPOSAL DATA REQUIREMENTS**
3. **PERFORMANCE GUARANTEES**
4. **SITE CONDITIONS AND REFERENCE MATERIALS**
5. **QA/QC (Including Inspection Test Plans)**
6. **STARTUP, TESTING, AND COMMISSIONING**
7. **PACKAGING, SHIPPING, AND STORAGE**

1. DELIVERABLES

(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule B)

Seller's Data Submission Schedule

Specifier – Add discussion of options and criteria that must be addressed

Documentation

Specifier – Add discussion of options and criteria that must be addressed including drawings, parts lists, O&M manuals

2. PROPOSAL DATA REQUIREMENTS

(To be inserted in the Bid Form)

NONSEGREGATED BUS DUCT DATA SHEET

Manufacturer shall provide the following data applicable to the equipment in the proposed scope of supply.

DATA SHEETS			
NON-SEGREGATED PHASE BUS DUCT (NSPBD)			
Manufacturer Name & Address			
Project			
Facility Location			
Delivery Date			
	UNITS	REQUIRED	SUPPLIER RESPONSE
Net Weight (not shipping weight)			
Complete equipment	lb		
Heaviest piece to handle during erection	lb		
Steel support structures only	lb		
Weight per foot of assembled three-phase bus and enclosure	lb		
Overall Dimensions, Assembled			
Width and height of assembled bus enclosure	in		
Length of largest shipping section	ft		
Bus Structure			
Rated voltage	V	5,000	
Operating voltage	V	4,160	
Frequency	Hz	60	
High potential withstand test at factory on assembled structure			
Rated 60 Hz dry withstand (1 minute)	kV	19	
Rated 60 Hz dew withstand	kV	15	
Impulse withstand (B!L) - full wave	kV	75	
Rated dc, dry withstand	kV	27	
High potential withstand test in field on assembled structure - 60 Hz for one minute	kV		
Continuous current rating	A	3,000	
Rated short circuit withstand which the conductors, supports, housing are mechanically braced to withstand	asym A	40,000	
Bus conductors			
Material (state grade)		Copper	
Conductivity at 20° C	%IACS		

Number of conductors per phase			
Type of conductor (bar, tube, rod, etc.)			
Dimensions of each conductor			
Width	In		
Depth	In		
Diameter	In		
Thickness	In		
Phase spacing, center-to-center	In		
Bus conductor supports			
Material used (ASTM designation)			
Insulation class			
Withstand potential tests Supplier			
Dry	kV		
Dew	kV		
Wet	kV		
Impulse- full wave	kV		
Bus Enclosure			
Shape (rectangular or round)			
Outside dimensions			
Width	in		
Depth	in		
Material (state grade and temper)			
Conductivity at 20°C	%IACS		
Thickness	in		
Type of material of gaskets			
Are short circuiting bands used on cross hanger members? (Answer Yes or No)			
Bus conductor insulation			
Materials used (ASTM designation)			
Insulation class			
Operating voltage and phase	V		
Maximum temperature rise above an outside maximum ambient of 50°C when carrying rated current			
Main bus conductors and connection	°C	65	
Bus enclosures (accessible) °C	°C	40	
Bus enclosures (in-accessible) °C	°C	70	
Material and size of ground conductor			
Will bus be shipped in factory assembled sections?			
Heaters			
Voltage	V	480	
Rating	W		

3. PERFORMANCE GUARANTEES

(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule number)

Specifier – Add discussion and criteria that must be addressed, include Acceptance Criteria

4. SITE CONDITIONS AND REFERENCE MATERIALS

(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule number)

Specifier – Add discussion and criteria that must be addressed

Maximum Temperature, F	
Minimum Temperature, F	
Humidity Range	
Site Elevation, ft	
Seismic Design Criteria	

5. QA/QC (Including Inspection Test Plans)

(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule number)

Specifier – Add discussion and criteria that must be addressed

6. STARTUP, TESTING, AND COMMISSIONING

(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule number)

Specifier – Add discussion and criteria that must be addressed

7. PACKAGING, SHIPPING, AND STORAGE

(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule number)

Specifier – Add discussion and criteria that must be addressed

8. Approved Vendors / Suppliers

Non-Seg Bus Duct

- Calvert
- Unibus/Powell
- Square D
- Cutler-Hammer

MASTER SPECIFICTION
FOR
Distributed Control System (DCS)

Revision A

REVISION HISTORY

Date	Revision	Change Description
12-2-2015	1	New

****
This specification is only for design, supply, and site technical assistance. Installation is typically performed by another contractor using other specifications.

In addition to revising this spec to correspond to project-specific requirements, update all highlighted areas with project-specific data.

Modify “Seller” to “Emerson” for Emerson Ovation DCS per Master Service Agreement.
****

GENERAL

DESCRIPTION

****
Insert project-specific description items (i.e. new construction project, replacement project, project location, etc.)
****

SUMMARY

Seller shall supply, program, test, configure and deliver complete a Distributed Control System (DCS) capable of performing all control, monitoring, trending, reporting, alarming, and interface functions as described in this specification. This specification sets forth the minimum requirements for the design, materials, fabrication, inspection, and testing of the DCS. Seller shall be responsible for integrating all DCS components, subsystems, and other systems into a complete and operable DCS, as well as the system testing, documentation, delivery, supervision and field support as described in this specification. Seller shall include, as a minimum, all required system hardware, operator/engineering workstations, foreign device interfaces, cabinets for DCS devices, system cables, system software applicable to all user requirements, application software, DCS testing, on-the-job training, and documentation.

All equipment shall be designed for continuous duty and to operate in the environmental conditions routinely anticipated in a power plant environment, but in any event not less severe than the environmental conditions described in this specification and attachments. The Seller shall specifically and clearly describe any modifications to the specified temperature and humidity, plant electromagnetic, and radio frequency environments that the proposed DCS will require in order to provide operation fully complying with these specifications.

Company shall be responsible for the following:

a. Receiving, unloading, storing, and field erection of all equipment and materials (unless specifically identified in the technical specifications)
b. Foundations and foundation anchor bolts
c. Permanent electric wiring to connect equipment terminal boxes to the plant electrical equipment supplied by Others.
d. Solvents and cleaning materials.
e. Operating personnel for startup and tests.

Seller shall allow Company personnel access to its factory during DCS assembly and for witness testing. Seller shall provide DCS manufacturing schedule and updates to the schedule to the Company. Travel costs for Company personnel for site factory visits are the responsibility of the Company.

APPLICABLE CODES AND STANDARDS

- State and local codes, laws, ordinances, rules and regulations
- Achilles Level 1 Certified
- ANSI - American National Standards Institute
- ASCE – American Society of Civil Engineers (7-10)
- ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
- IBC – International Building Code
- IEC – International Electrotechnical Commission (61131-3 and 1000-4-5)
- IEEE - Institute of Electrical and Electronic Engineers (472-1974 and 802.4)
- ISA – Instrumentation Society of Automation
- ISO – International Organization for Standardization (9000/9001)
- NEMA - National Electrical Manufacturer's Association
- NFPA - National Fire Protection Association
- UL - Underwriter's Laboratories

In the event of conflict or disagreement between codes and standards, the more stringent conditions shall govern.

TECHNICAL REQUIREMENTS

****

Update project-specific requirements (i.e. quantities, monitor sizes, time server, etc.).

To bid multiple sellers:
Update all highlighted sections to generic descriptions since these are Emerson Ovation specific.
****

1. GENERAL

The DCS shall be redundant down to, but not including, the I/O modules. The control system shall be designed and implemented such that no single point of failure will result in a plant shutdown, cause damage to plant equipment, or present an operational safety hazard.

The DCS shall be designed to prevent component power up (or initialization) from causing an unsafe situation.

All DCS components and software supplied for this project that become shall be the latest hardware available at the time of the hardware cutoff date.

2. HARDWRE

A. Processors (Controllers):

Controllers shall be Seller's OCR1100 (or newer), and meet the requirements of IEC. All controller modules shall be capable of being removed and/or inserted into the system while power is applied and shall meet the fault tolerant requirements of IEEE.

Each processor shall have a redundant network connection to the data highway (control system network).

B. GPS Clock:

Seller shall supply one (1) network time server capable to synchronize the DCS processors and workstations to within 1 millisecond of coordinated universal time for time dependent functions such as sequence of events and alarm reporting. A Symmetricom XLi 1U processor, GPS timing engine, and M12 based antenna (or engineer approved equal) shall be provided. The satellite clock shall be provided with a rack mounting kit, antenna, 50 ft. cable, with antenna mounting bracket, and additional instruction manuals (one for each copy of DCS documentation provided). The GPS receiver shall run the Network Time Protocol and shall have at least eight (8) Multicode IRIG-B (AM) output ports and one (1) additional Ethernet port for Company use.

C. Workstations:

All workstations and servers shall be provided with Microsoft's Windows 2007 or Microsoft's Server 2008 operating platforms (or newer), and shall be supplied with all of Seller's recommended software patches.

D. Workstation Monitors:

Seller shall provide Seller's standard twenty-four (24) inch Dell Ultrasharp Series and forty (40) inch monitors (or Company approved equal). Quantity to be supplied per Appendix 2.

All monitors furnished with the DCS shall be industrial quality diagonal high-resolution (1920x1200 or greater), high contrast (1000:1 or greater), vertically flat, non-interlaced, color monitor, and suitable for continuous-duty operation. Maintenance and adjustment shall be easily accomplished and shall be performed without removal of the unit from its mount. Local controls shall be provided on each monitor for contrast, brightness, tint, and focus.

****

Monitors: Update project-specific requirements for quantities, monitor sizes, and if stands are required.

To bid multiple sellers:
Modify highlighted sections to generic descriptions since these are Emerson Ovation specific.
****

E. Engineering/Database Workstation(s):

Seller shall provide Microsoft Windows-based, multi-screen engineer workstations with two (2) twenty-four (24) inch monitors per workstation. Quantity of engineering workstation to supply as shown in Appendix 2.

As a minimum, each engineering workstation shall be a rackmount server class machine and shall include a Pentium Xeon 2 GHz processor with 2 MB cache, 4 GB SDRAM, internal DVD +/- RW drive, four (4) internal 300GB hard drives (2 – RAID 1), RD1000 internal drive with removable 160GB media, dual twenty-four (24) inch monitors, dedicated heavy-duty 104 key PS/2 style QWERTY keyboard and separate optical mouse designed for industrial use in a continuous duty operation, all necessary communication hardware, and all software and operating systems. The engineering workstation shall be configured as an operator workstation and engineering/database server, and shall be provided with three (3) floating Ovation Developer Studio licenses. Two (2) additional temporary Developer Studio licenses shall be provided for startup and commissioning.

****

Workstations: Modify highlighted technical sections per Seller’s proposals as workstation specifications are frequently changing.

To bid multiple sellers:

Modify highlighted sections to generic descriptions since these are Emerson Ovation specific.
****

F. Operator Workstation(s):

Seller shall provide Microsoft Windows-based, multi-screen operator workstations with multiple monitors per workstation. Quantity of operator workstation to supply as shown in Appendix 2.

As a minimum, each operator workstation desktop shall include a Pentium Dual Core or Core 2 Duo 2.2 GHz processor with 2 MB cache, 1 GB SDRAM, internal 250 GB hard drive, internal DVD+/-RW drive, four (4) monitors, video cards and drivers capable of driving at least four (4) monitors of different sizes, speakers that audibly annunciate system and process alarms, dedicated heavy-duty 104 key PS/2 style QWERTY keyboards and separate optical mouse designed for industrial use in a continuous duty operation, all necessary communication hardware, and all software and operating systems. Each operator workstation shall be configured to function as an engineering workstation with appropriate login security level.

G. Historian:

Seller shall provide a rackmount historical storage, retrieval and log server workstation, complete with an external “hot swappable”, rackmount, disk RAID array storage system (no empty slots), three (3) internal 300GB hot swap hard drives (RAID 5), internal DVD RAM drive, with the latest technology data storage capabilities for long term data storage and retrieval as well as perform all functions of a normal operator/engineering workstation. The historian shall include a twenty-four (24) inch display, Microsoft Excel add-on, and 10,000 data point license (at a minimum). Quantities shown in Appendix 2.

The historian server shall be provided with all the necessary hardware, software and a storage interface medium such as Oracle with OBDC, or equivalent. The historian shall include a report/log generator for recording and archiving of plant data, which shall be designed for ease of use, and configured for creating and storing multiple custom displays and reports with automatic printing options. Any and all points in the DCS shall be available for report generation. Seller shall provide eighteen (18) pre-configured report formats designed to generate reports with varying quantities of points. At a minimum, Seller shall provide reports formats designed for 8, 16, 32, 64 and 80 point reports. Seller shall provide reports formats designed to export to Microsoft Excel properly and report formats designed to directly print properly.

As a minimum, the data historian shall record all hardwired I/O, analog process variables, and significant status variables (e.g. all digital

manual rejects). Additional data to be logged shall include, but not be limited to, history of process alarms, operator changes, and system errors. It shall also acquire continuous process history to support logs and trends and provide the source data for management reports and operational logs.

Historian external storage capacity (RAID) shall be sized to allow data to be sampled at a default 1.0 second rate for non-SOE points and 0.1 for SOE points and accumulated for 5 years. Varying the sampling rate shall make it possible to store more points or for longer periods. For the purpose of preliminary sizing of the system, for storage and licensing, the Seller shall use the Estimated DCS I/O Count in Appendix 2, with two hundred fifty (250) percent additional soft points shall be used.

The historical trend shall be for up to at least thirty (30) days.

Data shall be archived at least every thirty (30) days.

H. Asset Management System (AMS):

****

AMS is Emerson specific and project specific. Modify accordingly for multiple sellers and/or project.

****

Seller shall provide a rackmount Asset Management Server with a licensed number of points greater than the total number of Hart capable instrumentation on the complete project. All Hart capable points known before factory acceptance testing shall be configured in the factory prior to delivery. All Hart capable points remaining shall be added at Site with technical assistance. The AMS servers shall have the capability for one (1) client. For the purpose of preliminary sizing of a system, licensing shall use the applicable estimated DCS analog I/O count in Appendix 2 with 20% additional.

I. Domain Server:

A rackmount Domain Server shall be provided per Appendix 2, complete with four (4) Ethernet ports, internal DVD +/- RW drive, four (4) internal 300GB hard drives (2 - RAID 1), and an RD1000 internal drive with removable 160GB media. Prior to the Factory Acceptance Test (FAT), the Seller shall configure three (3) access levels: Administrator, Maintenance, and Operator. The Seller shall use this server to disable all unused ports and services to harden other workstations. Additional access levels shall be configurable by the Company based on plant design and access level.

J. Anti-Virus Server:

****

Anti-Virus is project specific. Many sites request or have an Ovation Security Center that includes anti-virus. Discuss CIP requirements with plant contact and Subject Matter Expert prior to sending specification to Seller(s).
****

A rackmount server shall be provided per Appendix 2. The server shall integrate seamlessly into the DCS network and will only be required for commissioning the system prior to the DCS's integration into the existing Ovation Security Center.

K. Performance Workstation:

****

Global Performance Advisor is Emerson and project specific. Discuss requirement with plant contact and Subject Matter Expert prior to sending specification to Seller(s).
****

A rackmount Global Performance Advisor (GPA) shall be provided per Appendix 2 and configured for new 2x1 combined cycle. Configurations shall include turbines, heat recovery steam generators (HRSG), cooling tower, medium voltage motors/pumps, and condenser.

L. Computer Cabinet:

****

Some sites are mounting all their computers remotely in a rack in a cleaner room, and some sites will still stuff them under or on top of desks. Discuss requirement with plant contact and Subject Matter Expert prior to sending specification to Seller(s).
****

One (1) Dell server cabinet shall be used to rackmount the Historian with external RAID drives, GPA server, Domain server, Anti-Virus server and the engineering/database server. A KVM switch shall be used to connect the GPA Server, Domain Server, and Anti-Virus Server to a single keyboard, mouse and monitor. The database server, Historian and other workstations with dedicated monitors and keyboards shall utilize fiber optic KVM extenders.

M. Printers:

Printers shall be suitable for a control room environment. They shall be able to print at least one hundred thirty-two (132) characters per line and utilize multiple fonts. All workstations shall be configured to allow printing to any of the network connected printers on the system. Printers shall be furnished with a one-year supply of ink/toner cartridges.

Color Laser Printers (quantity per Appendix 2): Each printer shall meet the following minimum capabilities:

- Selectable paper size up to 11" X 17"
- Print speed of minimum fifteen (15) pages per minute
- Two individual paper trays for 8½" X 11" and 11" X 17" sheets

- Input paper tray capacity of minimum 250 sheets each size
- User replaceable toner cartridge
- Minimum resolution of 1200 X 1200 dpi
- Duty cycle of minimum ten thousand (10,000) pages per month
- Printing mechanism shall not require specially treated paper
- Buffer large enough to store two graphic screen prints
- Ethernet connectivity

Each printer shall be equipped with any control or interface devices (e.g. print servers) necessary to interface it directly to the local network and to operate in conjunction with the operator and/or the engineering workstations. All network connected printers shall be capable of printing any screen displayed on any workstation including logic, graphic screens, and reports.

N. Spare Capacity:

The DCS shall allow for future expansion and provide spare capacity within the system. The Seller shall confirm that the proposed control equipment will be supported by the Seller with the supply of spares and replacement parts being guaranteed for the expected useful life. The Seller shall provide guarantees on hardware.

The DCS spare requirement shall be in accordance with Appendix 2 or this section, whichever requirement is more stringent. All percentages shall be rounded up to the next highest number.

- At each I/O cabinet area, the Seller shall supply a minimum of twenty (20) percent installed, unused spare capacity for each type of I/O available in the cabinet, excluding specialty modules.
- An additional minimum twenty (20) percent spare slots and space for twenty (20) percent spare modules shall be provided in each I/O cabinet area to allow for future installation of I/O modules.
- Each control processor shall be equipped with the amount of functional capacity and memory required to perform its control functions under all process conditions, plus a minimum spare capacity of fifty (50) percent. The required size and quantity of the processors is to be determined by the Seller based on extensive experience in power plant control system design and the information contained in this specification.
- Each router and Ethernet switch shall be sized with twenty (20) percent installed spare capacity.

O. Spares:

Seller shall provide one (1) complete set of parts indicated in the Seller's documentation requiring to be replaced during the construction, testing, startup, and commissioning phases of the project.

All spares supplied shall be strictly interchangeable with the parts that they are intended to replace and shall be of the same quality as the original parts.

In addition, Seller shall provide a complete listing of recommended spare parts. The spare parts shall include those required for all on-base and off-base equipment and materials including sub-sellers furnished under this agreement. The recommended spare parts lists shall be submitted in two separate lists. The lists include:

Recommended Start-Up Spare Parts List – The startup spare parts list shall include a listing of all consumables required to operate the Seller supplied equipment through startup and commissioning. This list shall include those parts which, based on past experience, the Seller recommends having available to replace parts that may fail during start-up.

Recommended Operational Spare Parts List – This list shall include those parts which, based on its maintenance guidelines, routine operation, and past experience, the Seller believes may require replacement in the first 24 months of plant operation.

The lists shall comply with the following:

- Lists shall be in Excel Format.
- Lists shall be inclusive for and applicable to all equipment components, auxiliaries, accessories, and materials being furnished under this agreement.
- Lists shall indicate whether the recommended spare is a stock item or a special-order item.
- Lists shall be identified with the Company's specification number, equipment tag number and equipment description.
- Lists shall classify the relative criticality of parts based on the Seller's experience and shall list the recommended quantities to be stocked.

P. RFI/EMI Protection:

****

The RFI/EMI section is for bidding new sellers or new hardware with limited industrial experience. Remove section for Xcel's standard DCS sellers like Emerson Ovation and Invensys Foxboro.

****

The DCS system and components shall not operate incorrectly or sustain damage from the influence of radiated or cable-conducted radio frequency fields or electromagnetic interference typically found in an electric power generation facility.

The system shall be supplied with provisions for protecting against system errors and hardware damage resulting from electrical transients on power or signal wiring. These transients include those generated by switching large electrical loads, by power line faults, and due to lighting strikes which induce surges on power or signal cables. Either the IEEE Standard 472-1974 or IEC Standard 1000-4-5 shall apply to all system power inputs and signal inputs from field devices. The Seller shall describe the method it intends to use to provide this protection in its proposal.

Portable FM transceivers will be used by plant personnel for communications purposes during startup and commissioning. The transceivers will operate in the 300 to 5,000 MHz range (UHF). Input power will be 5 watts and power output will be 3.5 to 4.0 watts. The DCS shall not exhibit any adverse effects which may be produced within the Seller's systems and not impose any restrictions on the use of such communications equipment and Seller's equipment shall not cause RFI interference to user's hand held radios.

EMI protection against hardware damage and system errors shall be provided for the equipment being furnished. Errors caused by EMI shall not exceed ±0.1 percent of span for exposure to field strengths of 30 volts/meter over the frequency range of 20-100 MHz.

RFI protection against hardware damage and system errors shall be provided for the equipment being furnished. Errors caused by RFI shall not exceed ±0.1 percent of span for exposure to field strengths of 10 volts/meter over the frequency range of 10-1000 MHz. A certified test report shall be required in the proposal to verify this performance. Seller's equipment shall meet all applicable RFI emissions standards.

3. I/O CABINETS AND NETWORK HARDWARE

A. General:

All I/O and network equipment shall be housed in cabinets and enclosures.

Final cabinet layouts shall be subject to Company's approval. DCS cabinet doors and panels shall be fitted with dust tight seals. DCS cabinets (located in an environmentally controlled area) for the processors, communication cards, power supplies and I/O modules shall conform to NEMA 1 standards. DCS cabinets shall be NEMA 12 with side covers. Cabinets will be installed in electrically unclassified areas, except where noted otherwise. The Seller shall design and supply a rigid, self-supporting freestanding cabinet for incorporation

within a suite of bolted cabinets. Cabinets shall be completely fabricated, assembled, wired and tested before leaving the Seller's factory.

****

The duct burner section is project specific for a combined cycle plant.

****

The HRSG duct burner DCS cabinets shall be designed to meet the requirements of NFPA 85 and shall include a relay panel with watchdog timers. Relay panel shall be designed by Seller to remove energy from igniters and safety valves per duct burner seller's documentation.

The I/O cabinets shall be designed for top or bottom entry of field cables.

Fans shall be provided in redundant pairs with integral filters, and shall be fused such that a fan failure does not trip the circuit breaker feeding the cabinet power.

A temperature alarm shall be provided for each cabinet with active electronics. These cabinet temperatures shall be available for display on the system status graphics and shall alarm at extreme temperatures.

Each cabinet or enclosure provided shall be clearly labeled with a nameplate containing the tag number, controller number, description and branches (front and rear). Where cabinets contain multiple sections, each section shall have its own nameplate. Where cabinets have front and rear access, each side shall be provided with a nameplate.

Nameplates shall be made from laminated plastic, white background, with black letters. All nameplates shall be permanently attached, and engraving shall be subject to Company review and approval.

All major system components located inside of cabinets or enclosures shall be clearly labeled and identified with the tag number or an equipment/device number that is referenced in the vendor drawings. This shall include electronic equipment, terminal block assemblies, fuse blocks, power supplies, media converters, network equipment, and any other device requiring maintenance or service.

Cabinets shall utilize lockable, vertically hinged doors. Hinges shall allow easy removal of the entire door. All door locks shall be provided with the same lock and key combination, and a minimum of two keys for each door shall be provided.

****
Remote I/O is project specific and requirements need to be discussed with plant contact. Lately projects have gone away from control through networking due to UOR incidents.

Recommend redundant network connections to each Ovation controller with remote I/O to prevent controller faults.
****

Remote I/O shall not be used.

All I/O branches shall be provided with full baseplate installation.

All DCS controller cabinets and DCS I/O cabinets shall have a width of thirty-two (32) inches.

The DCS cabinets shall be designed such that each set of redundant controllers shall have no more than sixteen (16) branches. The Seller shall add additional sets of redundant controllers as necessary at each location. As a minimum, the Seller shall provide a minimum of eight (8) redundant controllers with automatic failover as follows: One (1) for Unit 05 HRSG, one (1) for Unit 06 HRSG, one (1) HRSG 05 duct burner BMS, one (1) HRSG 06 duct burner BMS, one (1) STG, one (1) water treatment, one (1) cooling tower, one (1) medium-voltage electrical enclosure.

Controller redundancy will be provided in a one-to-one fashion; no more than one microprocessor will be backed-up by the redundant processor.

Equipment cabinets shall have cooling fans that exhaust from the top of the cabinet and filtered cooling air shall enter from the bottom.

DCS cabinets requiring Modbus serial connections shall include provisions for mounting (on DIN rail) and powering the associated serial-to-fiber media converters. Additionally, space shall be provided for mounting (on DIN rail) the associated fiber optic patch panel. The media converters and fiber optic patch panels shall be pre-installed and pre-wired at the factory.

B. Power Distribution and Grounding:

Each cabinet or equipment receiving power shall be provided with a main circuit breaker or breakers which shall be the point of interface to the power sources. The proper coordination of branch circuit protective devices shall be the Seller's responsibility. All breaker trips shall be alarmed in the DCS.

Two (2) power sources shall be available to each cabinet containing power supplies, processors, fans and cabinet lights. Two (2) essential service feeds shall be provided from the Site's Uninterrupted Power Source (UPS) system and/or essential service bus (supplied at 120 VAC). Additionally, two (2) essential service feeds (120 VAC) connected to an auto-transfer switch within the DCS cabinet shall be provided to each cabinet requiring routed power for digital outputs. Seller's system shall be fully functional if either of the essential service feeds is energized to the controller and I/O power supplies. The intent of this requirement is that no single point of failure in power feed, or power supply, shall degrade or interrupt the normal functioning of the Seller's system.

****

Different sites have different power source standards. Modify accordingly (ie AC versus DC, UPS versus house power).

****

The standard power supply terminals shall be factory wired out to easily accessible terminal blocks. These terminal blocks shall be screw down type capable of receiving a 12 AWG sized ring-tongue lug with covers to prevent accidental contact with power source.

Seller shall provide redundant power supplies, diode isolated, and fused to a common bus. Each power supply shall be loaded to not more than fifty (50) percent of its maximum capacity upon shipment. Faulty power supplies shall be able to be removed/replaced with the system on-line. Seller shall provide additional redundant power supplies as necessary at every controller location to maintain a maximum power supply loading of sixty (60) percent. Power supplies shall be internally monitored and alarm when out of tolerance from the DCS.

A grounding jumper shall be installed between the cabinet door and the cabinet on all DCS cabinets to ensure a solid ground is provided for the cabinet door. A shield bus bar shall be installed on the side of each cabinet.

Seller shall provide all interconnecting wiring and cables (wire or optical fiber) required for connections within cabinets and between the various physically separated items in Seller's scope of supply in accordance with the network overview drawing provided.

Recovery of the system after power failure must be automatic, with control loops and sequence control placed back into the failsafe position.

C. Network Equipment:

All network cabinets and server cabinets will be powered by redundant separate 120VAC UPS power sources.

Where fiber optic cable is used, Seller shall provide (in each originating and remote location), a fiber optic patch panel and media converters (if required). Each remote controller and workstation location patch panel and set of media converters shall be capable of terminating the required fiber plus one hundred (100) percent spare capacity. The network cabinet location patch panel and media converters shall be capable of terminating the required fiber plus twenty (20) percent spare capacity. In no case shall the patch panel violate the minimum bending radius required for the fiber optic cable. Fiber optic connectors shall be ST type. Patch cables between media converters and patch panels shall be provided by Seller.

A media converter chassis shall be factory installed near the respective fiber optic patch panel within a Seller provided cabinet at each originating and remote location and the chassis power shall be factory wired to a power supply terminal strip in the same cabinet.

All network equipment necessary for Seller's system to operate shall be provided, and located in a network equipment cabinet. Network equipment shall be powered by redundant feeds provided by Company. The network equipment cabinet shall be located over a raised floor, and shall accommodate bottom entry cabling. Network equipment shall be redundant to the extent that no single power feed or equipment failure shall disrupt normal operation of the data highway. The network cabinet shall be provided with ten units (10U) of spare space for rack mounted equipment provided by Others. The Seller shall provide a DCS fiber optic patch panel(s) for DCS fiber and shall be adequately sized to allow twelve (12) bulk fiber optic cables (with six pairs of fiber in each cable) to be terminated.

Seller shall only provide Cisco brand switching, firewall and routing equipment. The use of hubs is forbidden.

Controllers shall be dual-homed.

A Seller DMZ router shall be provided in the DCS network, and shall be installed in the network cabinet. Seller shall connect the DMZ to the DCS network. Company will connect the DMZ to Company's network. Company will establish the technical requirements for the DMZ router and size the hardware to properly handle all the required functions, timing requirements, alternate routings, and allow for future expansion with Seller's assistance.

4. COMMUNICATIONS

A. General:

The communications network is a set of elements that transfers information between processors, workstations, switches, routers, controllers, or other devices that constitute the system. “Data Highway” refers to the controller network, and any network architecture internal to the Seller’s system. “Datalink” refers to a third-party interface with other systems or devices.

All communication networks shall be provided with error checking and diagnostics and shall alert the operator to faults in the system (i.e. loss of communication) through alarm messaging and system status graphics.

Communications interfaces shall be replaceable on-line without interruption to the system.

All outside communications to any control system shall be accomplished in cooperation with Company such that the Company’s data security requirements are met.

B. Data Highway:

The data highway shall be fault tolerant, redundant (to the processor bus interface level), and shall continuously monitor the highway performance, and log and transmit all system diagnostic alarms for display.

The data highway equipment shall be capable of transmission over a distance of a minimum of five thousand (5000) meters.

Seller shall supply all necessary hardware, highway cables, and connectors required for the system within each controller cabinet and between each connected I/O expansion cabinet. Seller shall install fiber optic patch panels in all controller cabinets and connect fiber optic jumper cables between the fiber optic patch panels and media converters.

Redundant data highway shall be active at all times. Each shall be able to operate independently for indefinite period of time with no system degradation.

Microprocessor based controllers or controller server systems shall be dual redundant configuration. The backup equipment shall have

parallel access to the data highway and shall continuously update while in the backup state. The intent of this requirement is to maintain the status of the backup equipment current with the primary equipment such that transfer of information from the failing primary controller to the secondary controller is not required. It is also the intent of this requirement that failure of one branch of redundant data highway shall not result in failing to the backup controller.

In no case shall data propagation times be longer that two hundred (200) milliseconds.

The data highway shall also provide the following:

- No single point of failure or single loss of power shall cause communications to cease functioning
- An upset in plant conditions shall not cause the data highway to operate in a degraded mode. Bandwidth shall be capable of maintaining required update time under upset conditions
- Data highway rate shall be a minimum of one hundred (100) Mbps
- Variables in the system-wide global database shall be uploaded a minimum of once per second with compatibility of updating once per second with compatibility of updating critical variables every tenth (1/10) of a second to all controllers in the system.

C. Datalink:

Interface capability shall be provided to allow communication using industry standard protocols. The various types of communication specified in Appendix 2 shall be supported. The DCS system shall accept daisy chained or communication protocols that are series segments to the DCS without the need for separate modules at the DCS. Fieldbus, Profibus, and DeviceNet shall not be used in any system. Protocols to be supported include, but are not limited to:

- Modbus (Serial and TCP/IP)
- EIA RS-232/422/485
- Allen-Bradley DH+
- HART
- GSM
- DNP3.0

****

Different sites have different datalink standards. Modify according to the plant's requirements.

****

Systems interfaced with include, but are not limited to:

- Programmable Logic Controllers (PLCs)
- Compressor control systems

- Turbine control systems
- Remote Terminal Units (RTUs)
- HART enabled field devices

****
Different projects have different interfaces. Modify accordingly.
****

The system shall support redundancy all datalink interfaces.

All datalinks shall alarm on loss of communication.

Datalinks shall enable the DCS to control and monitor equipment on a supervisory level.

5. I/O MODULES

A. General:

The Seller shall terminate all process I/O in an arrangement that will assure that electrical characteristics are matched and will support construction/installation. The Seller shall not terminate process I/O in a particular order solely to satisfy Seller requirements. Process I/O identifying codes, termination locations, functional descriptions, and electrical characteristics shall be submitted by the Seller for approval by Company. Each block and terminal shall be suitably identified in accordance with termination drawings and wire lists.

Inputs and outputs servicing complementary pairs of equipment shall be assigned to separate I/O modules and branches. Redundant instrumentation shall be terminated on separate branches.

All hardwired signals shall be terminated to the controller's I/O in which the logic for the signal is being processed in. All I/O not meeting this requirement shall be flagged and reviewed with Company for acceptance.

The Seller shall furnish all redundant power supplies required for powering remote transmitters that are not self-powered. All transmitters will be of either the two-wire or four-wire type. Transmitter circuits shall be individually fused or current limited. The fuses shall be located in the I/O cabinets. Bridge circuits and power supplies required for resistance temperature detectors and slide wires shall be provided in the I/O cabinets.

Seller shall reduce the amount different I/O group types to the extent possible.

Any required peripheral or auxiliary equipment for signal conditioning, impedance matching, load balancing, ground detection, surge protection, and other similar functions shall be furnished and installed by Seller.

****

Recommend removing the rest of the general section below for known DCS sellers (Ovation and Foxboro). Standard equipment from these sellers is acceptable and well tested.

****

The I/O modules shall be capable of accepting the input/output signals described below and used in conjunction with the controller modules described herein.

All inputs and outputs shall be individually able to be removed from scan and forced to an operator determined value from any operator workstation. A forced points log shall be generated to display and identify by tag any forced points.

Provision shall be included to allow all inputs to be able to be deleted from and restored to alarm status.

The quality of all inputs shall be determined, and classified as good, questionable, forced, or bad. When bad quality of a value occurs, it shall be clearly displayed and alarmed. The system shall include the capability to set the upper and lower limits of each analog input that determines good or bad quality.

I/O modules shall be replaceable without removing any wiring.

All low voltage digital I/O and temperature inputs (RTD, T/C) and all analog I/O shall be capable of being electrically isolated from other I/O, incoming power cables, and from all cabinet wiring.

Terminal blocks for analog signals shall be sized to receive 16 thru 14 AWG wire.

Terminal blocks for digital signals shall be sized to receive 16 thru 14 AWG wire.

Circuit protection shall be provided such that a fault on one channel will not cause other channels to fail.

Individual status lights shall be provided for each digital input and each digital output on a direct-wired I/O module. I/O module slots shall accept either input modules or output modules as required.

****

**Recommend removing sections marked with a double asterisk section below for known CS sellers (Emerson Ovation and Foxboro) with a list of model numbers and quantities from final proposal, but *verify model numbers first*. Standard equipment from these sellers is acceptable and well tested.

****

B. Analog Input:

Analog input modules shall be installed and configured in the factory such that unused or spare channels on the module do not create an alarm for the module or its associated I/O branch. All unused channels shall be capable of being put back in service if necessary by Company.

**Conversion to engineering units shall be software based, such that each point on any I/O module can have its own range.

**Provision for different conversion types which shall include linear, thermocouple, RTD, flow compensation, polynomial approximation for special input and all other types required for this application. Each of the conversion types shall have the capability to handle different ranges for the variable.

**Analog inputs shall contain over/under range protection to protect the equipment from ground faults and high voltage.

**The DCS system and components shall be capable of supporting the latest version of HART protocol communications with transmitters and control valves. Analog I/O shall have the required loop resistance to support HART communications. Analog I/O modules capable of reading the HART protocol on the milliamp signal shall be provided.

**All analog I/O's shall check for quality.

C. Analog Input (4-20 mA) Modules:

Each analog input channel shall be capable of HART communication.

**Analog inputs shall be furnished with individual analog-to-digital converters, accuracy better than +/- 0.10% of span.

**The choice of internal (loop) or external (field) power source shall be individually selectable on a per point basis.

D. Analog Input (TC) Modules:

The cold junction compensation (CJC) value shall be available for display to the operator and shall have adjustable alarm limits. CJC shall be provided on a per module basis.

**Thermocouple input modules shall be designed so that different thermocouple types can be mixed on each module. This shall include as a minimum ungrounded and grounded thermocouples of type K. The system shall include selectable linearization for thermocouples, and CJC.

**All thermocouple inputs shall be checked for open circuit with each thermocouple scan. The delay between the check and the determination of an open circuit condition shall not be more than one (1.0) second.

**Series mode signal-to-noise rejection ratio shall be not less than one thousand to one (1,000:1) for thermocouples.

E. Analog Input (RTD) Modules:
**The system shall be compatible with 2-wire, 3-wire and 4-wire RTD types.

F. Analog Output Modules:
Analog output modules shall be installed and configured in the factory such that unused or spare channels on the module do not create an alarm for the module or its associated I/O branch. All unused channels shall be capable of being put back in service if necessary by the Company.

**Analog outputs shall be individually fused or current-limited and shall produce 4-20 mA DC current loops capable of driving 750-ohm loads at 24 volts DC.

**Analog outputs shall be capable of producing 1-5 VDC or 0-10 VDC signal levels if required. Using a shunting resistor to achieve these outputs is acceptable.

**Analog outputs shall be furnished with individual digital-to-analog converters, accuracy better than +/- 0.25% of span.

**Failure mode pre-selection is required, allowing analog outputs to be configured to fail open, fail closed, or fail last upon loss of communication with the control processor.

**Optical isolation shall be provided for all analog outputs.

**An open loop shall result in indication of bad quality

**All analog outputs shall be open circuit and short circuit protected.

**An individual integral HART modem shall be provided for each analog output channel.

G. Discrete Input Modules:

All digital inputs shall be 60-48VDC power. Input modules with onboard DC wetting voltage are acceptable. Additionally, fail-safe condition checking of digital inputs shall be done such that a failure of a digital input module will not allow for the controller to detect a “set” state of the input signal. The option to disable all points on a module based on a ground fault detection shall be disabled.

**Discrete inputs from field devices will be dry contacts, and both momentary and/or maintained.

**Contact input modules shall be able to be located in any processor I/O cabinet.

**Contact inputs shall be provided with contact bounce filtering. The filter shall delay contact inputs to protect against input device bounce and electrical noise on input lines.

**Sensing modules for contact inputs shall be high impedance. Interrogation voltage for contact inputs used for data acquisition and/or control shall be provided from DCS generated 48VDC source as required. The choice of internal or external power source shall be individually selectable on a per module basis.

**Each discrete input module shall be current-limited to protect against field short circuits.

**All discrete inputs shall have sequence of events capabilities with a resolution of one (1) millisecond.

H. Pulsed Input Modules:

**The DCS shall be able to receive inputs from periodic (or pulse) input devices. A periodic input shall be defined as: A zero based pulse, rectangular wave or sinusoidal wave form with amplitude of 24 volts DC, and rate of 0 to 50,000 pulses per second (50 KHz frequency).

I. **Discrete Output Modules:**

DCS powered 120VAC outputs are to be provided for solenoid operated valves, as defined in the I/O list. The DCS cabinet breaker(s)

feeding these DCS powered digital outputs should be sized to be capable of providing current up to one (1) amp per valve assuming that fifty (50) percent of the valves on any module will be operated simultaneously. These breakers shall also be monitored by the DCS and alarm when field power is not available.

Power distribution terminal blocks shall be provided for all 120VAC solenoid valves identified in the I/O list.

The discrete output points shall be designed to accept supply power for contact outputs either from I/O power supplies within the Seller's systems or from an external power source (field selectable).

**Discrete output modules shall be provided to switch either DC or AC loads as specified by the I/O list. Relays shall be provided for all discrete output points.

**Each relay output shall be able to switch a minimum of ten (10.0) amps @ 250VAC or three (3.0) amps @ 125VDC (with embedded arc suppression circuitry; arc suppression should be external to allow ease of replacement, without having to replace the whole module) with all outputs on a module active at the same time.

**Higher current ratings of up to ten (10) amps AC/DC may be required in some cases, and shall be provided by interposing plug-in relays if the I/O modules or relay type terminal blocks cannot support this requirement. This shall not require separate relay cabinets.

**Contacts outputs shall close within fifteen (15) msec.

**Fail-safe features required on discrete outputs include a configuration option to fail open or fail closed on loss of communication with the control processor. Internal circuit protection for output modules shall be provided such that a fault on one output does not cause other outputs to fail.

6. SOFTWARE

A. General:

The DCS shall be programmed utilizing Seller's most current revision of Ovation software, release Ovation 3.5 (or newer). Minor software revision upgrades (such as 3.5.1 to 3.5.2, 3.5.3) and Seller verified operating system patches shall be provided and installed up to twelve (12) months after receipt of DCS workstation equipment on Site.

Seller shall program and implement complete control logic for a complete DCS system. Seller will be provided with P&IDs, graphic sketches, logic diagrams, and control narratives for guidance. Seller shall use Company's standard Emerson logic macros.

Program documentation (including interlock and alarm setpoints as well as setpoints required by the programming algorithms) showing the implementation of the templates and narratives shall be submitted for review in accordance with the deliverable schedule. The program documentation submitted for review shall be in Seller's standard logic format. In addition, all programming documentation submitted shall indicate all setpoints and cross references required to determine that the software will perform as required by the templates and narratives.

Seller shall submit all logic diagrams for the system in sufficient time for complete engineering review of the logics and incorporation of comments on the logic into the system programming prior to FAT. System logics shall be submitted in at least three equal packages, spaced thirty (30) calendar days apart, with the final package submitted in sufficient time for a review period and incorporation of logic comments into the system prior to the initiation of the FAT. Late submittal of logics, or submittal of substantially non-compliant logics, by Seller shall be equivalent day-for-day to late delivery of the DCS system and subject to the liquidated damages in Appendix 3.

****

Liquidated damages should be discussed with Sourcing prior to issuing specification since most Master Service Agreements (MSA) already address damages.

****

A complete set of software program packages shall be provided to implement the control functions of the DCS. Seller shall be responsible for developing, debugging, and testing all software programs used. A set of maintenance software programs shall also be provided to perform on-line and off-line diagnostic functions for both the hardware and software components of the system.

The software to be furnished shall include any and all proprietary and non-proprietary software utilized or required in any way for configuration, programming, debugging, operation or maintenance of the system hardware and/or control programs and display screens. This shall include any configuration automation programs or utilities, software add-ons, collections of algorithms or configuration blocks including utilities or programs available to the Seller's configuration and programming personnel.

The Seller shall furnish all necessary software license(s) for each software package provided. The Seller shall also furnish a backup copy of all licenses and programs contained in the package in a binder. One (1) set shall be delivered to the Site separately from the system hardware.

****

Add software license details and quantities in final proposal to this section.

****

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Different projects and sellers have different controller scan rates. Modify accordingly or remove. Control Tasks below are Emerson Ovation specific.

****

Controller Scan Rates
Control Task 1 - Unit Protection – fast loops at 100ms (ie unit trips)
Control Task 2 - Analog Control – slow loops at 1000ms (ie temperature control)
Control Task 3 - Data Acquisition – 500ms
Analog Control – medium loops at 250 to 500ms (ie pressure and flow controls)
Discrete/Logic Control – 250 to 500ms

Bad signal quality shall be alarmed and the process control loop should be placed in manual.

Redundant instruments shall use the 2XMTR algorithm. Triple redundant instruments shall use the “Median Select” algorithm.

Each process variable, set point, position feedback, and demand signal shall be check for excessive deviation and shall alarm at a minimum.

Notes should be added to control sheets to clarify complicated control or to indicate scaling where possible. (Necessary for consistency and ease of troubleshooting).

****

Highlighted below are project specific requirements. The first one is a plant specific requirement, the second is a project specific requirement. Modify accordingly.

****

All points must have an English description. Output point descriptions should start with a verb or contain the words “demand” or “command”. (i.e. Open BFP 1A Discharge Valve).

The water treatment system shall be programmed in the DCS. As such, the Seller shall be required to work with the water treatment

vendor (US Water) to program the system in accordance with the vendor's requirements (utilizing the project logic macros and graphic symbols).

B. System Database:

All letters used in the database and point definition shall use capital letters. Only exception is for engineering units that call for distinction (ie. mA - milliamps versus MA – mega-amps).

Software shall also be provided to reinitialize communication devices from permanently stored data following a computer failure. Re-initialization shall restore the devices to continue performing the functions that were in progress prior to the failure without operator intervention. The devices to be reinitialized shall include display screens and demand logs.

System software shall be password protected. This shall include database configuration and logic modification. All passwords shall be provided to Company.

Strict adherence to the point naming, alarm priority, and characteristic standards is required. (Necessary for consistency and ease of troubleshooting).

All points that leave a control sheet (internal or I/O) must have a custom name per the point naming standards and a custom description. No points leaving a control sheet should be allowed to have default names or descriptions. (Necessary for consistency and ease of troubleshooting).

C. Re-initialization:

Software and hardware shall be provided to reinitialize the system following a computer failure or long-term power failure.

The re-initialization software shall contain necessary programs for Company to install all operating system and application programs onto the system memory with a series of screens displaying guidance messages throughout the entire installation process.

The software shall cover all aspects of the installation process including checking each type of memory for defects, testing system hardware for the proper functioning of each component, and procedures for installing individual programs.

D. Control Functionality:

Critical Logic: Company's critical logic shall be integrated as-is unless Seller identifies areas of code violations or high risk of equipment damage. Seller shall notify Company of all areas of concern identified by Seller for immediate resolution.

Digital logic shall be programmed without the use of complex Boolean algorithms (such as NOR, NAND, Exclusive OR). Typically the use of AND, OR and NOT along with special functions such as flip-flops, time delays, one-shots are to be used. (Ease of reading control sheets and ease of trouble shooting).

All tripping signals from triple redundant instrumentation shall be based on two (2) out of three (3) voting logic with bad quality signals voting to trip. The bad quality signal monitors shall check the actual signal input from the individual instruments, not the median or any other compensated signal.

If a field signal becomes unavailable or bad, protection of the control output shall be provided (e.g., reject to manual, etc.).

****

Items remaining are Emerson Ovation specific. Modify accordingly.

****

Analog control will flow top to bottom and discrete (digital) control will flow left to right.

Digital control and analog control will not be mixed on the same control sheet. Exceptions are where digital control points are necessary on analog algorithms and where analog points are needed to determine digital logic (e.g. high limit of a pressure). (Ease of reading control sheets and ease of troubleshooting).

All inputs to PID algorithms and all outputs from MA Stations shall have custom names.

Function blocks shall be included after all MA Stations to allow for linearizing or inverting signals.

All function blocks shall have a function graph.

E. Point Identification:

****

Point identification is project specific. Modify accordingly.

****

A typical variable identification tag shall be composed as follows:

1) 2 alpha-character for Plant System Code

2) 2 alpha-character for Plant Sub-System Code
3) Up to 4 alphanumeric characters for Function Code Identifier
4) 2 numeric characters as Unit Identifier
5) 3 numeric characters as equipment/line number
6) 2 numeric characters for Sequence number
7) 1 trailing alpha-character for redundant instrumentation (if required)

F. Display Modes:

Overview Display: An overview display shall enable the operator to determine the overall operation of a large segment of the plant. This overview shall have page connections to all other display screens. Navigation shall be designed to take only two clicks of the mouse to get to any piece of equipment from any graphic (not including faceplate).

Graphic Displays: Dynamic interactive graphics of all sections of the plant shall be able to be displayed on any operator workstation. Graphic displays shall use symbols from a library of standard/user defined graphic symbols. Different plant systems shall be displayed on different pages.

Graphics Configuration: Seller shall provide complete graphics configuration for all operator interface functions for plant operation. This includes interface to all functionalities controlled by the DCS as well as summary displays (for example, turbine monitor screens) for items monitored by the DCS. Seller shall submit draft and final screen displays to Company for review in accordance with the deliverable schedule.

Seller shall utilize the Company's standard graphic symbols.

Each PID shall be able to be displayed as a faceplate with an analog type display of variables such as measured process variable, set point and controller output. Faceplates shall have a scale in engineering units with appropriate divisions.

Pointers (arrows) or any other identifiable symbols shall display high/low limits of output and alarm limits for process variables. In the case of status inputs, these shall be displayed with an indication of status (e.g., open or closed, etc.).

All rotating equipment shall have a graphic start and stop button on a graphic screen.

Seller shall arrange the control systems graphics in a hierarchical or tree structure starting with plant overall performance summary with branching into each major component; CTGs, HRSGs, STG, condenser, SWYD/SWGR, and BOP. Company will supply sketches for all required DCS graphic displays, text displays, and faceplate displays along with descriptions of dynamic actions, such as color changes, alarm messages, pop-up window, etc.. Graphics will incorporate Emerson's latest combine-cycle standard macros and Company's standard macros for equipment operation. Equipment with permissives to start or stop shall use Emerson's Diagnostic Window Center, and details of all the permissives and their current status will be displayed. Equipment with automatic functionality will have indication of the current automatic or manual status on the macro (or next to the macro), such that the status is visible on the main graphic without opening a faceplate.

Motors larger than 480VAC shall show run times, thermal capacity, thermal capacity alarm, estimated trip time on overload, average motor load, average motor current, motor speed and temperatures on the graphic if I/O is available.

G. Alarm Functions:

Alarming shall be programmed per Company's and/or Site's standards.

The DCS shall be capable of alerting the operator to abnormal process conditions or internal control system faults. All alarms generated shall be able to be displayed on an operator workstation using color change. Alarm displays shall comply with ANSI/ISA-18.1-1979 - (R2004) and ANSI/ISA-18.2-2009.

The DCS shall alert the operator to each alarm with an audio and a visual signal. Regardless of the current display on the screen, the operator shall be able to call up the relevant alarm display with a single keystroke or mouse click. The system shall be designed so that all alarms can be acknowledged from any operator workstation.

Alarms and interlocks shall be designed based upon an "open to alarm" philosophy.

First-Out Alarms & Sequence of Events: The DCS shall provide a first out alarm resolution capacity. In the case of an avalanche of alarms, the system shall be able to discriminate between them by time and date tagging the alarms in the order of their occurrence. Repeat contacts, if specified, shall be available from the DCS generated alarms and for the field instruments alarms to be interfaced with external hard wired annunciators. The audio alarm must have a

minimum of five discernible tones. However, more than five tones are preferred. The tones shall be assignable depending on alarm priority, or the kind of alarms (e.g., process alarms, operation error, and diagnostic alarms).

7. MEETINGS

A. Kick-off Meeting:

Seller shall attend a project kick-off meeting within two (2) weeks after the Company's contract award with the Seller. The following subjects, as a minimum, shall be discussed:

- Project organization and working protocol
- Seller's project implementation plan
- Overall project schedule
- Overall configuration
- System jobsite training (operators and technicians)
- Documentation format

B. Design Review Meetings:

Two (2) design review meetings be conducted with all parties involved to incorporate all of the Company's total requirements and preferences. There shall be at least two (2) design reviews prior to final system configuration. As a minimum, these meetings shall address the following:

- Hardware configuration
- System interface
- I/O database
- Software configuration (logic and functionals)
- Graphic displays
- Control logic
- Historian configuration
- Alarming
- Datalinks, and protective relaying.

C. Web-based Meetings:

Control logic shall be verified with simulation by Company prior to Factory Acceptance Test through two (2) web-based meetings with the Seller. Timing of web-based meetings shall be determined by the Seller.

D. Weekly Meetings:

Weekly conference call meetings with web conferencing shall be conducted between Seller and Company team members to discuss the

status of the project. An action item list shall be maintained and discussed during these calls. Timing of weekly meetings shall be determined during kick-off meeting.

8. SERVICES

A. Field Services:

See Appendix 6 for service representative requirements.

B. Project Management:

Seller shall include an experienced project manager to plan, control, monitor and report the status of the overall project.

Seller shall be responsible for, but not limited to, the following:

- Project kick-off meeting
- Weekly review meetings with web conferencing.
- System configuration and hardware manufacturing schedule.
- Detailed development and implementation schedule.
- Contract administration and monthly status reports.
- Initialization and verification of the system hardware at the Seller's factory.
- System Shipment
  Upon completion of the factory acceptance testing, Seller's project manager shall ready system hardware, software and documentation for shipment to Site. Project manager shall contact Company to coordinate an acceptable date for delivery prior to shipment.
- Overall Project Follow Up
  The Contractor's project manager shall provide overall project follow-up to ensure that the project is executed according to the agreed upon scope and schedule, and all punchlist items have been closed.

APPENDICES TO SPECIFICATION

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.
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1. DELIVERABLES
2. PROPOSAL DATA REQUIREMENTS
3. PERFORMANCE GUARANTEES
4. SITE CONDITIONS AND REFERENCE MATERIALS
5. QA/QC (Including Inspection Test Plans)
6. STARTUP, TESTING, AND COMMISSIONING
7. PACKAGING, SHIPPING, AND STORAGE

1. Deliverables

****
The following is a list of minimum suggested deliverables and deliverable information. Revise per project requirements as necessary:
****

Software:
Software updates shall be provided for the duration of the warranty period.

Manufacturer Drawings and Documentation:
Documentation shall be provided for editing, loading and configuration of Seller's system and any sub-system within the Seller's scope. Where third-party hardware is utilized, Seller shall include manufacturer's operation and instruction manuals and cut sheets.

Deliverables shall be in accordance with the schedule located within.

All deliverables shall be submitted in electronic format. O&M Manuals shall be submitted in hard copy and electronic format. All "as shipped" drawings shall be provided in file format per Company's Vendor Drawing Standard.

Seller shall provide the following documentation as a minimum requirement:

a. Dimensioned outlined drawings (English dimension units).
b. System layout drawings.
c. Heat load and electrical load requirements.
d. Cabinet nameplate drawings.
e. Cabinet panel layout, schematics and wiring diagrams.
f. Monthly progress reports.
g. Project schedule.
h. Drawings and data with Company's interface.
i. QA/QC documentation.
j. Hardware documentation manuals (electronic and three (3) hard copies).
k. Termination list.
l. Database provided in Microsoft Access or Microsoft Excel format.
m. Mutually agreed upon factory acceptance testing forms.
n. Mutually agreed upon start-up and commissioning checklist forms.

Sensitive documentation shall be provided through Seller's FTP service only. Sensitive documentation to be determined during kick-off meeting.

Operation and Maintenance (O&M) Manuals:
O&M manuals shall include the following minimum information:

a. Installation instructions

b. Operating instructions
c. Maintenance instructions
d. Nameplate data
e. Manufacturer drawing/documentation
f. Bill of Material with vendor part numbers
g. Cut sheets and brochure data for all transformer auxiliary equipment
h. Recommended spare parts list
i. Certified (final) test reports
j. Storage and Handling instructions
k. Special tools required for installation, operation and/or maintenance
l. Warranty information

****

Include project-specific requirements for the following:

- Seller Deliverable Schedule
- Deliverable Format
- Deliverable Quantities
- Monthly Status Reports

****

2. PROPOSAL DATA REQUIREMENTS

DISTRIBUTED CONTROL SYSTEM (DCS) DATA SHEET

Seller shall provide the following minimum technical data applicable to the equipment in the proposed scope of supply.

DISTRIBUTED CONTROL SYSTEM	REQUIREMENTS	SELLER RESPONSE
Manufacturer	Seller	
Model	Seller	
Location of Assembly:		
City, State	Seller	
Country	Seller	
HARDWARE PARAMETERS:		
Operator Workstation(s):		
Quantity		
Computer Manufacturer	Seller	
Computer Model	Seller	
Hard-drive size(s)	Seller	
RAM	Seller	
Monitor Manufacturer and Model No.	Seller	
Monitor Quantity and Size(s)		
Monitor Stand Included		
Heat and Electrical Load	Seller	
Desktop or Rackmount		
Engineering Workstation(s):		
Quantity		
Computer Manufacturer	Seller	
Computer Model	Seller	
Hard-drive size(s)	Seller	
RAM	Seller	

Monitor Manufacturer and Model No.	Seller	
Monitor Quantity and Size(s)		
Monitor Stand Included		
Heat and Electrical Load	Seller	
Desktop or Rackmount		
Domain Server(s):		
Quantity		
Computer Manufacturer	Seller	
Computer Model	Seller	
Hard-drive size(s)	Seller	
RAM	Seller	
Monitor Manufacturer and Model No.	Seller	
Monitor Quantity and Size(s)		
Monitor Stand Included		
Heat and Electrical Load	Seller	
Desktop or Rackmount		
Historian Workstation(s):		
Quantity		
Computer Manufacturer	Seller	
Computer Model	Seller	
Point count of license(s)		
Hard-drive size(s)	Seller	
RAM	Seller	
Monitor Manufacturer and Model No.	Seller	
Monitor Quantity and Size(s)		
Monitor Stand Included		
Heat and Electrical Load	Seller	
Desktop or Rackmount		
Anti-Virus Server:		
Quantity		

Computer Manufacturer	Seller	
Computer Model	Seller	
Hard-drive size(s)	Seller	
RAM	Seller	
Monitor Manufacturer and Model No.	Seller	
Monitor Quantity and Size(s)		
Monitor Stand Included		
Heat and Electrical Load	Seller	
Desktop or Rackmount		
Additional Monitors:		
Quantity and Size(s)		
Printer(s):		
Quantity		
Manufacturer and Model No.	Seller	
Color or B/W printing		
Print size(s)		
DCS Controllers:		
Quantity		
Manufacturer/Model	Seller	
Processor type/speed	Seller	
SOE resolution (msec)	Seller	
Maximum I/O per controller	Seller	
Operating temperature limits	Seller	
Controller Cabinets:		
Enclosure type	NEMA 12	
Cabinet Lights	120V (house power)	
Cabinet Fan(s)	24VDC (fused)	
Heat and Electrical Load	Seller	
Height x Width x Depth & Weight		

Extended I/O Cabinets:		
Enclosure type	NEMA 12	
Cabinet Lights	120V (house power)	
Cabinet Fan(s)	24VDC (fused)	
Heat and Electrical Load	Seller	
Height x Width x Depth & Weight		
GPS Time Server:		
Manufacturer and Model No.	Seller	
Estimated I/O Counts:		
Digital Inputs		
Digital Outputs		
Analog Inputs (4-20mA)		
Analog Inputs (TC)		
Analog Inputs (RTD)		
Analog Outputs		
Non-redundant Datalinks (quantity/# of points)		
Redundant Datalinks (quantity/# of points)		
Network:		
Network Switch(es)		
Network Router(s)		
DMZ Router(s)		
Network Media Converters		
Media Converter Racks		
Software:		
Number of custom main Graphics		
Number of macro Graphics		
Service(s):		

Days of field service assistance		
Number of trips		
Days of phone support		
Days of training		
Quantity of documentation for students in training		
Hardware Factory Acceptance Testing (days)		
Software Factory Acceptance Testing (days)		
Design Review (days)		
O&M Manuals:		
Hardcopies		

Seller shall provide, with bid, preliminary drawings showing: quantity of cabinets, door access requirements, dimensions and weights of cabinets, and an overview of network topology. Seller shall also provide heat rejection requirements of all power consuming Seller provided hardware. In addition, the Seller shall state any required cable separation, grounding and shielding requirements.

Seller's quality manual and project specific quality plan be submitted with Seller's bid material.

Seller shall state with the proposal the power requirements at each location for the equipment supplied. Seller shall list separate requirements for essential service feeds and utility power feeds.

Adds/Deletes:
Seller shall provide line item pricing to add and delete I/O modules, cabinets, power supplies, and controllers as necessary for changes in point counts during the design process. Delete pricing shall be valid until the hardware cutoff date. Add pricing shall be valid until the cabinet shipment date.

****
The following additional information shall also be included with proposals:

1. Seller variances, clarifications, and exceptions to the specification.
2. Itemization of proposed estimated materials.
3. Recommended spare parts list with pricing.

Documentation:

Seller shall provide, with offer, a list and examples of its standard deliverables. Deliverables should include (but are not limited to):

- Network and Communications Overview Drawing
- Termination Lists (Hardcopy and Excel format)
- Cabinet, Console, and I/O Module Layout Drawings
- Power Consumption Drawings
- Functional logic drawings based upon Engineer's narrative for review

****

3. PERFORMANCE GUARANTEES

****
Revise Appendix 3 according to project-specific requirements.

Discuss with Sourcing the Master Service Agreement terms already established with DCS sellers to determine what performance guarantees (LDs) to add.
****

DCS Final Acceptance:
Completion will be based on Seller providing the completed Site acceptance testing documentation and provide deliverables listed in Appendix 1 to Company no later than thirty (30) days after completion; Company will provide approval. If applicable, the Release and Indemnity shall be executed by Seller and delivered to Company.

Maintenance of Work Progress:
Late submittal of logics, or submittal of substantially non-compliant logics, by Seller shall be equivalent day-for-day to late delivery of the DCS equipment. Late delivery of successful FAT, or delivery of hardware and software to Site per agreement delivery schedule shall be subject to termination on default.

4. SITE CONDITIONS AND REFERENCE MATERIALS

****
Include project-specific site location and condition requirements.

****

Site location:

Company's Cherokee Station site is located in Adams County, CO at 6198 Franklin St. Denver, CO 80216.

Meteorological data:

Table 1 below lists the major site conditions which are based on ambient weather conditions taken from several data references. The following abbreviations apply to this table:

DBT: Dry Bulb Temperature
MCWB: Mean coincident wet bulb for a given dry bulb temperature
AMSL: Above Mean Sea Level

TABLE 1 – MAJOR SITE CONDITIONS

PARAMETER	DATA
Site Elevation	5131 feet AMSL
Site Ambient Conditions	
Record low dry bulb temperature: MCWB for record low DBT:	-29°F -29°F
99% winter design dry bulb temperature: MCWB for 99% winter design DBT:	-5°F -8°F
Average winter dry bulb temperature: MCWB for average winter DBT:	-35°F -29°F
Annual average dry bulb temperature: MCWB for annual average DBT:	50°F 39°F
Summer 1% dry bulb temperature: MCWB for summer design 1% DBT: (Comparable to ASHRAE cooling, 0.4% occurrence)	95°F 70°F
Record high dry bulb temperature: MCWB for record high DBT:	105°F 72°F
Dry bulb temperature for ISO System Accreditation: MCWB for ISO System Accreditation DBT:	95°F 70°F
Relative Humidity Range	0% to 100%
Annual Average Precipitation	18 inches
Maximum 24 Hour Rainfall Total	3 inches
Annual Average Snowfall	60 inches
Maximum 24 Hour Snowfall Total	48 inches

Seismic Criteria:

Structures shall be designed using the seismic criteria in the IBC as applicable to Colorado. Basic seismic parameters, per the IBC, are as follows:

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration at a short period (0.2 seconds), S_s = 0.217g.
Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration a 1 second period), S_s = 0.056g.
Seismic Importance Factor, I_E = 1.25.
Based on the information presented in the Geotechnical Report, the project site has been assigned to Site Class D, to be verified by a site-specific geotechnical report.

HVAC Design (typical):

TABLE 2 – TYPICAL INDOOR CONDITIONS

Building / Area	**Indoor Temp.**		**Humidity Control**	**Minimum Ventilation Rate, Based on 15°F Temp Rise**	**Particulate Filtration Efficiency**	**Pressurization**
	Max °F	Min °F	%RH	Ac / h	%	
Turbine building electrical rooms	74	68				
Control Room	74	68	50	ASHRAE STD-62	High / Low	Positive
PDC enclosures	74	68	N/A	ASHRAE STD-62	ASHRAE STD-62	Neutral

Reference Materials:

****

Note for DCS Ovation projects: Revise Appendix 4 to include Emerson Ovation control standard reference materials. Also, check with plant contact for site-specific control system standard reference materials if DCS is going into an existing facility.

Minimum existing plant materials to consider:

- Graphic and logic macros
- Alarm list configurations and priority levels
- Graphic color standards (ie. Red = close)
- Graphic navigation and hierarchy

****

5. QA/QC (Including Inspection Test Plans)

****
Revise this Appendix accordingly per project-specific requirements.
****

Inspection and Test Plans:

Seller shall submit their standard Factory Acceptance Test documents or Inspection and Test Plan (ITP) for approval in accordance with Appendix 1 requirements.

Quality Assurance and Quality Control:
Seller shall have in effect at all times, a QA/QC program that clearly establishes the authority and responsibility of those responsible for the quality system. Persons performing quality functions shall have sufficient and well-defined authority to enforce quality requirements that initiate, identify, recommend and provide solutions to quality problems and verify the effectiveness of the corrective action. The quality system shall provide for the planned and systematic control of all quality-related activities performed during design. Implementation of the system shall be in accordance with the Seller's quality manual and project specific quality plan.

Quality assurance and testing shall be designed to meet ISO 9000/9001 QA/QC procedures.

Inspection:
Company representative(s) will at a time (or times) mutually agreed to, visit the Seller's facilities and inspect system progress with respect to software and hardware. The intent of such a visit will be to confirm that the typical logic used for various devices as well as the method for displaying field status information is in accordance with the project requirements, and that the hardware is constructed in accordance to Seller's provided drawings and Company's specifications prior to shipment. The items tested may include (but are not limited to):

- Hardware production progress
- Quality and Workmanship of hardware
- Confirmation that hardware provided matches drawings submitted
- Typical graphic status displays (permissive pop-ups, M/A stations, transmitter select blocks, standard and cascade PID loops, etc.)
- Logic template testing

During an inspection, the Seller shall make available to the Company a complete set of the latest Revision of hardware drawings.

****

Determine frequency of Company inspections of Seller's facilities during fabrication, prior to delivery, etc. and add requirements to this section as required. Review Company Intranet QA/QC Toolbox for various tools and templates for the following, as project requirements dictate:

- Shop inspection reports
- Non-conformance reports
- Release for shipment
- Site delivery receipt

Add these documents to this Appendix as required.
****

Factory Acceptance Test:
Two (2) formal Factory Acceptance Tests (FAT) shall be conducted in accordance with a written test procedure. The Seller shall furnish a written test procedure to the Company per the deliverable schedule for approval and revision. Company and/or Others will witness the entire FAT. The first FAT shall include complete testing and acceptance of all hardware provided by the Seller. The second FAT shall include complete testing and acceptance of all software.

Prior to staging the FAT, a full functional test of the programmed logic and graphics, and comprehensive test of the complete system shall be performed by the Seller. The purpose of this test is to ensure that reasonable measure has been taken to identify and correct programming errors before the FAT. Documented proof that the comprehensive system test has been completed shall be required prior to the start of the FAT. (100% I/O testing is required for the hardware test.)

The duration of the FAT will be in accordance with Appendix 2. Seller shall provide, at no additional cost, additional testing time. Seller shall include additional time for implementation of changes resulting from the FAT prior to shipment.

The Seller shall demonstrate that the DCS has capability to communicate with all defined foreign device interfaces (datalinks) at the FAT. (Such testing shall include simulation of protocols by Seller provided emulator(s) and/or Company provided field devices such as PLCs).

The seller shall furnish the following for the duration of the FAT:

- Complete system available for testing (all hardware and software)
- Sufficient number of trained personnel
- One complete set of "as built" functional logic diagrams with index for Company's use at the FAT
- One complete set of system reference manuals
- One complete set of Seller supplied drawings

- Any required testing equipment (may include: emulator(s) to test operation of input or output signals, multi-meters, signal generators, and emulator(s) to test datalink operation)

Testing procedure will typically include, but is not limited to:

- Demonstration of all modulating control loop action
- Demonstration of all operator interface function
- Demonstration of single point communication and power failure immunity
- Demonstration of spare capacity
- Demonstration of historical logging, reporting, and trending
- Demonstration of processor scan time and loading
- Operator keyboard functions
- On-line editing/tuning function
- Point forcing
- Display and printing routines
- Variable calculations
- Control logic testing
- Alarm output, management, and priority functions
- Demonstrate functionality of bumpless controller fail-over and power supply redundancy

Seller shall provide tie-back simulation logic to be used during the FAT. The simulation logic shall tie the control system outputs to their associated inputs in order to close the control loops and allow for control logic testing. Simulation logic shall be provided to Company at completion of software FAT.

It is expected that the Seller make minor adjustments and corrections that may be discovered during the FAT. If serious defects in design and performance are discovered, the FAT shall be discontinued and the test be repeated at Seller's expense after the necessary corrections are made.

The equipment shall not be shipped until a successful FAT has been completed as determined by the Company.

Upon completion of the test, and prior to shipping the system, Seller shall provide the Company with a complete "as shipped" system backup on suitable media.

All steam flow calculations and algorithm parameters shall be set according to site-specific process conditions prior to the FAT.

Completion and sign-off by Company of successful FAT does not relieve Seller of the requirements of this specification.

6. STARTUP, TESTING, AND COMMISSIONING

Site Pre-Energization Inspection:
At Company's request, Seller shall fully inspect power, grounding, network, etc. connections, prior to system energization at Site. Seller shall verify system is ready for energization.

Site Acceptance Test (SAT):
The DCS shall be completely tested at the job site after energization. All site testing shall be witnessed by representatives of the Engineer and/or Company. Seller shall provide a SAT procedure to be approved by Company. Schedule and scope of SAT shall be at Company's discretion. SAT will typically include (but is not limited to) demonstration of:

- All hardware
- All communication systems
- Alarms
- Graphics
- Reports
- Printing

Service Representatives:
Service representatives shall be technically competent, factory trained, experienced in the installation and operation of the equipment, and authorized by the Seller to perform the Work stipulated.

The duties of Seller's technical service representatives may include, but may not be limited to, the following:

a. Provide technical advice to assist the installation the equipment.
b. Inspect and complete all site acceptance testing documentation provided by Seller for the equipment after installation and directing any changes or adjustments required to assure proper operation.
c. Provide technical direction during startup and initial operation of the equipment.
d. Direct any warranty work.
e. Demonstrate to Company's personnel the operation and maintenance of the equipment.
f. Provide services required as a condition to providing the warranties and guarantees specified.
g. Make any required programming changes to the application software provided with the equipment.
h. Submit a service report to Company with information on whether or not the equipment is ready for operation.

i. Install patch and software updates during the commissioning phase.

All personnel who visit the Site are required to complete safety training before they are allowed to work. Seller shall provide a minimum of forty-eight (48) hours notice, in order for the Company to arrange for the safety training, before arriving at the Site.

Service personnel shall be at the Site at the times required to meet the overall construction schedule. The Seller will be notified as far in advance as possible when service personnel will be required. Service personnel shall not be removed from the Project without Company's approval.

Service personnel shall maintain a master set of as-builts of all drawings and data submitted. Prior to leaving the site, the service personnel shall submit a copy of all as-built drawings and data to the Company. The master set of as-builts shall be returned to the Seller for incorporation of comments and final submittal of all affected drawings and data to the Company.

Upon completion of installation and inspections, field service representatives shall submit a written report to the Company, including test data, daily reports and certification that the equipment is properly installed and ready for operation.

Service personnel supplied by the Seller shall follow Company's prescribed procedures on keeping records of service time and activities of service personnel while at the project Site. The following procedures shall be followed:

Upon arrival at the Site, the service representatives shall make their presence known to the Company and supply the Company with the following information:

- Name of representative(s)
- Company Name
- Company Purchase Order Number
- Local address and phone number
- Service to be performed

The service representative shall give the Company a written timesheet and daily report of the Work they performed each day. The representative must clear with the Company for any period spent away from the project for other than normal off-time and advise the Company how a representative can be reached in the event of an emergency.

7. PACKAGING, SHIPPING, AND STORAGE

Seller shall prepare equipment for shipment following successful completion of factory acceptance testing and resolution of QA/QC non-conformances (see Appendix 5 for additional details).

Shipping shall be FOB jobsite, freight prepaid and allowed.

Delivery address:
****
Insert project-specific shipping address for jobsite or electrical enclosure vendor's site.
****

Cabinets may be broken down into smaller sections to allow for ease of shipment and installation.

Seller shall prepare equipment to withstand any possible damage or loss due to rough handling during transit.

Lifting points shall be clearly marked on the shipped equipment and eye-bolts shall be installed as required to allow for field handling, skidding, and hoisting.

Ancillary materials that are "shipped loose" shall be separately boxed and secured to a pallet for shipping and handling.

Seller shall provide the following minimum unloading/handling information:

- Shipping weight and dimensions of each article
- Pick points
- Rigging requirements
- Sensitivities

A QA/QC inspection certification, signed by the Seller shall be issued to the company prior to shipment. A copy of this certificate shall be included with the Bill of Lading.

Shipping documentation shall include the following minimum information:

- Company destination (Plant, Unit)
- Company agreement number
- Sellers order number
- Date shipped
- Shipping origin
- Company equipment tag information
- Seller's equipment identification information
- Shipment tracking information

- Shipment description
- Shipment quantity
- Gross weight
- Special handling requirements
- Identification of spare equipment
- Barcode, RFID, or similar material control information

Seller shall coordinate all deliveries with Company prior to shipment. Coordination shall include resolution of QA/QC non-conformances, delivery schedule, unloading/handling requirements, and storage requirements.

MASTER SPECIFICTION
FOR

Emergency Power Supply System

Revision 1.0

REVISION HISTORY

Date	Revision	Change Description
3-4-2015	1.0	Enhancements; Required Format

EMERGENCY POWER SUPPLY SYSTEM

****

In addition to revising this spec to correspond to project-specific requirements, update all highlighted areas with project-specific data.

****

GENERAL

DESCRIPTION

****

Insert project-specific description items (i.e. new construction project, replacement project, project location, etc.).
****

SUMMARY

****

Insert project-specific scope of work summary items. Revise the following *example* as required
****

Seller shall design, test and deliver [quantity], [fuel type], [service duty rating] emergency power supply systems (EPSS). EPSS ratings shall be as specified in Appendix 2.

Seller shall be responsible for the following:

a. Design, testing and delivery of EPSS as specified herein.
c. Field assembly
e. Field testing
f. Operation and maintenance training for site personnel.

Company shall be responsible for the following:

a. Foundation(s)
b. Equipment unloading and setting
c. Single-point auxiliary power connection
d. Control connections
e. Grounding connections

Company personnel shall be able to access factory during EPSS assembly and to witness testing. Seller shall provide manufacturing schedule and schedule updates. Travel costs for Company personnel for site factory visits are the responsibility of the Company.

Reference Drawings

The following drawings, included in Appendix 4, contain additional scope requirements as part of this specification:

- General Arrangements
- One-Line Diagrams
- Three-Line Diagrams
- Control and Protection Schematic Diagrams
- Auxiliary equipment connection details.
- EPSS Load List:

Technical Proposal Documentation

See Appendix 2 for technical proposal requirements.

APPLICABLE CODES AND STANDARDS

- State and local codes, laws, ordinances, rules and regulations
- ANSI - American National Standards Institute
- ASTM - American Society for Testing and Materials
- ICEA - Insulated Cable Engineers Association
- IEEE - Institute of Electrical and Electronic Engineers
- NEMA - National Electrical Manufacturer's Association
- NFPA - National Fire Protection Association
- OSHA - Occupational, Health and Safety Administration
- UL Underwriter's Laboratories

In the event of conflict or disagreement between codes and standards, the more stringent conditions shall govern.

TECHNICAL REQUIREMENTS

ENVIRONMENTAL

EPSS shall be manufactured to withstand site environmental conditions. See Appendix 4 for site specific environmental conditions.

****

Coordinate fuel specifications, emission requirements, fuel storage, acoustic requirements, etc. with Xcel Environmental prior to finalizing spec. Insert additional requirements in this section and in Appendix 2 as required.

****

RATINGS

EPSS ratings shall be as specified in Appendix 2 Data Sheets.

DESIGN & CONSTRUCTION FEATURES

1. EPSS system shall be mounted on a common steel base and housed in an enclosure per Appendix 2.

2. EPSS shall be equipped with all auxiliary equipment required to locally and remotely operate the unit.

3. EPSS shall be provided with all electrical equipment, including transformers, required to operate EPSS low voltage equipment from Owner-provided single-point auxiliary power connection.

4. All EPSS motor starters, breakers and related electrical equipment shall be integral to the EPSS.

ENGINE

1. Engine shall be a low-emission, liquid-cooled engine in accordance with Appendix 2.

****
Coordinate fuel specifications, emission requirements, etc. with Xcel Environmental for additional engine-related specifications. Insert additional requirements in this section and in Appendix 2 as required.
****

VIBRATION ISOLATION

1. Engine and generator shall be mounted to the common steel base with vibration isolation mounts. Isolation mounts shall not amplify seismic forces.

ENCLOSURE

1. EPSS shall be fully enclosed in an integral weatherproof enclosure.
2. Enclosure shall provide access for routine maintenance and removable sections for major maintenance access.
3. Enclosure lighting shall be provided with switches at each access point.
4. See Appendix 2 for enclosure acoustical requirements.

5. Each phase conductor shall be installed in a weather-tight and dust-tight enclosure. The enclosure shall be electrically bonded to eliminate induced currents in the surrounding metallic structures.
6. Each bus and each electrical connection between bus enclosures shall provide a continuous path for currents equal to the maximum current ratings of the enclosed bus.
7. Contractor shall provide bus transition sections for connection of bus duct to the following equipment:

FIRE DETECTION

1. Fire/heat detection per NFPA shall be provided to detect fire inside the enclosure.
2. Fire detection system shall include a fire alarm control panel with remote alarm connections.
3. Fire alarming shall include an external fire alarm horn and strobe.
4. Fire detection shall not falsely activate during normal operation.

STARTING SYSTEM

1. An electric starting system shall be supplied with the following minimum equipment:
    a. Batteries
    b. Battery charger

c. Battery rack
d. Battery heating pads (if required)
e. Cell connectors
f. Auxiliary components required to start EPSS without external AC power available.

2. Starting system shall not require an external AC power supply for starting or operation.
3. Battery shall be sized to provide a minimum of five (5) starts with 30 seconds cranking for each start attempt.
4. Battery charger shall be sized to fully recharge the battery within 12 hours, minimum.
5. Battery charger shall have a charger trouble alarm, loss of power alarm and an automatic equalize timer for fast recharge.
6. DC motor-driven equipment shall be provided as required (e.g. startup fuel priming pump, etc.).

LOADING

1. EPSS shall be capable of accepting load up to its full rating with the largest load step equal to the largest emergency load plus 15%.

FUEL SUPPLY SYSTEM

1. A regulated-flow fuel system supply shall be furnished to maintain constant rated speed regardless of load variations.
2. The fuel system shall include the following minimum equipment:
a. Engine governor
b. Fuel metering equipment
c. Actuator
d. Strainer
e. Engine-driven fuel pump
f. Relief valving
g. Fuel filtration
h. Fuel cutoff valving
i. Fuel pressure instrumentation

FUEL TANK

1. An integral fuel tank shall be provided within the confines of the common steel base.
2. Tank shall be sized per NFPA requirements.
3. Tank shall have the capability to be connected to an external fuel tank.
4. All associated valves, piping and pumps shall be provided to interconnect the tank with the EPSS equipment.
5. Tank shall be equipped with a level gauge with low and high fuel level alarming.
6. Tank shall be double-walled with leak detection/alarming.
7. Fuel filling operations shall not affect the accuracy of fuel level indication system.
8. Tank shall be provided with the following minimum connections:
a. Full-size fuel fill
b. Full-size fuel return
c. Screened vent

d. Exterior fill
e. Drain
f. Two (2) level gauge connections

9. Above-ground storage tanks over 600 gallons which are used to store petroleum-based fluids shall be registered in the State of Colorado.

LUBRICATION SYSTEM

1. The EPSS lubrication system shall provide positive lubrication for all high-speed bearings and main gears. Pressure jets shall be provided for secondary gears. Remaining bearings and gears may be splash-lubricated.
2. Lubrication system shall include the following minimum equipment:
   a. Engine-driven oil pump
   b. System pressure regulator
   c. Engine block heater
   d. Lube oil heating
   e. Lube oil circulating pumping
   f. Full-flow filtration
   g. Heat exchanger
   h. Pressure and temperature monitoring
3. Lube oil heat exchanger shall be integral to the unit base and shall utilize engine coolant as the coolant medium.
4. DC motor-driven equipment shall be provided as required (e.g. startup fuel priming pump, etc.).
5. Provisions for removal of used engine and lube oil shall be provided.

AIR FILTRATION

1. Dry-type filters shall be provided for engine intake airflow.
2. Airflow monitoring shall be provided and shall include indication of filter restriction.
3. Air filtration shall have automatic louvers which open during equipment operation.

EXHAUST SYSTEM

1. The exhaust system shall include the following minimum equipment:
   a. Exhaust silencer
   b. Expansion joints
   c. Interconnecting duct work
   d. Exhaust piping
2. Exhaust system shall prevent ingress of moisture into the system.

GENERATOR

1. The generator shall be a synchronous unit rated for direct connection to the engine.
2. Generator shall include damper windings and shall conform to the applicable industry standards for synchronous, salient-pole machines.

3. The generator and exciter shall be provided with an open, drip-proof, fully-guarded, screened enclosure.
4. Generator shall have a rated capacity equal to, or greater than, the maximum engine overload capacity at the rated power factor load (see Appendix 2 for details).
5. Generator shall be able to operate at maximum capacity, continuously and at reduced loading during maximum enclosure ambient temperatures.
6. Generator shall be able to maintain voltage, current and frequency within the allowable tolerances for all connected loads.
7. Stator windings shall be form wound with vacuum pressure impregnation (VPI).
8. Field and stator winding shall be coated with fungus-resistant resin.
9. Generator total harmonic distortion (THD) shall be less than 5%.

GENERATOR INSULATION SYSTEM

1. The insulation system of field and stator shall be a minimum of Class F (155 ºC hot spot). Based on the maximum ambient conditions and a 10 ºC hot spot allowance, the temperature rise ratings (resistance method) shall not exceed the following:

SERVICDE DUTY	CLASS F INSULATION (155 ºC hot spot)	CLASS H INSULATION (180 ºC hot spot)
Standby	130 ºC	150 ºC
Prime	105 ºC	125 ºC
Continuous	80 ºC	105 ºC

GENERATOR EXCITATION SYSTEM

1. Generator/excitation system shall be capable of sustaining 300% of rated full-load current 10 seconds during fault current conditions.
2. Generator excitation system shall include an automatic voltage regulator (AVR) with three-phase sensing. AVR shall have over-excitation protection.
3. Generator voltage shall be able to be manually adjustable.

GENERATOR NEUTRAL GROUNDING

1. Generator shall be grounded via neutral grounding equipment (transformer, resistor, current transformers, etc.).

WIRING

1. EPSS internal wiring and raceway shall be factory installed and factory tested.
2. All internal wiring shall be installed in wiring gutters, conduit, or raceway.
3. All power supply circuits shall be protected via fuses or circuit breakers.
4. All control wiring shall be 600V, SIS, VW-1, XLPE, gray, switchboard wire.
5. Internal wiring shall have heat-shrink wire markers at both ends of conductors, labeled with wire termination information.
6. Minimum wire size shall be #10 AWG for current transformer circuits and #14 AWG for all other circuits.
7. Wiring shall be protected from contact with sharp edges with grommet material.
8. Flexible wire guards shall be installed for wiring which cross hinge points.

9. Terminal blocks shall be provided with a minimum of 20% spare terminals.
10. When compatible with Manufacturer's standard supply, all circuits shall be terminated with ring-type connectors.
11. All spare contacts shall be wired to terminal blocks.
12. Current transformer circuits shall be wired to shorting terminal blocks.

UNIT JUNCTION BOXES

1. EPSS units shall have the following separate unit junction boxes:
    a. Generator output terminals
    b. Auxiliary AC power
    c. Auxiliary DC power
    d. Instrumentation and control

PRIMARY CONNECTIONS

1. Generator terminal compartment shall be sized to accommodate primary connection stress cones as applicable.
2. Primary conductor vertical supports shall be provided at a minimum of 18 inch intervals.
3. Generator terminal compartment shall be sized to accept the size and number of conductors required to connect EPSS to Owner's system.

UNIT CONTROL AND PROTECTION

1. Integral unit control and protection panels shall be provided as part of the EPSS.
2. Panels shall be NEMA 12 with hinged fronts.
3. Unit control and protection panels shall be accessible from the exterior of the EPSS enclosure with weatherproof, transparent door sections which allow visual inspection of relays, alarms, etc.
4. Unit control and protection panels shall have anti-condensation heaters, as required.
5. A weatherproof emergency shutdown (ESD) mushroom switch shall be provided on the exterior of the EPSS enclosure in proximity to the personnel door. ESD shall have protective cover to prevent inadvertent operation.
6. See Appendix 2 and Appendix 4 for required EPSS protective relay requirements.

CURRENT TRANSFORMERS

1. Current transformers (CT) shall be provided per Appendix 2 for protective, monitoring and control functions.

VOLTAGE TRANSFORMERS

1. Voltage transformers (VT) shall be provided per Appendix 2 for protective, monitoring and control functions.
2. VTs shall be provided with current-limiting primary fuses

TEST SWITCHES

1. Test switches shall be installed for all protective relaying, metering, current and voltage inputs and relay outputs.
2. Test switches shall be ABB FT-1.
3. Current Transformer test switches shall be shorting type.
4. Test switches shall have black handles for current and voltage poles, red handles for trip poles.

GROUNDING

1. A continuous 2 inch-by ¼ inch (minimum) bare copper ground bus shall be provided for the entire length of the protection and control panels.
2. All associated equipment shall be connected to this ground bus.
3. A NEMA 2-hole, threaded bronze grounding pad shall be provided as part of the generator frame, adjacent to the main lead terminal housing.
4. Exterior NEMA 2-hole, threaded bronze grounding pads shall be provided on each end of the EPSS common frame.

POWER SUPPLIES

5. EPSS protection and metering equipment shall be fed via 125 VDC power supply.
6. EPSS auxiliary equipment shall be fed via Owner's single auxiliary AC power feed (see Appendix 2 for voltage/phase requirements).
7. Seller shall provide all auxiliary transformers, distribution panelboards, motor starters, contactors, circuitry, etc. to power all auxiliary EPSS loads.

BLACK START

1. EPSS shall be capable of starting, loading to full load and operating continuously without auxiliary power available.
2. All lube oil pumps, fuel pumps, and other motors required for black starting, shall be powered by the EPSS DC starting system.

EPSS CONTROL

1. EPSS shall include a governor and load controller capable of both automatic droop control and automatic isochronous frequency control.
2. Load control mode shall be locally and remotely selectable.
3. EPSS shall include automatic synchronization equipment to automatically raise/lower load and raise/lower voltage to permit synchronization with a live bus.
4. Following synchronization, the load controller shall ramp to a programmable, preset load setpoint.
5. EPSS shall also be capable of connecting to a dead bus in isochronous mode.
6. All equipment, software, software licenses, settings, temporary cabling, etc. shall be provided for setting and programming EPSS control systems.

EPSS CONTROL FEATURES

1. EPSS control system shall include the following minimum features:

a. Isochronous and Droop Control
b. Programmable preset default-loading setpoint – used when initially connecting the EPSS in droop control. When operating in isochronous control the load control setpoint shall automatically follow the isochronous operating load to allow for bumpless transfer when switching to droop control.
c. Automatic generator loading/unloading for bumpless load transfer.
d. Automatic synchronizing system which can be remotely or manually initiated. Automatic synchronizing system shall be able to select and synchronize the EPSS across its generator breaker or switchgear breaker. Automatic synchronizing system shall have capability for dead bus closing of the generator breaker.
e. Dead bus closing and live bus synchronizing.
f. Engine speed control.
g. EPSS black starting without auxiliary AC power.
h. Automatic and manual voltage control.
i. Automatic system to synchronize with utility following restoration of normal power.
j. Local and remote control interfaces

2. **Remote Control Functions** – EPSS control system shall accept the following remote control signals:

   a. <u>START</u> – EPSS shall perform the following upon closure of dry contact START command:
      i. EPSS shall start.
      ii. Live bus condition: EPSS shall synchronize to a live bus and ramp up in load to the preset loading value.
      iii. Dead bus condition: EPSS shall close its generator breaker and energize a dead bus.
   b. <u>STOP</u> – EPSS shall perform the following upon closure of dry contact STOP command:
      i. Droop control condition: EPSS shall unload, disconnect from the bus and perform normal shutdown.
      ii. Isochronous control condition: EPSS shall open its generator breaker and perform a normal shutdown
   c. <u>RESTORE</u> - EPSS shall perform the following upon closure of dry contact RESTORE command:
      i. Automatically synchronize across the bus main breaker and close that breaker when synchronized.
      ii. EPSS shall unload, disconnect from the bus and perform normal shutdown.
   d. <u>ISOCHRONOUS MODE</u> – EPSS shall operate in isochronous control upon closure of dry contact Isochronous Mode select command. EPSS shall operate in droop control when this contact is open.
   e. <u>RAISE LOAD</u> - EPSS shall perform the following upon closure of dry contact RAISE LOAD command:
      i. Droop control condition: EPSS shall increase load. Step change shall be programmable.
      ii. Isochronous control condition: EPSS shall increase speed. Step change shall be programmable.

f. LOWER LOAD - EPSS shall perform the following upon closure of dry contact RAISE LOAD command:
    i. Droop control condition: EPSS shall decrease load. Step change shall be programmable.
    ii. Isochronous control condition: EPSS shall decrease speed. Step change shall be programmable.
g. RAISE VOLTAGE - EPSS shall increase generator terminal voltage upon closure of dry contact RAISE LOAD command. Step change shall be programmable.
h. LOWER VOLTAGE - EPSS shall decrease generator terminal voltage upon closure of dry contact RAISE LOAD command. Step change shall be programmable.
i. PERMIT TO START – EPSS shall require a dry contact closure command to allow EPSS starting.
j. OPEN GENERATOR BREAKER – EPSS shall open its generator breaker.

3. **Remote Status/Alarms** – The following minimum EPSS remote status points shall be provided for connection to Owner's DCS system:

    a. READY FOR REMOTE START – A dry contact shall be provided which is closed when EPSS is ready to be started. Permissive logic for this contact closure shall include the Local/Remote switch is in "Remote" position.
    b. RUNNING – A closed dry contact shall be provided when EPSS is running.
    c. STOPPED – A dry closed contact shall be provided when EPSS is not running.
    d. EPSS TROUBLE – An open dry contact shall be provided when the EPSS detects trouble/errors with any EPSS equipment or system.
    e. PROTECTION TRIPPED – An open dry contact from the generator protective relaying shall be provided when the relaying trips.
    f. PROTECTION TROUBLE – An open dry contact from the generator protective relaying shall be provided for relay trouble outputs.
    g. GENERATOR BREAKER STATUS – Breaker position contacts shall be provided to verify breaker Open/Closed status.
    h. GEN BREAKRE PROTECTION TRIPPED – An open dry contact from the generator breaker protective relaying shall be provided when the relaying trips.

ALARMS

1. In addition to alarms and status indications required elsewhere in this specification, EPSS shall include the following minimum local alarms. All required remote status/alarms shall also be provided locally:

    a. Loss of AC power
    b. Loss of DC power
    c. Low battery voltage
    d. Battery charger trouble
    e. Governor trouble

f. Generator trouble
g. Excitation trouble
h. Low fuel level
i. High fuel level

STATUS/INDICATION

1. In addition to status indications required elsewhere in this specification, EPSS shall include the following minimum local status/indications. All required remote status/indication shall also be provided locally:

    a. Generator breaker position
    b. EPSS running status
    c. EPSS ready to load status
    d. Battery voltage
    e. Exhaust temperature
    f. Oil temperature
    g. Oil pressure
    h. Coolant temperature
    i. Hours of operation

HEATERS

1. EPSS shall be furnished with heaters to maintain the interior of the enclosure and it components above dew point for all ambient conditions. See Appendix 4 for site conditions.
2. Engine heater and control system shall be provided.
3. Heater rated voltage shall be a minimum of 1.5 times the applied voltage.
4. Heaters shall be supplied with all internal wiring, branch circuit protection and raceway.
5. Enclosure heater control shall be via multiple thermostats.
6. Enclosure heaters shall be interlocked such that heaters are de-energized while the unit is operating.

NAMEPLATES

1. Engraved nameplates shall be furnished on the outside of EPSS.
2. EPSS nameplates shall be stainless steel.
3. Nameplates shall indicate the following minimum information:
    a. Manufacturer's standard information
    b. Equipment description/name
    c. Equipment tag number
    d. EPSS equipment ratings
4. Engraved nameplates shall also be furnished for auxiliary devices and terminal blocks mounted inside EPSS enclosure, panels and compartments.
5. Nameplates shall be mounted using stainless steel, pan-head, self-tapping screws.

CATCHBASINS AND DRAINS

1. EPSS shall be provided with a single, valved, gravity-drain exit point.

TESTING

Testing requirements are defined in Appendix 6.

DELIVERABLES

Deliverable requirements are defined in Appendix 1.

PROPOSAL DATA REQUIREMENTS

Seller shall provide proposed equipment data in accordance with Appendix 2.

SITE CONDITIONS

Site conditions are defined in Appendix 4.

QUALITY ASSURANCE

QA/QC requirements are defined in Appendix 5.

PACKAGING STORAGE & SHIPPING

Packing, shipping storage requirements are defined in Appendix 7.

MATERIALS & WELDING

Additional materials and welding requirements are defined in Appendix 5.

PERFORMANCE GUARANTEES

Performance requirements are defined in Appendix 3

SOUND CONTROL REQUIREMENTS

EPSS equipment and enclosures shall be designed in accordance with the maximum allowable noise level requirements herein and in Appendix 2.

CLEANING, PAINTING & COATING

****

Fill in as required

****

SPARE PARTS

****

Fill in as required

****

APPENDICES TO SPECIFICATION

****

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.

****

1. DELIVERABLES
2. PROPOSAL DATA REQUIREMENTS
3. PERFORMANCE GUARANTEES
4. SITE CONDITIONS AND REFERENCE MATERIALS
5. QA/QC (Including Inspection Test Plans)
6. STARTUP, TESTING, AND COMMISSIONING
7. PACKAGING, SHIPPING, AND STORAGE
8. ACCEPTABLE MANUFACTURERS

APPENDIX 1

DELIVERABLES

****

The following is a list of minimum suggested deliverables and deliverable information. Revise per project requirements as required:

****

Manufacturer drawings:

1. Shipping layout drawings
2. Installation instructions/details including rigging information and equipment loadings
3. Dimensioned plan, elevation and detail drawings including engine details, generator details, auxiliary system details, weights, grounding details.
4. Bills of Material
5. Owner connection details
6. Nameplate schedule and details
7. EPSS one-line drawings
8. EPSS three-line drawings
9. Control and relaying/protective device schematics and wiring diagrams
10. Control panel layout drawings
11. Current transformer excitation curves
12. Panelboard schedules

Test data:

1. Factory test data/test report. See Appendix 6 for details.
2. Field test data/test report. See Appendix 6 for details.

Operation and Maintenance Manuals:

1. Operation and maintenance (O&M) manuals shall include the following minimum information:
    a. Installation instructions.
    b. Operating instructions.
    c. Maintenance instructions.
    d. Nameplate data.
    e. Assembly drawings.
    f. Bill of Material with vendor part numbers.
    g. Recommended spare parts list.
    h. Certified (final) test reports
    i. Storage and Handling instructions.
    j. Special tools required for installation, operation and/or maintenance.
    k. Warranty Information

Other:

1. EPSS control software, software licenses and control settings.

APPENDIX 1

DELIVERABLES

2. EPSS protective device software, software licenses and control settings.
3. EPSS protective device settings in native formats.

QA/QC:

Seller's QA/QC Inspection and Test Plan (ITP)

****
Include project-specific requirements for the following:
****

- Seller Deliverable Schedule
- Deliverable Format
- Deliverable Quantities

APPENDIX 2

PROPOSAL DATA REQUIREMENTS

EMERGENCY POWER SUPPLY SYSTEM (EPSS) DATA SHEET

Seller shall provide the following minimum technical data applicable to the equipment in the proposed scope of supply.

****
In addition to revising this spec to correspond to project-specific requirements, update all highlighted areas with project-specific data.
****

EMERGENCY POWER SUPPLY SYSTEM (EPSS)	UNITS	REQUIREMENTS	SELLER RESPONSE
Manufacturer		Seller	
City & Country of Manufacture		Seller	
Service Duty		Standby	
Service Duty Load Factor	%	60	
GENERATOR:			
Real Power	kW	2250	
Apparent Power	kVA	2812	
Power Factor		0.8	
Synchronous Speed	RPM	1800	
Rated Nominal Voltage	kV	0.48	
Voltage Phases		3	
Phase Rotation		A, B, C	
Operating Frequency	Hz	60	
Insulation System		Seller	
Temperature rise	°C	125	
Generator Enclosure		Seller	
Exciter type		Seller	
Voltage Regulation, no-load to full-load	%	+/-0.5%	
Frequency Regulation	%	+/-0.25%	
Total Harmonic Distortion	%	Less than 5%	

Generator cooling		Seller	
ENGINE:			
Configuration (block material, aspiration method, number of cylinders, etc.)		Seller	
Bore		Seller	
Stroke		Seller	
Displacement		Seller	
Battery capacity		Seller	
Starting voltage		Seller	
Air filter type		Seller	
Fuel filter		Seller	
Lube oil filter types		Seller	
Cooling system		Seller	
Emissions Compliance		EPA Tier II	
Fuel requirements:			
Max sulfur content		15 ppm	
Min Cetane index		40	
Max aromatic compound content	%	35	
Acoustical Requirements	dB	85	
Auxiliary Power Voltage/Phase		480V/3	
Protection and Control Voltage	VDC	125	
FINISH			
Color			

****

Coordinate fuel specifications, emission requirements, fuel storage, acoustic requirements, etc. with Xcel Environmental prior to finalizing spec. Insert additional requirements in this section and spec body

****

APPENDIX 2

PROPOSAL DATA REQUIREMENTS

****

The following additional information shall also be included with proposals:

1. Seller variances or exceptions to the specification.
2. Itemization of proposed estimated materials.

****

APPENDIX 3

PERFORMANCE GUARANTEES

****

Typically, emissions guarantees are required for EPSS systems. Coordinate emission guarantee requirements with Xcel Environmental prior to finalizing spec.

Add any additional project-specific performance guarantees (e.g. generator electrical performance, fuel consumption, etc.) in this Appendix and spec body.

****

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

****

In addition to revising this spec to correspond to project-specific requirements, update all Appendix highlighted areas with project-specific data.

****

SITE CONDITIONS

LOCATION

Xcel Energy's Cherokee Station site is located in Adams County, CO at 6198 Franklin St. Denver, CO 80216.

METEOROLOGICAL DATA

Table 1 below lists the major site conditions which are based on ambient weather conditions taken from several data references. The following abbreviations apply to this table:

DBT:	Dry Bulb Temperature
MCWB:	Mean coincident wet bulb for a given dry bulb temperature
AMSL:	Above Mean Sea Level

APPENDIX 4

TABLE 1 – MAJOR SITE CONDITIONS

PARAMETER	DATA
Site Elevation	5131 feet AMSL
Site Ambient Conditions	
Record low dry bulb temperature: MCWB for record low DBT:	-29°F -29°F
99% winter design dry bulb temperature: MCWB for 99% winter design DBT:	-5°F -8°F
Average winter dry bulb temperature: MCWB for average winter DBT:	-35°F -29°F
Annual average dry bulb temperature: MCWB for annual average DBT:	50°F 39°F
Summer 1% dry bulb temperature: MCWB for summer design 1% DBT: (Comparable to ASHRAE cooling, 0.4% occurance)	95°F 70°F
Record high dry bulb temperature: MCWB for record high DBT:	105°F 72°F
Dry bulb temperature for ISO System Accrediation: MCWB for ISO System Accrediation DBT:	95°F 70°F
Relative Humidity Range	0% to 100%
Annual Average Percipitation	18 inches
Maximum 24 Hour Rainfall Total	3 inches
Annual Average Snowfall	60 inches
Maximum 24 Hour Snowfall Total	48 inches

APPENDIX 4

WIND LOADING

Wind loads shall be in accordance with the IBC. Basic wind design parameters are as follows:

DESCRIPTION	CHEROKEE	NOTES
Classification of Structure Category	III	Ref. ASCE 7-05, Section 1.5
Exposure	C	Ref. ASCE 7-05, Section 6.56
Wind Importance Factor	1.15	
Reference Wind Velocity, V	90 mph	3 sec. gust @ 33 ft. above ground. Ref. ASCE 7-05

SEISMIC CRITERIA

Structures shall be designed using the seismic criteria in the IBC as applicable to Colorado. Basic seismic parameters, per the IBC, are as follows:

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration at a short period (0.2 seconds), S_s = 0.217g.

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration a 1 second period), S_s = 0.056g.

Seismic Importance Factor, I_E = 1.25.

Based on the information presented in the Geotechnical Report, the project site has been assigned to Site Class D, to be verified by a site-specific geotechnical report.

APPENDIX 4

REFERENCE MATERIALS

The following drawings contain additional scope requirements as part of this specification:

- General Arrangements
- One-Line Diagrams
- Three-Line Diagrams
- Control and Protection Schematic Diagrams
- Auxiliary equipment connection details.
- EPSS Load List

****

For each essential load to be connected to the EPSS add the following minimum information to the EPSS load list:

****

- Load type (motor, static)
- HP
- Service Factor
- Static kVA
- Demand Factor
- kW
- kVA
- kVAR
- Full-load Current
- Locked Rotor Current

APPENDIX 5

QA/QC (Including Inspection Test Plans)

****
Revise this Appendix accordingly per project-specific requirements.
****

QA/QC

INSPECTION AND TEST PLANS

Seller shall submit their standard Inspection and Test Plan (ITP) for approval in accordance with Appendix 1 requirements.

QA/QC INSPECTIONS/REPORTING

****
Determine frequency of Xcel inspections of Seller's facilities during fabrication, prior to delivery, etc. and add requirements to this section as required. Review Xcel Intranet QA/QC Toolbox for various tools and templates for the following, as project requirements dictate:

- Shop inspection reports
- Non-conformance reports
- Release for shipment, etc.

Add these documents to this Appendix as required.
****

WELDING

****
Discuss welding requirements with Xcel Quality during the spec development process and insert their most current requirements in this section.
****

APPENDIX 6

STARTUP, TESTING AND COMMISSIONING

****
The following are minimum suggested testing requirements. Revise per project requirements as required:
****

TESTING

Factory Testing:

1. Perform standard factory tests per Industry Standards referenced herein.
2. EPSS engine and generator shall completely factory assembled and tested to prove correct assembly and to verify ratings prior to shipment. The following minimum testing criteria apply:
   a. EPSS shall be operated at full-load for a minimum of 30 minutes.
   b. Vibration values shall be tested throughout the full-load test.
   c. Emission levels shall be tested throughout the full-load test.
   d. Noise levels shall be tested throughout the full-load test.
   e. Fuel consumption shall be tested throughout the full-load test.
   f. Control system operation modes, described herein, shall be tested.
   g. Point-to-point wiring verification shall be performed.
3. Submit test data/test reports in accordance with Appendix 1.

Shop Tests:

1. Perform standard shop tests in accordance with Industry Standards referenced herein.

****
Revise the following section per project-specific requirements. Minimum commissioning considerations are as follows:

****

COMMISSIONING

The following field commissioning services shall be provided by the Seller:

1. Furnishing of all required EPSS fluids including fuel, lube oil, coolant. EPSS fluids shall be filled after testing and shall be full as a pre-requisite for final acceptance.
2. Verification of all fluid levels.
3. Verification of proper EPSS installation.
4. Verification of all EPSS auxiliary system operation.
5. Test all alarms, safety shutdown devices for proper operation.

APPENDIX

STARTUP, TESTING AND COMMISSIONING

6. Verification of proper orientation and alignment of all EPSS components.
7. Verification absence of exhaust leaks, oil leaks, coolant leaks and excessive vibrations.
8. Performance of a 4-hour load test at full nameplate ratings using Owner's plant load. Record the following minimum values at 15 minute intervals:
   a. Service meter hours
   b. Voltage per phase
   c. Current per phase
   d. Frequency
   e. Power Factor
   f. VARS
   g. Engine coolant temperature
   h. Oil Pressure
   i. Fuel Pressure
   j. Ambient temperature
9. Protective relay testing
10. Full operational mode testing for each EPSS operation mode described herein.
11. EPSS electrical field testing per NETA guidelines.
12. Operation and maintenance training for Owner personnel.

APPENDIX 7

PACKAGING, SHIPPING AND STORAGE

PACKAGING, SHIPPING AND STORAGE

Seller shall prepare equipment for shipment following successful completion of factory testing and resolution of QA/QC non-conformances (see Appendix 5 for additional details.

Seller shall prepare equipment to withstand any possible damage or loss due to rough handling or exposure to weather during transit or extended outdoor storage (up to two (2) years).

Seller shall install all required covers to protect equipment from rain, hail, wind, dust, snow and environmental conditions detrimental to the equipment.

Equipment shall be adequately sealed and protected during shipment to prevent corrosion, foreign matter egress and freeze damage which could result from the presence of residual water.

Lifting points and centers of gravity shall be clearly marked on the shipped equipment.

Shipping structural bracing shall be installed as required to allow for field handling, skidding and hoisting.

Equipment supplied with space heaters shall have heater leads accessible without requiring disassembly of shipping containers.

Threaded outlets shall have plugs or caps installed prior to shipping.

Ancillary materials which are “shipped loose” shall be in separately boxed and re secured to the main equipment containers.

Seller shall provide the following minimum unloading/handling information:

- Shipping weight and dimensions of each article
- Pick points
- Rigging requirements
- Weight distribution
- Center of gravity
- Sensitivities
- Hazards

A QA/QC inspection certification, signed by the Seller shall be issued to the company prior to shipment. A copy of this certificate shall be included with the Bill of Lading.

APPENDIX 7

PACKAGING, SHIPPING AND STORAGE

Shipping documentation shall include the following minimum information:

- Company Destination (Plant, Unit)
- Company Agreement number
- Sellers order number
- Date shipped
- Shipping origin
- Company equipment tag information
- Seller's equipment identification information
- Shipment tracking information
- Shipment description
- Shipment quantity
- Gross weight
- Special handling requirements
- Identification of spare equipment
- Barcode, RFID, or similar material control information

Seller shall coordinate all deliveries with Company prior to shipment. Coordination shall include resolution of QA/QC non-conformances, delivery schedule, unloading/handling requirements, and storage requirements.

APPENDIX 8

ACCEPTABLE MANUFACTURERS

****
The following list contains the typically preferred manufacturers. Coordinate with Xcel Sourcing to determine final bid list:
****

Acceptable manufacturers are as follows:

- Caterpillar
- Cummins
- Detroit Diesel

MASTER SPECIFICTION
FOR

Isolated Phase Bus Duct

Revision 1.0

REVISION HISTORY

Date	Revision	Change Description
12-5-2014	1.0	New

GENERAL

DESCRIPTION

****
Insert project-specific description items (i.e. new construction project, replacement project, project location, etc.). Revise the following *example* as required:
****

The isolated phase bus duct shall be designed and constructed for use on an 18 kV, 3-phase, 60-hertz system.

One complete sectionalized assembly of a three phase, weatherproof, self-cooled, zero-flux design bus duct shall be required for connection from the generator main terminals to the generator step-up (GSU) transformer. Bus run taps shall be furnished for connection to the generator potential / surge equipment cubicle and generator excitation transformer for each turbine-generator package.

Bus duct provided under these Specifications shall include all fittings, bus-to-equipment terminations, supports, flexible connectors, accessories, connection hardware and any special tools required for a complete installation.

SUMMARY

Reference Drawings

The following drawings, included in Appendix 4, contain additional scope requirements as part of this specification:

- General Arrangements
- One-Line Diagrams
- Bus Duct Layouts
- Transformer Connection Details
- Generator Connection Details
- Auxiliary equipment connection details.

Technical Proposal Documentation

See Appendix 2 for technical proposal requirements.

APPLICABLE CODES AND STANDARDS

- State and local codes, laws, ordinances, rules and regulations
- ANSI - American National Standards Institute

- ASTM - American Society for Testing and Materials
- ICEA - Insulated Cable Engineers Association
- IEEE - Institute of Electrical and Electronic Engineers
- NEMA - National Electrical Manufacturer's Association
- NFPA - National Fire Protection Association
- OSHA - Occupational, Health and Safety Administration
- UL Underwriter's Laboratories

In the event of conflict or disagreement between codes and standards, the more stringent conditions shall govern.

TECHNICAL REQUIREMENTS

DESIGN & CONSTRUCTION FEATURES

1. **Environmental**

   Isolated phase bus duct shall be manufactured to withstand site environmental conditions. See Appendix 4 for site specific environmental conditions.

2. **Ratings**

   Isolated phase bus duct ratings shall be as specified in Appendix 2 Data Sheets.

BUS CONSTRUCTION

1. Bus duct construction shall be high conductivity circular aluminum with welded joints and shall be in accordance with IEEE C37.23.

2. All bus conductor terminations shall have bolted connections. All bolted joints shall have silver-to-silver contact surfaces. Bolts shall be stainless steel.

3. Bus conductors shall be installed with wet-process porcelain insulating supports capable of withstanding the mechanical forces (compression, tension, and cantilever) imposed by short-circuit currents, and all other loading requirements.

4. The bus hot-spot and temperature rise ratings shall be greater than or equal to the worst-case hot-spot and temperature rise ratings of the equipment bushings connected to the bus.

5. Bus insulators shall be designed to allow bus thermal expansion.

6. Bus insulators shall be provided with externally removable, bolted access panels to allow maintenance/replacement of insulators without requiring bus disassembly.

7. See Appendix 5 for bus welding requirements.

ENCLOSURE CONSTRUCTION

****
This spec section is for a typical self-cooled bus duct system. Add project-specific forced-cooling requirements as applicable.
****

1. Bus duct enclosures shall be fabricated from high conductivity aluminum sheets formed into a circular shape with fully welded longitudinal seams.
2. Bus duct enclosures shall be zero-flux, continuous, and weatherproof for an indoor/outdoor installation.
3. Hardware for all fasteners used on the exterior portions of the duct shall be stainless steel.
4. Each phase conductor shall be installed in a weather-tight and dust-tight enclosure. The enclosure shall be electrically bonded to eliminate induced currents in the surrounding metallic structures.
5. Each bus and each electrical connection between bus enclosures shall provide a continuous path for currents equal to the maximum current ratings of the enclosed bus.
6. Contractor shall provide bus transition sections for connection of bus duct to the following equipment:

   ****
   Insert project-specific requirements for bus transition sections (new equipment, connection to existing transitions, etc.). Examples of bus connected equipment are as follows:
   ****

   a. Generator main terminals
   b. VT/surge cubicle terminals
   c. GSU transformer terminals
   d. UAT terminals
   e. Excitation transformer terminals
   f. Generator breaker terminals
   g. Interior-to-exterior transitions

7. Bus transition sections shall have externally removable, gasketed access panels which allow removal and connection of flexible bus connectors. Minimum access panel openings shall be two (2) feet by two (2) feet.
8. Bus shall be designed to permit removal of equipment bushings with a minimum of bus disassembly and without cutting/re-welding any part of the bus assembly.
9. Expansion joints shall be provided at all bus transition sections and at all fire stop isolation barriers to prevent mechanical stresses due to bus thermal expansion and equipment vibration.
10. Vapor isolation barriers or seal-off bushings shall be furnished at each equipment termination location, where required to provide an airtight seal.
11. Filtered drain plugs shall be provided for bus duct enclosure low points.
12. Bus duct enclosures and transition sections shall be primed and finish painted in accordance with the manufacturers' standard.
13. Bus enclosure shorting plates shall be provided at all equipment transition sections.
14. Outdoor bus shall be constructed to allow for the effects of solar radiation heat

gain without the use of separate heat shields.

15. Sealing, 2-hour fire-stop isolation barriers shall be provided at the generator, building walls and at transformer containment walls.

16. See Appendix 5 for enclosure welding requirements

CONDENSATION CONTROL

1. Condensation control shall be via space heaters or pressurized air as specified in Appendix 2.

****

Choose either Space Heater of Pressurized Air section below depending on project requirements.

****

2. **Space Heaters**
    a. Anit-condensation space heaters shall be located and thermally insulated to prevent surface damage or discoloration. Space heater capacity shall maintain the compartment and the bus duct internal temperature above the dew point temperature under all operating conditions.
    b. Bus duct heater monitoring shall be provided at ground-level control panels. Heater control panels shall provide the following minimum equipment:
        i. Local indication of the status of bus duct heater operation
        ii. Local indication of heater faults.
        iii. One (1) Form C, common alarm relay for remote panel monitoring via Owner DCS.
    c. Heaters shall be rated for 240 VAC and energized and sized for application at 120 VAC. Space heaters shall be controlled by an adjustable thermostat, factory set at the Manufacturer's recommended set points. Space heaters shall be completely factory wired except for shipping split connections.

3. **Positive Air System**
    a. A tap connection in each phase bus run shall be provided for connection to plant dry instrument air. The positive pressure air provisions are intended to pressurize the bus enclosure to prevent dust or moisture entering the bus enclosure.
    b. One connection point for air supply and metering and one connection point for pressure monitoring shall be furnished in each phase bus enclosure. Connection points shall be 1/2 inch NPT; shipped with plugs. All air supply and metering connection points shall be at the top of enclosure.
    c. Pressure regulating stations, including orifices, valves, and filters shall be provided to regulate the compressed air within pressure limits of the bus enclosures. Each phase bus enclosure run shall be equipped with a pressure relief valve to prevent bus damage in case of regulator device failure, exposing the duct to high supply pressure.
    d. Pressure regulating stations shall also include the following minimum equipment:
        i. Airflow monitoring instrumentation

ii. Air pressure instrumentation
iii. Form C relay outputs for high pressure, low pressure and system fault. Relay outputs shall be used for remote DCS monitoring.

e. Manual valves shall be furnished with the pressure regulator system to allow manual purging of each phase bus enclosure.
f. Seal-off assemblies shall be furnished to prevent air leakage from the bus enclosure to all transition sections.

EQUIPMENT TERMINATIONS

1. Flexible connectors and bus duct termination enclosures/fittings shall be provided for bus-to-equipment terminations.
2. Flexible connectors, with non-magnetic bolts, shall be provided at all electrical equipment terminals and allow a minimum of 1-inch movement of any phase lead in any direction.
3. Removable, flexible, braided connectors shall be supplied to provide electrical insulation between bus duct and equipment, to isolate equipment vibration and to facilitate equipment testing and removal. Flexible connectors shall have a continuous current rating equal or greater than bus conductors.
4. The flexible connectors shall also serve as a disconnect means from the termination equipment and the bus conductors. Equipment shall be electrically isolated when the flexible connectors are removed.
5. Braided expansion links shall be installed at building penetrations on both the interior and exterior boundaries.

GROUNDING

1. A ground bus shall be furnished in parallel with each bus run to ensure all enclosures are grounded. Each ground bus shall be capable of carrying the rated bus short-circuit current.
2. The bus duct enclosure may serve as the ground bus provided it is constructed and connected such that it provides a continuous path for the maximum calculated short-circuit current.
3. Ground pads with standard NEMA 2-hole or 4-hole spacing shall be provided for all bus ground connections.
4. All bolted clamping cover assemblies shall be provided with ground straps as applicable.

INFRARED INSPECTION PANES

1. Infrared (IR) inspection viewing panes shall be installed to permit thermography inspection of all bus duct equipment connections, transitions and expansion joints. IR inspection viewing panes shall be oriented to allow viewing from ground level.
2. IR inspection viewing pane NEMA rating shall be equal to, or greater than, that of the enclosure in which it is being installed.
3. IR inspection viewing panes shall be NFPA 70E compliant.
4. IR inspection viewing panes shall be 3” minimum diameter and shall consist of reinforced polymeric optic material.

BUS DUCT SUPPORTS

1. Bus duct supports shall be rigid, self-supporting, galvanized steel beams. Supports shall be designed to withstand environmental loads (wind, snow, seismic, etc.), listed in Appendix 4, while bus duct is operating at design conditions and under fault conditions.
2. The vertical loadings imposed at the equipment connections shall not exceed the manufacturer's maximum loading.
3. A support structure with four (4) columns shall be furnished for all 90-degree horizontal bends of the three-phase bus duct. 2-column support structures shall be furnished for straight sections of the three-phase bus duct runs.
4. Supports shall be finished per the following requirements:
    a. Support structures shall be galvanized steel by the hot dip process in accordance with ASTM A123. Structures shall be galvanized both inside and out after all cutting; punching, welding and cleaning have been completed.
    b. Finished galvanized surfaces shall be uniform in color, appearance and texture and shall be free of roughness, lumps and runs.
    c. Support locations shall be in accordance with NEC working clearance requirements and shall be at least 3 feet from mechanical equipment to allow maintenance access.
    d. Support locations shall be reviewed with Company to ensure unobstructed clearance for doorways, forklift access, roadway access, personnel egress and headroom prior to final design and installation.

TESTING

Testing requirements are defined in Appendix 6.

DELIVERABLES

Deliverable requirements are defined in Appendix 1.

PROPOSAL DATA REQUIREMENTS

Seller shall provide proposed equipment data in accordance with Appendix 2.

SITE CONDITIONS

Site conditions are defined in Appendix 4.

QUALITY ASSURANCE

QA/QC requirements are defined in Appendix 5.

PACKAGING STORAGE & SHIPPING

Packing, shipping storage requirements are defined in Appendix 7.

MATERIALS & WELDING

Additional materials and welding requirements are defined in Appendix 5.

PERFORMANCE GUARANTEES

****
Fill in Appendix 3 as required
****

SOUND CONTROL REQUIREMENTS

****
Fill in as required
****

INSTRUMENTATION & CONTROL REQUIREMENTS

****
Fill in as required
****

CLEANING, PAINTING & COATING

****
Fill in as required
****

SPARE PARTS

****
Fill in as required
****

APPENDICES TO SPECIFICATION

****

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.

****

1. DELIVERABLES
2. PROPOSAL DATA REQUIREMENTS
3. PERFORMANCE GUARANTEES
4. SITE CONDITIONS AND REFERENCE MATERIALS
5. QA/QC (Including Inspection Test Plans)
6. STARTUP, TESTING, AND COMMISSIONING
7. PACKAGING, SHIPPING, AND STORAGE
8. ACCEPTABLE MANUFACTURERS

APPENDIX 1

DELIVERABLES

****
The following is a list of minimum suggested deliverables and deliverable information. Revise per project requirements as required:
****

Manufacturer drawings:

1. Bus duct plan and elevation drawings showing phasing arrangement, weights and detailed dimensions.
2. Bus duct connection details.
3. Schematics/wiring diagrams and P&ID showing connections for bus condensation control.
4. Bus duct support types, details, anchor bolt plan, and support locations.
5. Bus duct nameplate data.

Test data:

1. Factory and field test data/test report. See Appendix 6 for details.

Operation and Maintenance Manuals:

1. Operation and maintenance (O&M) manuals shall include the following minimum information:
   a. Installation instructions.
   b. Operating instructions.
   c. Maintenance instructions.
   d. Nameplate data.
   e. Assembly drawings.
   f. Bill of Material with vendor part numbers.
   g. Recommended spare parts list.
   h. Certified (final) test reports
   i. Storage and Handling instructions.
   j. Special tools required for installation, operation and/or maintenance.

QA/QC:

1. Seller's QA/QC Inspection and Test Plan (ITP).

****
Include project-specific requirements for the following:
****

- Seller Deliverable Schedule
- Deliverable Format
- Deliverable Quantities

APPENDIX 2

PROPOSAL DATA REQUIREMENTS

ISOLATED PHASE BUS DUCT DATA SHEET

Seller shall provide the following minimum technical data applicable to the equipment in the proposed scope of supply.

****

In addition to revising this spec to correspond to project-specific requirements, update all highlighted areas with project-specific data.

****

ISOLATED PHASE BUS DUCT	UNITS	REQUIREMENTS	SELLER RESPONSE
Manufacturer		Seller	
City & Country of Manufacture		Seller	
Duty Cycle		Continuous	
Cooling		Self-Cooled	
ELECTRICAL PARAMETERS:			
Bus Conductor Material		Aluminum	
Enclosure Material		Aluminum	
Rated Nominal Voltage	kV	18	
Rated Maximum Voltage	kV	27	
Operating Frequency	Hz	60	
Rated Continuous Current at Max Ambient - Main Bus	A	7500	
Rated Momentary Current (167 ms) – Main Bus	kA	130	
Rated Momentary Current (max peak) – Main Bus	kA	219	
Rated Short-Time Current (1 sec) – Main Bus	kA	75	
Rated Continuous Current at Max Ambient - Tap Bus	A	1200	
Rated Momentary Current (167 ms) – Tap Bus	kA	235	
Rated Momentary Current (max peak) – Tap Bus	kA	396	
Rated Short-Time Current (1 sec) – Tap Bus	kA	130	
Rated Bus Temp Rise Above Max Ambient	°C	65	

Rated Enclosure Temp Rise Above Max Ambient	ºC	40	
Rated Insulation Level (BIL)	kV	125	
Rated One Minute Dry Frequency Withstand	kV	60	
Total Electrical Loss at Rated Current	Watts/3-phase foot	Seller	
CONDENSATION CONTROL:			
Pressurized Air System			
Normal Operating Pressurized Air System Usage	scfm	Seller	
Max (startup) Operating Pressurized Air System Usage	scfm	Seller	
WEIGHTS AND DIMENSIONS:			
Bus Conductor Outside Diameter - Main Bus	inches	Seller	
Bus Conductor Outside Diameter - Tap Bus	inches	Seller	
Bus Conductor Wall Thickness - Main Bus	inches	Seller	
Bus Conductor Wall Thickness - Tap Bus	inches	Seller	
Enclosure Outside Diameter – Main Bus	inches	Seller	
Enclosure Outside Diameter – Tap Bus	inches	Seller	
Phase-to-Phase Spacing – Main Bus	inches	Seller	
Phase-to-Phase Spacing – Tap Bus	inches	Seller	
Bus Insulator Support Spacing	inches	Seller	
Bus Support Spacing	feet	Seller	
Total Weight per Single Phase Foot – Main Bus	pounds	Seller	
Total Weight per Single Phase Foot – Tap Bus	pounds	Seller	
FINISH			
Color		ANSI 70, Light Gray	

****

The following additional information shall also be included with proposals:

1. Seller variances or exceptions to the specification.
2. Itemization of proposed estimated materials.
3. Add/deduct pricing for bus duct cost per lineal foot, each type of bus duct fitting, flexible connectors, etc.

****

APPENDIX 3

PERFORMANCE GUARANTEES

****

Typically, isolated phase bus systems do not have performance guarantees associated with them. However, consider all project-specific requirements to determine the applicability of this Appendix.

****

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

****

In addition to revising this spec to correspond to project-specific requirements, update all Appendix highlighted areas with project-specific data.

****

SITE CONDITIONS

LOCATION

Xcel Energy's Cherokee Station site is located in Adams County, CO at 6198 Franklin St. Denver, CO 80216.

METEOROLOGICAL DATA

Table 1 below lists the major site conditions which are based on ambient weather conditions taken from several data references. The following abbreviations apply to this table:

DBT:	Dry Bulb Temperature
MCWB:	Mean coincident wet bulb for a given dry bulb temperature
AMSL:	Above Mean Sea Level

APPENDIX 4

TABLE 1 – MAJOR SITE CONDITIONS

PARAMETER	DATA
Site Elevation	5131 feet AMSL
Site Ambient Conditions	
Record low dry bulb temperature: MCWB for record low DBT:	-29°F -29°F
99% winter design dry bulb temperature: MCWB for 99% winter design DBT:	-5°F -8°F
Average winter dry bulb temperature: MCWB for average winter DBT:	-35°F -29°F
Annual average dry bulb temperature: MCWB for annual average DBT:	50°F 39°F
Summer 1% dry bulb temperature: MCWB for summer design 1% DBT: (Comparable to ASHRAE cooling, 0.4% occurance)	95°F 70°F
Record high dry bulb temperature: MCWB for record high DBT:	105°F 72°F
Dry bulb temperature for ISO System Accrediation: MCWB for ISO System Accrediation DBT:	95°F 70°F
Relative Humidity Range	0% to 100%
Annual Average Percipitation	18 inches
Maximum 24 Hour Rainfall Total	3 inches
Annual Average Snowfall	60 inches
Maximum 24 Hour Snowfall Total	48 inches

APPENDIX 4

WIND LOADING

Wind loads shall be in accordance with the IBC. Basic wind design parameters are as follows:

DESCRIPTION	CHEROKEE	NOTES
Classification of Structure Category	III	Ref. ASCE 7-05, Section 1.5
Exposure	C	Ref. ASCE 7-05, Section 6.56
Wind Importance Factor	1.15	
Reference Wind Velocity, V	90 mph	3 sec. gust @ 33 ft. above ground. Ref. ASCE 7-05

SEISMIC CRITERIA

Structures shall be designed using the seismic criteria in the IBC as applicable to Colorado. Basic seismic parameters, per the IBC, are as follows:

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration at a short period (0.2 seconds), S_s = 0.217g.

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration a 1 second period), S_s = 0.056g.

Seismic Importance Factor, I_E = 1.25.

Based on the information presented in the Geotechnical Report, the project site has been assigned to Site Class D, to be verified by a site-specific geotechnical report.

APPENDIX 4

REFERENCE MATERIALS

The following drawings contain additional scope requirements as part of this specification:

- General Arrangements
- One-Line Diagrams
- Bus Duct Layouts
- Transformer Connection Details
- Generator Connection Details
- Auxiliary equipment connection details.

APPENDIX 5

QA/QC (Including Inspection Test Plans)

****
Revise this Appendix accordingly per project-specific requirements.
****

QA/QC

INSPECTION AND TEST PLANS

Seller shall submit their standard Inspection and Test Plan (ITP) for approval in accordance with Appendix 1 requirements.

QA/QC INSPECTIONS/REPORTING

****
Determine frequency of Xcel inspections of Seller's facilities during fabrication, prior to delivery, etc. and add requirements to this section as required. Review Xcel Intranet QA/QC Toolbox for various tools and templates for the following, as project requirements dictate:

- Shop inspection reports
- Non-conformance reports
- Release for shipment, etc.

Add these documents to this Appendix as required.
****

WELDING

****
Discuss welding requirements with Xcel Quality during the spec development process and insert their most current requirements in this section.
****

APPENDIX 6

STARTUP, TESTING AND COMMISSIONING

****
The following are minimum suggested testing requirements. Revise per project requirements as required:
****

TESTING

Factory Testing:

1. Perform standard factory tests in accordance with IEEE C37.23.
2. Submit test data/test reports in accordance with Appendix 1.

Shop Tests:

1. Perform standard shop tests in accordance with IEEE standards.

****
Depending on project requirements, determine if factory field support is required to startup/commission iso-phase systems. Minimum commissioning considerations are as follows:

- Construction/installation inspections
- International Electrical Testing Association (NETA) standard field tests (e.g. bus high potential testing, etc.)
- Anti-condensation system/controls commissioning
- Forced-air cooling system/controls commissioning

****

APPENDIX 7

PACKAGING, SHIPPING AND STORAGE

PACKAGING, SHIPPING AND STORAGE

Seller shall prepare equipment for shipment following successful completion of factory testing and resolution of QA/QC non-conformances (see Appendix 5 for additional details.

Seller shall prepare equipment to withstand any possible damage or loss due to rough handling or exposure to weather during transit or extended outdoor storage (up to two (2) years).

Seller shall install all required covers to protect equipment from rain, hail, wind, dust, snow and environmental conditions detrimental to the equipment.

Equipment shall be adequately sealed and protected during shipment to prevent corrosion, foreign matter egress and freeze damage which could result from the presence of residual water.

Lifting points and centers of gravity shall be clearly marked on the shipped equipment.

Shipping structural bracing shall be installed as required to allow for field handling, skidding and hoisting.

Equipment supplied with space heaters shall have heater leads accessible without requiring disassembly of shipping containers.

Threaded outlets shall have plugs or caps installed prior to shipping.

Ancillary materials which are “shipped loose” shall be in separately boxed and re secured to the main equipment containers.

Seller shall provide the following minimum unloading/handling information:

- Shipping weight and dimensions of each article
- Pick points
- Rigging requirements
- Weight distribution
- Center of gravity
- Sensitivities
- Hazards

A QA/QC inspection certification, signed by the Seller shall be issued to the company prior to shipment. A copy of this certificate shall be included with the Bill of Lading.

APPENDIX 7

PACKAGING, SHIPPING AND STORAGE

Shipping documentation shall include the following minimum information:

- Company Destination (Plant, Unit)
- Company Agreement number
- Sellers order number
- Date shipped
- Shipping origin
- Company equipment tag information
- Seller's equipment identification information
- Shipment tracking information
- Shipment description
- Shipment quantity
- Gross weight
- Special handling requirements
- Identification of spare equipment
- Barcode, RFID, or similar material control information

Seller shall coordinate all deliveries with Company prior to shipment. Coordination shall include resolution of QA/QC non-conformances, delivery schedule, unloading/handling requirements, and storage requirements.

APPENDIX 8

ACCEPTABLE MANUFACTURERS

****
The following list contains the typically preferred manufacturers. Coordinate with Xcel Sourcing to determine final bid list:
****

Acceptable manufacturers are as follows:

- Calvert
- Delta-Unibus
- General Electric
- Technibus

MASTER SPECIFICTION
FOR

Low Voltage Motors

Revision 1.0

REVISION HISTORY

Date	Revision	Change Description
12-30-2014	1.0	New

****

In addition to revising this spec to correspond to project-specific requirements, update all highlighted areas with project-specific data.
****

GENERAL

DESCRIPTION

****
Insert project-specific description items (i.e. new construction project, replacement project, project location, etc.)
****

SUMMARY

This specification details the requirements for low voltage (LV) AC motors. This specification does not cover valve, gate, elevator, machine tool, chemical feed, crane, submersible pump, HVAC, DC or other specialty motors.

Reference Drawings

The following drawings, included in Appendix 4, contain additional scope requirements as part of this specification:

- General Arrangements
- One-Line Diagrams
- Three-Line Diagrams
- Schematic Diagrams
- Wiring Diagrams

****
For motor replacement projects, consult with Mechanical for existing driven equipment requirements and update this section with mechanical drawings as applicable.
****

Technical Proposal Documentation

See Appendix 2 for technical proposal requirements.

APPLICABLE CODES AND STANDARDS

- State and local codes, laws, ordinances, rules and regulations
- ABMA – American Bearing Manufacturers Association
- ANSI - American National Standards Institute
- ASTM - American Society for Testing and Materials
- ICEA - Insulated Cable Engineers Association
- IEEE - Institute of Electrical and Electronic Engineers

- NEMA - National Electrical Manufacturer's Association
- NFPA - National Fire Protection Association
- OSHA - Occupational, Health and Safety Administration
- UL Underwriter's Laboratories

In the event of conflict or disagreement between codes and standards, the more stringent conditions shall govern.

TECHNICAL REQUIREMENTS

DESIGN & CONSTRUCTION FEATURES

1. **Design and Construction**

   a. Motor design and construction shall be coordinated with the driven equipment requirements and shall be suited for their intended use.
   b. Motors for use with variable frequency drives (VFD) shall be VFD-rated and shall be able to maintain cooling requirements at the minimum design drive speeds.
   c. Motors shall be rated for continuous duty for site conditions specified in Appendix 4.
   d. All three-phase motors furnished under this specification shall be designed in accordance with IEEE 841.

2. **Environmental**

   Motors shall be manufactured to withstand site environmental conditions. See Appendix 4 for site specific environmental conditions.

3. **Ratings**

   Motors ratings shall be as specified in Appendix 2 Data Sheets.

MOTOR VOLTAGE RATINGS

Motor operating voltages shall be as follows:

MOTOR HP	NOMINAL SYSTEM VOLTAGE	MOTOR NAMEPLATE VOLTAGE	PHASE
Less than 0.75 HP	120	115	1
Greater-than-or-equal-to 0.75 HP and less-than-or-equal-to 250 HP	480	460	3

ENCLOSURES

1. All motors shall be self-ventilated.
2. Enclosures shall be cast iron or cast steel.
3. Enclosure parts, including frames, bearing brackets, fan covers, etc. shall be cast

iron, cast steel, sheet steel or steel plates.

4. Aluminum enclosures or enclosure parts are not permitted.
5. Fan-cooled motors shall have fans constructed from non-sparking fan material.
6. Motor rotation shall be permanently marked on motor enclosures.

TOTALLY ENCLOSED MOTORS

1. Totally enclosed, fan cooled (TEFC) motors shall have rotating shaft seals where available.
2. Drain holes shall be provided for TEFC motors.
3. TEFC motors shall have all exposed metal surfaces painted with a corrosion-resistant polyester coating.
4. TEFC motors shall have interior surfaces and the stator/rotor air gap surfaces protected with an alkyd enamel or polyester or epoxy coating.
5. TEFC motors shall meet NEMA requirements for a fully guarded machine.
6. Fastening hardware shall be heavy cadmium-plated steel or stainless steel.

INSULATION AND WINDINGS

1. All windings shall be copper.
2. Windings shall have Class F, non-hygroscopic insulation systems.
3. Insulation resistance, corrected to 40 °C, shall not be less than motor-rated kV+1 megohms for all windings.
4. Two-speed motors shall be furnished with two (2) separate windings. Single winding two-speed motors are not permitted.

ROTOR

1. Three-phase horsepower motors 250 HP and less shall have squirrel-cage copper rotors.

TEMPERATURE RISE

1. Winding temperature rise shall not exceed NEMA MG-1 requirements for a Class B insulation system.
2. Temperature rise shall be determined for motor operation at nameplate horsepower multiplied by the service factor and operation at maximum ambient temperature specified in Appendix 4.

SERVICE FACTOR

1. Motor service factor (SF) shall be 1.15 where available.

SPACE HEATERS

1. All motors 25 horsepower and larger shall have space heaters.
2. Heaters shall be rated for 240 VAC and energized and sized for application at 120 VAC.
3. Heaters shall be accessible via terminal housing which shall be separate from the motor power leads.

4. Heater leads shall be stranded copper with high temperature insulation.

TERMINAL HOUSING

1. Separate terminal housings shall be provided for motor power leads and accessory leads (heater leads, etc.) and shall be mounted to the motor frame.
2. Terminal housings shall be cast iron, stamped steel or fabricated steel.
3. Terminal housing gaskets shall be provided for housing access panels and between housings and motor frame.
4. Terminal housing shall be oversized and shall be capable of rotation in 90-degree steps.
5. Minimum motor lead terminal housing for 460V motors shall be 4-inches by 4-inches by 2-inches.
6. Minimum motor lead terminal housing for 115V motors shall be 3-inches by 3-inches by 2-inches

LEADS

1. All motor and accessory leads shall be permanently marked in accordance with NEMA MG-1.

GROUNDING

1. Motor ground provisions shall be furnished per NEMA MG-1.
2. Motors shall be furnished with provisions for connecting grounding conductors to the motor frame inside the motor lead terminal housing.

ANTI-FRICTION BEARINGS

1. Anti-friction bearings shall be provided in accordance with ABMA standards to have a minimum L-10 rating life of not less than 10,000 hours unless otherwise approved by the Owner.
2. Grease-lubricated radial bearings shall be double-shield type where available.
3. Motor bearing mountings shall prevent entrance of lubricant into the motor enclosure and prevent entrance of external contaminants into to the bearings.
4. Bearing mountings shall be provided with pipes and drain plugs.
5. Grease-lubricated bearing fittings shall provide access for external lubrication while motor is in service.
6. Pump motors shall be equipped with either external shaft slingers or seals to prevent liquid entry at motor bearings.
7. Grease-lubricated bearings shall be self-lubricating with external grease connections.
8. Bearings and bearing housings shall allow field disassembly for inspection and removal of rotor.

TORQUE CHARACTERISTICS

1. Motor torque characteristics shall be per NEMA MG-1.
2. Locked rotor kVA/HP for three-phase, 10 HP through 150 HP, shall not exceed 6.3 kVA/HP.

3. Locked rotor kVA/HP for three-phase, above 150 HP, shall not exceed 5.6 kVA/HP.

MOTOR EFFICIENCY

1. Three-phase motors shall be premium efficiency type motors.
2. Motor average nominal efficiency and power factor values shall meet NEMA standard requirements for “Energy Efficient”.

NAMEPLATES

1. Motor nameplates and attachment hardware shall be stainless steel.
2. Nameplates shall be stamped per NEMA requirements.

SPARE PARTS AND TOOLS

****
Fill in as required
****

TESTING

Testing requirements are defined in Appendix 6.

DELIVERABLES

Deliverable requirements are defined in Appendix 1.

PROPOSAL DATA REQUIREMENTS

Seller shall provide proposed equipment data in accordance with Appendix 2.

SITE CONDITIONS

Site conditions are defined in Appendix 4.

QUALITY ASSURANCE

QA/QC requirements are defined in Appendix 5.

PACKAGING STORAGE & SHIPPING

Packing, shipping storage requirements are defined in Appendix 7.

MATERIALS & WELDING

****
Fill in as required
****

PERFORMANCE GUARANTEES

****

Fill in Appendix 3 as required

****

SOUND CONTROL REQUIREMENTS

Sound levels shall be less than 85 dBA at three feet from motor boundary.
Sound levels shall be determined in accordance with IEEE 85.

CLEANING, PAINTING & COATING

****

Fill in as required

****

APPENDICES TO SPECIFICATION

****

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.

****

1. DELIVERABLES
2. PROPOSAL DATA REQUIREMENTS
3. PERFORMANCE GUARANTEES
4. SITE CONDITIONS AND REFERENCE MATERIALS
5. QA/QC (Including Inspection Test Plans)
6. STARTUP, TESTING, AND COMMISSIONING
7. PACKAGING, SHIPPING, AND STORAGE
8. ACCEPTABLE MANUFACTURERS

APPENDIX 1

DELIVERABLES

****
The following is a list of minimum suggested deliverables and deliverable information. Revise per project requirements as required:
****

Manufacturer drawings:

1. Shipping layout drawings
2. Installation instructions/details including rigging information and equipment loadings
3. Nameplate schedule and details
4. Dimensioned motor outline drawings
5. Motor wiring diagrams
6. Motor data sheets

Test data:

1. Factory and field test data/test report. See Appendix 6 for details.

Operation and Maintenance Manuals:

1. Operation and maintenance (O&M) manuals shall include the following minimum information:
    a. Installation instructions.
    b. Operating instructions.
    c. Maintenance instructions.
    d. Nameplate data.
    e. Assembly drawings.
    f. Bill of Material with vendor part numbers
    g. Cut sheets and brochure data
    h. Recommended spare parts list
    i. Certified (final) test reports
    j. Storage and Handling instructions.
    k. Special tools required for installation, operation and/or maintenance
    l. Warranty information

APPENDIX 1

DELIVERABLES

QA/QC:

1. Seller's QA/QC Inspection and Test Plan (ITP)

****
Include project-specific requirements for the following:
****

- Seller Deliverable Schedule
- Deliverable Format
- Deliverable Quantities

APPENDIX 2

PROPOSAL DATA REQUIREMENTS

LOW VOLTAGE MOTOR DATA SHEET

Seller shall provide the following minimum technical data applicable to the equipment in the proposed scope of supply.

****

In addition to revising this spec to correspond to project-specific requirements, update all highlighted areas with project-specific data.

****

LOW VOLTAGE MOTORS	UNITS	REQUIREMENTS	SELLER RESPONSE
120V MOTORS			
Motor Application			
Equipment Tag Number			
Manufacturer		Seller	
Model Number		Seller	
City & Country of Manufacture		Seller	
Motor Horsepower	HP		
Motor Voltage	V	120	
Phase		1	
Frequency	Hz	60	
Service Factor		1.15	
Full Load Speed	RPM		
NEMA Design Letter			
Insulation		Class F	
Temperature Rise (at 40 ºC)	ºC		
Duty Rating		Continuous	
Enclosure Type		TEFC	
NEMA Frame			
Full Load Current	A		
Locked Rotor Current	A		

APPENDIX 2

PROPOSAL DATA REQUIREMENTS

LOW VOLTAGE MOTOR DATA SHEET

LOW VOLTAGE MOTORS	UNITS	REQUIREMENTS	SELLER RESPONSE
Locked Rotor kVA Letter			
Starting Method			
Overload Protection			
Belted or Direct-coupled			
Mounting			
Bearing Type			
Motor Weight			
460V MOTORS			
Motor Application			
Equipment Tag Number			
Manufacturer		Seller	
Model Number		Seller	
City & Country of Manufacture		Seller	
Motor Horsepower	HP		
Motor Voltage	V	460	
Phase		3	
Frequency	Hz	60	
Poles			
Service Factor		1.15	
Rotor Material/Type		Copper/Squirrel Cage	
Winding Material		Copper	
Full Load Speed	RPM		
NEMA Design Letter			
Insulation		Class F	
Temperature Rise (at 40 ºC)	ºC		

APPENDIX 2

PROPOSAL DATA REQUIREMENTS

LOW VOLTAGE MOTOR DATA SHEET

LOW VOLTAGE MOTORS	UNITS	REQUIREMENTS	SELLER RESPONSE
Duty Rating		Continuous	
Enclosure Type		TEFC	
IEEE 814 Rating		Yes	
NEMA Frame			
Full Load Current	A		
Locked Rotor Current	A		
Locked Rotor kVA Letter			
Starting Method			
Belted or Direct-coupled			
Mounting			
Bearing Type/Rating			
Motor Weight	lb		
Motor Full-Load Torque	lb-ft		
Motor Locked Rotor Torque	lb-ft		
Motor Nominal Efficiency (50% load)	%		
Motor Nominal Efficiency (75% load)	%		
Motor Nominal Efficiency (100% load)	%		
Space Heater Voltage	V		
Heater Quantity			
Heater Power Consumption (per heater)	W		
Minimum Starting Voltage	V		
Safe Stall Time (rated voltage, ambient temp)	sec		
Safe Stall Time (rated voltage, operating temp)	sec		
Safe Stall Time (80% voltage, ambient temp)	sec		
Safe Stall Time (80% voltage, operating temp)	sec		

APPENDIX 2

PROPOSAL DATA REQUIREMENTS

LOW VOLTAGE MOTOR DATA SHEET

LOW VOLTAGE MOTORS	UNITS	REQUIREMENTS	SELLER RESPONSE
Combined Motor and Load Acceleration Time (100% voltage)	sec		
Rotor Inertia	lb-ft^2		
Load Inertia	lb-ft^2		
Motor Pull-up Torque	lb-ft		
Motor Breakdown Torque	lb-ft		
Motor X/R Ratio			
Locked Rotor Power Factor			

****

The following additional information shall also be included with proposals:

1. Seller variances or exceptions to the specification.
2. Itemization of proposed estimated materials.

****

APPENDIX 3

PERFORMANCE GUARANTEES

****
Insert project-specific performance guarantee requirements in this Appendix.
****

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

****

In addition to revising this spec to correspond to project-specific requirements, update all Appendix highlighted areas with project-specific data.

****

SITE CONDITIONS

LOCATION

Xcel Energy's Cherokee Station site is located in Adams County, CO at 6198 Franklin St. Denver, CO 80216.

METEOROLOGICAL DATA

Table 1 below lists the major site conditions which are based on ambient weather conditions taken from several data references. The following abbreviations apply to this table:

DBT:	Dry Bulb Temperature
MCWB:	Mean coincident wet bulb for a given dry bulb temperature
AMSL:	Above Mean Sea Level
IBC:	International Building Code

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

TABLE 1 – MAJOR SITE CONDITIONS

PARAMETER	DATA
Site Elevation	5131 feet AMSL
Site Ambient Conditions	
Record low dry bulb temperature: MCWB for record low DBT:	-29°F -29°F
99% winter design dry bulb temperature: MCWB for 99% winter design DBT:	-5°F -8°F
Average winter dry bulb temperature: MCWB for average winter DBT:	-35°F -29°F
Annual average dry bulb temperature: MCWB for annual average DBT:	50°F 39°F
Summer 1% dry bulb temperature: MCWB for summer design 1% DBT: (Comparable to ASHRAE cooling, 0.4% occurance)	95°F 70°F
Record high dry bulb temperature: MCWB for record high DBT:	105°F 72°F
Dry bulb temperature for ISO System Accrediation: MCWB for ISO System Accrediation DBT:	95°F 70°F
Relative Humidity Range	0% to 100%
Annual Average Percipitation	18 inches
Maximum 24 Hour Rainfall Total	3 inches
Annual Average Snowfall	60 inches
Maximum 24 Hour Snowfall Total	48 inches

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

WIND LOADING

Wind loads shall be in accordance with the IBC. Basic wind design parameters are as follows:

DESCRIPTION	CHEROKEE	NOTES
Classification of Structure Category	III	Ref. ASCE 7-05, Section 1.5
Exposure	C	Ref. ASCE 7-05, Section 6.56
Wind Importance Factor	1.15	
Reference Wind Velocity, V	90 mph	3 sec. gust @ 33 ft. above ground. Ref. ASCE 7-05

SEISMIC CRITERIA

Structures shall be designed using the seismic criteria in the IBC as applicable to Colorado. Basic seismic parameters, per the IBC, are as follows:

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration at a short period (0.2 seconds), S_s = 0.217g.

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration a 1 second period), S_s = 0.056g.

Seismic Importance Factor, I_E = 1.25.

Based on the information presented in the Geotechnical Report, the project site has been assigned to Site Class D, to be verified by a site-specific geotechnical report.

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

REFERENCE MATERIALS

The following drawings contain additional scope requirements as part of this specification:

- General Arrangements
- One-Line Diagrams
- Three-Line Diagrams
- Schematic Diagrams
- Wiring Diagrams

****

For motor replacement projects, consult with Mechanical for existing driven equipment requirements and update this section with mechanical drawings as applicable.

****

APPENDIX 5

QA/QC (Including Inspection Test Plans)

****
Revise this Appendix accordingly per project-specific requirements.
****

QA/QC

INSPECTION AND TEST PLANS

Seller shall submit their standard Inspection and Test Plan (ITP) for approval in accordance with Appendix 1 requirements.

QA/QC INSPECTIONS/REPORTING

****
Determine frequency of Xcel inspections of Seller's facilities during fabrication, prior to delivery, etc. and add requirements to this section as required. Review Xcel Intranet QA/QC Toolbox for various tools and templates for the following, as project requirements dictate:

- Shop inspection reports
- Non-conformance reports
- Release for shipment, etc.

Add these documents to this Appendix as required.
****

APPENDIX 6

STARTUP, TESTING AND COMMISSIONING

****
The following are minimum suggested testing requirements. Revise per project requirements as required:
****

TESTING

Factory Testing:

1. Perform factory tests in accordance with IEEE/ANSI and NEMA standards.
2. Motor testing shall be performed with motor terminal housing installed on motor.
3. Factory tests shall include the following minimum tests:
   a. No-load running current
   b. No-load speed
   c. Insulation resistance
   d. Winding resistance
   e. Mechanical balance
   f. Locked rotor current
   g. Motor efficiency
4. Submit test data/test reports in accordance with Appendix 1.

Shop Tests:

1. Perform standard shop tests in accordance with NEMA and IEEE standards.

****
Depending on project requirements, determine the level of factory field support required for startup/commissioning.

****

APPENDIX 7

PACKAGING, SHIPPING AND STORAGE

PACKAGING, SHIPPING AND STORAGE

Seller shall prepare equipment for shipment following successful completion of factory testing and resolution of QA/QC non-conformances (see Appendix 5 for additional details.

Seller shall prepare equipment to withstand any possible damage or loss due to rough handling or exposure to weather during transit or extended outdoor storage (up to two (2) years).

Seller shall install all required covers to protect equipment from rain, hail, wind, dust, snow and environmental conditions detrimental to the equipment.

Equipment shall be adequately sealed and protected during shipment to prevent corrosion, foreign matter egress and freeze damage which could result from the presence of residual water.

Lifting points and centers of gravity shall be clearly marked on the shipped equipment.

Shipping structural bracing shall be installed as required to allow for field handling, skidding and hoisting.

Equipment supplied with space heaters shall have heater leads accessible without requiring disassembly of shipping containers.

Threaded outlets shall have plugs or caps installed prior to shipping.

Ancillary materials which are “shipped loose” shall be in separately boxed and re secured to the main equipment containers.

Seller shall provide the following minimum unloading/handling information:

- Shipping weight and dimensions of each article
- Pick points
- Rigging requirements
- Weight distribution
- Center of gravity
- Sensitivities
- Hazards

A QA/QC inspection certification, signed by the Seller shall be issued to the company prior to shipment. A copy of this certificate shall be included with the Bill of Lading.

APPENDIX 7

PACKAGING, SHIPPING AND STORAGE

Shipping documentation shall include the following minimum information:

- Company Destination (Plant, Unit)
- Company Agreement number
- Sellers order number
- Date shipped
- Shipping origin
- Company equipment tag information
- Seller's equipment identification information
- Shipment tracking information
- Shipment description
- Shipment quantity
- Gross weight
- Special handling requirements
- Identification of spare equipment
- Barcode, RFID, or similar material control information

Seller shall coordinate all deliveries with Company prior to shipment. Coordination shall include resolution of QA/QC non-conformances, delivery schedule, unloading/handling requirements, and storage requirements.

APPENDIX 8

ACCEPTABLE MANUFACTURERS

****
The following list contains the typically preferred manufacturers. Coordinate with Xcel Sourcing to determine final bid list:
****

Acceptable manufacturers are as follows:

- Baldor
- General Electric
- Louis Allis
- Reliance
- Marathon
- Toshiba
- WEG

MASTER SPECIFICTION
FOR
Medium Voltage Motors

Revision 1.0

REVISION HISTORY

Date	Revision	Change Description
12-30-2014	1.0	New

****
In addition to revising this spec to correspond to project-specific requirements, update all highlighted areas with project-specific data.
****

GENERAL

DESCRIPTION

****
Insert project-specific description items (i.e. new construction project, replacement project, project location, etc.)
****

SUMMARY:

1. This specification describes the standards for motors that are applicable to design and construction for Xcel Energy's Energy Supply construction projects.

2. The specification describes alternating current, medium voltage induction motors. Excluded are low voltage motors (480 volts or smaller).

3. All equipment and materials shall be in accordance with applicable requirements of the Federal "Occupational Safety and Health Administration" Standards.

.

Reference Drawings

The following drawings, included in Appendix 4, contain additional scope requirements as part of this specification:

- General Arrangements
- One-Line Diagrams
- Three-Line Diagrams
- Schematic Diagrams
- Wiring Diagrams

****
For motor replacement projects, consult with Mechanical for existing driven equipment requirements and update this section with mechanical drawings as applicable.
****

Technical Proposal Documentation

See Appendix 2 for technical proposal requirements.

APPLICABLE CODES AND STANDARDS

A. State and local codes, laws, ordinances, rules and regulations
B. ABMA – American Bearing Manufacturers Association
C. ANSI - American National Standards Institute
D. ASTM - American Society for Testing and Materials
E. ICEA - Insulated Cable Engineers Association
F. IEEE - Institute of Electrical and Electronic Engineers
G. NEMA - National Electrical Manufacturer's Association
H. NFPA - National Fire Protection Association
I. OSHA - Occupational, Health and Safety Administration
J. UL Underwriter's Laboratories

In case of conflict or disagreement between codes and standards, the more stringent conditions shall govern.

TECHNICAL REQUIREMENTS

DESIGN & CONSTRUCTION FEATURES

1. **Design and Construction**

   a. Motor design and construction shall be coordinated with the driven equipment requirements and shall be suited for their intended use.
   b. Motors for use with variable frequency drives (VFD) shall be VFD-rated and shall be able to maintain cooling requirements at the minimum design drive speeds.
   c. Motors shall be rated for continuous duty for site conditions specified in Appendix 4.
   d. All three-phase motors furnished under this specification shall be designed in accordance with IEEE 841.

2. **Environmental**

   a. Motors shall be manufactured to withstand site environmental conditions. See Appendix 4 for site specific environmental conditions.
   b. Considerations shall be given to the exposure to solar heat in the areas of outdoor installation.

3. **Ratings**

   a. Motors ratings shall be as specified in Appendix 2 Data Sheets.

MOTOR VOLTAGE RATINGS

1. Motor operating voltages, excluding motor-operated valves, shall be as follows:

Power (horsepower)	Nominal System Voltage	Motor Nameplate Voltage	Frequency (Hz)	Phases
Greater than 250 and less than 7500	4160	4000	60	3

ENCLOSURES

1. All medium voltage motors shall be provided with Weather-Protected II (WP II) enclosures. Enclosure parts for all motors (e.g., frames, bearing brackets, terminal housings, external fan covers) shall be made of cast iron, cast steel, sheet steel, or steel plates. Aluminum enclosure parts are not acceptable. All hardware shall be made of corrosion resistant material.

2. Removable washable impingement type air filters shall be furnished. A pressure differential device shall be provided at the air inlet of all motors furnished with air filters. The device shall be furnished with a snap-action sealed switch having normally open contacts which close on high-pressure differential. The switch shall have an adjustable setpoint which is accessible for calibration while the motor is in service. The initial setpoint shall be set at the factory and shall be set to prevent high motor temperatures due to clogged filters.

3. Motors located in areas classified as hazardous shall be furnished with enclosures certified for use in the classified area.

4. Except for two-pole motors, cooling fans, when provided, shall be bi-directional to allow for continuous motor operation in either a clockwise or counterclockwise direction. Specific cases where such a fan is impractical for mechanical reasons shall be brought to the attention of the Company.

5. Motors shall be designed to permit convenient access for drilling vertically through the motor feet for installation of tapered dowel pins after the motors are mounted with driven equipment. Where motor design requires angle drilling of dowel pinholes through the motor feet, the Contractor shall start the dowel pinholes at the required angle, and shall drill each hole to a depth not less than one-half the thickness of the motor feet. The tapered dowel pins shall be furnished by the Contractor.

6. Motor rotation shall be permanently marked on motor enclosures.

TOTALLY ENCLOSED MOTORS

1. Totally enclosed motors shall be furnished with drain holes and rotating shaft seals. Motors furnished with sliding type bearings shall have a rotating labyrinth shaft seal on the shaft extension end of the motor. Drain holes shall be provided with combination water drain-breather plugs.

2. External cooling fans for fan cooled motors shall be fabricated of brass, bronze, aluminum alloy containing not more than 0.2% copper, malleable iron, or plastic. All plastic fans shall be fabricated of a reinforced thermosetting plastic.

3. All exposed metal surfaces shall be protected with a corrosion resistant polyester paint or coating and shall have enclosure interior surfaces and the stator and rotor air gap surfaces protected with a corrosion-resistant alkyd enamel or with polyester or epoxy paint or coating. The stator air gap surfaces shall be protected with a vacuum pressure impregnation coating.

4. Bolts, nuts, screws, and other hardware items shall be corrosion-resistant or zinc dichromate treated metal.

INSULATION AND WINDINGS

1. All stator coils shall utilize copper conductors, shall be form-wound, and shall be insulated with mica based materials. All stator-winding materials shall have a Class F (155°C) thermal classification and shall utilize a vacuum pressure impregnation (VPI) system. After winding, the stator shall be subjected to two (2) complete VPI cycles. Following these two (2) cycles, the wound stator shall be coated with a solvent type epoxy varnish.

2. Motor insulation systems shall be rated for use in power plant applications utilizing either vacuum or SF6 bottles for an interrupting medium in either medium voltage switchgear or medium voltage controllers. The insulation system shall not require the installation of surge arresters or capacitors in either the switchgear or at the motor terminals.

3. All multi-turn form-wound stator coils shall have turn-to-turn insulation in accordance with IEEE Standard 522.

4. The temperature rise at rated output shall not exceed those for a Class B thermal insulation classification

ROTORS

1. All induction motors shall have squirrel-cage rotors. Rotors shall be sized to avoid overheating during acceleration of the motor and driven equipment. Rotors shall be copper or copper alloy cage material. All fabricated cage rotors shall include a swaging or wedging method during the installation of rotor bars to prevent rotor bar vibration.

2. All motor rotating components shall be dynamically balanced after mounting on the shaft. Motor vibration shall not exceed the peak-to-peak amplitude values listed in the following table. In addition, the magnitude of vibration values for twice the line frequency vibrations shall not exceed 0.0005 inches (0.013 mm).

3. The minimum clearance space required for removal of the rotor shall be indicated both in the proposal data and on the dimensional outline drawing.

TEMPERATURE RISE

1. Winding temperature rise shall not exceed NEMA MG-1 requirements for a Class B insulation system.

2. Temperature rise shall be determined for motor operation at nameplate horsepower multiplied by the service factor and operation at maximum ambient temperature specified in Appendix 4.

SERVICE FACTOR

1. Motor service factor (SF) shall be 1.15 where available.

SPACE HEATERS

1. Heaters shall be located and insulated so they do not damage motor components or finish. Space heaters shall be sized as required to maintain the motor internal temperature above the dew point when the motor is idle. Space heaters shall be easily removable on all modular frame construction. If space heaters are not removable and if the motor is not of modular frame construction, redundant space heaters of low watt density silicon rubber wrap-around type shall be wired to the accessory terminal housing.

2. Space heater leads shall be stranded copper cable with high temperature insulation and shall include terminal connectors.

3. Sheaths of metal-sheathed strip type space heaters shall be of a corrosion-resistant, non-oxidizing material and shall have a thickness of not less than 0.025 inch.

4. Heaters shall be rated for 240 VAC and energized and sized for application at 120 VAC.

TERMINAL HOUSING

1. An oversized terminal housing for power leads and a separate accessory terminal housing for accessory leads shall be furnished on all motors. All terminal housings shall be externally mounted on the motor frame enclosure. The terminal housing shall be able to be rotated in 90-degree steps to any vertical or horizontal orientation. Terminal housings for all motors shall be cast iron or sheet steel. Minimum protection requirements shall be equivalent to NEMA 4. All motor leads located in the housings shall be permanently marked for ease of identification. Provisions shall be provided within the power lead terminal box for attaching a grounding conductor.

2. A separate accessory terminal housing shall be provided for space heater leads, temperature detector leads, and other similar accessory equipment leads. It shall be complete with screw type terminal blocks for termination of such leads. Each terminal in the blocks shall be identified and marked for its respective leads. Accessory terminal housings shall be accessible from outside the motor.

3. Motor current transformers shall be mounted in the power lead terminal housing.

4. Motor power lead terminal housings shall be large enough to provide working space for the field fabrication of stress relief kits for shielded cable within the housing and to contain the stress relief kits after fabrication. Termination distance shall be defined as the inside dimension of the terminal box between the external conduit connection and either the centerline of the motor lead entrance or the bus bar terminal for connection of external power cable.

The motor terminal box minimum requirements shall be as follows:

Full Load Current at SF Load (Amps)	Termination Distance (Inches)	Conduit*Openings	Depth (Inches)	Width (Inches)
Less than 200 A	24	1-4 in.	18	27
Greater than 200 A Less than 400 A	30	2-4 in.	18	30
Greater than 400 A	30	As Approved by Company.	25	30

*Smaller conduit opening may be furnished if approved by the Company. If removable plate is supplied it shall have a space for connecting specific conduit and size.

LEADS

1. All leads, including motor power leads, space heater leads, and temperature detector leads, shall be wired into their respective terminal housings.

2. All motors shall have the direction of rotation marked by an arrow mounted visibly on the stator frame near the terminal housing or on the nameplate and the leads marked for phase sequence to correspond to the direction of rotation and supply voltage sequence.

3. Leads for dual voltage rated or for multispeed motors shall be easily connected or reconnected in the terminal housing for the operating voltage or for the specified speeds.

4. When current transformers for motor differential protection are required for single-speed motors, the motor phase leads shall be wired to the motor power lead terminal housing for connection for self balancing current type differential protection. Each current transformer shall encircle all power leads to the associated winding. The motor winding wye or delta connections shall be completed at the factory, leaving only three (3) leads, T1, T2, T3, for field connection in the power lead terminal housing. The wye or delta connection shall be completed in a manner that shall allow easy access to the end of each phase for field-testing.

5. Cable type leads shall be provided with compression type terminal connectors.

GROUNDING

1. Motor ground provisions shall be furnished per NEMA MG-1.

2. Motors shall be furnished with provisions for connecting grounding conductors to the motor frame inside the motor lead terminal housing.

3. External grounding pads shall be provided in at least two (2) locations (near mounting feet at opposite corners).

BEARINGS

1. The type of bearing furnished shall be as specified on the Medium Voltage Motor Data Sheet, Appendix 2. If Manufacturer standard is specified, the motor and driven equipment manufacturers shall determine the type of bearing to be furnished based upon the load, speed, and thrust conditions of the driven equipment.

2. Bearings shall be capable of operating for extended periods of time at any of the thrust loadings imposed by the specific piece of driven equipment during starting and normal operation without damage to the bearing, the motor frame, or other motor parts.

SLIDE TYPE BEARINGS

1. Sleeve bearings for horizontal motors shall be oil ring lubricated type. The bearings, end bells, and bearing housings shall be split type when available. Air gap measurement holes or other acceptable means shall be provided in each motor end enclosure for checking air gap of sleeve bearing motors.

2. Sleeve bearings on horizontal motors shall be designed and located centrally, with respect to running magnetic center, to prevent the rotor axial thrust from being continuously applied against either end of the bearing. The motors shall be capable of withstanding without damage the axial thrusts that are developed when the motor is initially energized.

3. Vertical motors with plate type thrust bearings shall have oil lubricated split sleeve guide bearings.

4. Bearing lubrication shall be furnished by an internal lubricant recirculation system. Oil reservoir capacity and ventilation of the bearing housing and oil reservoir shall maintain proper cooling of the oil and bearings.

ANTI-FRICTION BEARINGS

1. Antifriction bearings shall be designed and fabricated in accordance with ABMA standards to have an L-10 rating life of no less than the following under the load, speed, and thrust requirements: Direct-connected motors in continuous use: 100,000 hours unless otherwise approved by the Company.

2. Belt or chain-connected service: 42,500 hours.

3. Motors furnished with spherical roller thrust bearings shall be furnished with deep groove radial guide bearings. One guide bearing shall be locked to the shaft so that the guide bearing shall take upward thrust and to assure that the thrust bearing is always loaded. If spring-loading is furnished, the guide bearing shall not be preloaded during normal operation.

4. Stacked antifriction bearings are not acceptable.

5. Antifriction bearings shall be grease lubricated except where the specified speed and thrust require oil lubrication for the specified life. Grease lubricated bearings shall be self-lubricating and regreaseable.

MISCELLANEOUS BEARING REQUIREMENTS

1. All bearing mountings shall be designed to prevent the entrance of lubricant into the motor enclosure or dirt into the bearings and shall be provided with pipes and drain plugs.

2. Filler caps or grease fittings for lubrication shall be arranged for safe, easy addition of lubricant from the outside of the motor while the motor is in service.

3. Bearings and bearing housings shall be designed to permit disassembly in the field for inspection of the bearings or removal of the rotor.

4. All oil lubricated bearings shall be provided with oil level sight glasses marked for required oil level at motor running and standstill. Plastic sight windows or bottles shall be of a material not adversely affected by continuous exposure to sunlight.

5. Insulation shall be provided to prevent circulation of shaft current on bearings, on bearing temperature detectors, or on oil piping connections.

6. Bearing lubricants shall contain a corrosion inhibitor. The type and grade of lubricant shall be indicated on a nameplate attached to the motor frame or end shield adjacent to the lubricant filling device. The Contractor shall furnish all lubrication information required to assure proper equipment startup and subsequent bearing maintenance.

TORQUE CHARACTERISTICS

1. Breakaway, run-up/pull-up, and pull-out/breakdown torque shall at all times be at least 10% higher than the load-torque of the driven machine, at minimum specified starting voltage.

2. Motor torque in percent of rated full-load torque at rated voltage and frequency shall not be less than the standard torque valves specified in MEMA MG1.

3. Load-torque characteristics shall be furnished by the driven equipment Manufacturer; however, the responsibility for successful starting under the given conditions rests with the motor manufacturer

MOTOR EFFICIENCY

1. Three-phase motors shall be premium efficiency type motors.

2. Motor average nominal efficiency and power factor values shall meet NEMA standard requirements for “Energy Efficient”.

NAMEPLATES

1. All motor nameplate data shall conform to the requirements of NEMA MG 1. The following additional nameplate data shall be included:
    a. Insulation system class designation.
    b. Maximum ambient temperature for which motor is designed and temperature rise by resistance.
    c. Starting capabilities at rated volts and at minimum starting voltage (may be a separate nameplate):
        1. Number of successive starts (coasting to a rest between starts) allowable after:
            a. Motor initially at maximum specified ambient temperature.
            b. Motor driving maximum expected operating load in the maximum specified ambient temperature and coasting to a stop.
        2. Cooling period required after completion of the preceding maximum number of starts before making an additional start with the motor in the following conditions:
            a. Motor running driving maximum expected operating load in the maximum specified ambient temperature.
            b. Motor running with the driven equipment uncoupled.
            c. Motor at rest after being de-energized on reaching rated speed.
            d. Direction of rotation and voltage sequence.
            e. For dual voltage rated or multispeed motors, connection diagram for the specified voltage or the

specified speeds.

f. For motors with connections to an external lubricant re-circulating system, or with an integral forced lubrication system, oil pressure and oil flow required.

g. Type and grade of bearing lubricant, attached adjacent to lubricant filling devices.

h. Add motor weight.

i. For motors with current transformers for differential protection, connection diagram indicating motor lead terminal connections.

j. For motors with air filters, recommended set point for differential pressure device, attached on or near device enclosure.

k. All motor nameplates and attachment pins shall be corrosion-resistant metal.

OIL LUBRICATION SYSTEMS

1. If an external lubricant re-circulating system is provided, the Contractor shall furnish pipe taps for oil inlet and outlet connections in addition to the internal lubricant re-circulating system previously specified. Pipe taps for vertical motors shall be arranged to recirculate oil from the motor thrust bearing oil reservoir for cooling. The Contractor's lubrication system shall maintain proper lubrication and cooling of the bearings over the complete performance range of the external lubricant re-circulating system. The internal lubricant re-circulating system shall provide proper lubrication and cooling of the bearings during startup and coast-down with no oil flow from the external lubricant re- circulating system.

2. Where water cooling of bearing oil is required, the Contractor shall furnish pipe taps for the water inlet and outlet connections. The Contractor's lubrication system shall maintain proper cooling of the oil and bearings under the cooling water conditions specified.

SHAFTS

1. All shafts shall be solid. Each shaft shall be furnished with a corrosion-resistant treatment or shall be made of a corrosion-resistant material.

2. Motors furnished with sleeve bearings shall have permanent indicators indicating the motor magnetic center and end float limits when level and running at rated speed. A permanent, identified reference point shall be indicated or attached to the bearing housing or shaft seal. The markings shall be easily identifiable for use during motor installation.

3. For horizontal sleeve bearing motors, the rotor end float and coupling end play shall be in accordance with NEMA requirements. The distance from the magnetic

center line mark to each end float limit mark shall be not less than 37.5% of the total rotor end float.

SOLE PLATES

1. Soleplate drawings shall be furnished indicating the size and location of the anchor bolts holding each soleplate to the concrete foundation and all mounting, alignment, and connection details and procedures. Motor mounting bolts shall be furnished with each soleplate. All foundation anchor bolts, washers, and nuts shall be furnished by others.

2. Soleplate anchor bolt cross-sectional area shall not be less than the cross-sectional area of the motor mounting bolts. Anchor bolt holes shall be shop drilled and shall be oversized 1/4 inch (6 mm) in diameter. The anchor bolts shall be located under the motor, and all projections, including washers and nuts, shall clear the motor and its appurtenances completely. Grout holes shall be provided in the central portion of each soleplate. Motor mounting holes shall be drilled and tapped.

CRITICAL SPEEDS

1. Motors shall be designed to keep torsional and rotational natural frequencies of vibration at least 25% above or below, preferably above, the motor rated speed ranges to avoid resonant vibration over the operating speed range of the equipment-motor unit.

VIBRATION TRANSDUCER MOUNTING

1. Two (2) provisions per bearing for non-contact Bently Nevada vibration probes shall be provided on the drive end and non-drive end of the motors.

TEMPERATURE DETECTORS

1. Temperature detectors shall be furnished ungrounded. A grounding terminal for each temperature detector shall be included with the detector lead terminals. The grounding terminals shall be provided with internal wiring to a common ground connection. The internal wiring shall be removable.

2. Resistance type temperature detectors shall be non-inductively wound, annealed after winding to ensure accuracy and stability, and insensitive to vibration and strain. Each detector shall be furnished with three (3) leads.

3. Winding temperature detectors and detector lead insulation class shall be the same as the stator coil insulation class. Detector leads shall be provided with protective brass interlocked spiral armor external to the slot.

BEARING PROTECTIVE DEVICES

1. A bearing temperature detector shall be furnished for each bearing of the motor. Each detector shall be complete with a detector head and holder assembly. The

detector temperature-sensitive tip shall be hermetically sealed.

2. When temperature detectors are to be applied on sleeve type bearings, the detector tip shall be held in close proximity with the outside diameter of the bearing babitt, not more than 1/8 inch from the shaft surface of the bearing. Where plate type (Kingsbury) thrust bearings are furnished, each detector tip shall be held in intimate contact with the shoe babbitt, not more than 1/8 inch from the runner surface of the shoe.

3. When temperature detectors are to be applied on antifriction type bearings, the detector tip shall be held on the outer race or in close proximity to the bearing metal.

4. When vibration monitoring is utilized with the anti-friction bearings, Robertshaw Model 376A Vibraswitches or Company-approved equivalent shall be mounted on the motor frame. The switches shall come complete with set point guard.

VARIATIONS FROM RATED VOLTAGE AND RATED FREQUENCY

1. Motors shall operate successfully under running conditions at rated load with a variation in the voltage or the frequency up to the following:
    a. Plus or minus 10% of rated voltage, with rated frequency.
    b. Plus or minus 5% of rated frequency with rated voltage.
    c. A combined variation in voltage and frequency of 10% (sum of absolute values) of the rated values, provided the frequency variation does not exceed plus or minus 5% of rated frequency.

SOUND CONTROL REQUIREMENTS

1. In no case shall the average no-load sound pressure level produced by the motor exceed 86 dBA free field at 3 feet.

2. In addition to the required overall sound pressure level, single frequency siren type to other noise, regardless of cause of source, shall not exceed levels which are irritating or which can produce damage to the human ear.

3. Sound reduction baffles, mufflers, and materials shall be contained within the motor enclosure.

INFRARED INSPECTION VIEWING PANES

1. Infrared (IR) inspection viewing panes shall be installed to permit thermography inspection of motor lead connections. IR inspection viewing panes shall be oriented to allow viewing from ground level.

2. IR inspection viewing pane NEMA rating shall be equal to, or greater than, that of the enclosure in which it is being installed.

3. IR inspection viewing panes shall be NFPA 70E compliant.

4. IR inspection viewing panes shall be 3” minimum diameter and shall consist of reinforced polymeric optic material.

SPARE PARTS AND TOOLS

Commissioning spares to be included/supplied with the equipment.

TESTING

Testing requirements are defined in Appendix 6.

DELIVERABLES

Deliverable requirements are defined in Appendix 1.

PROPOSAL DATA REQUIREMENTS

Seller shall provide proposed equipment data in accordance with Appendix 2.

SITE CONDITIONS

Site conditions are defined in Appendix 4.

QUALITY ASSURANCE

QA/QC requirements are defined in Appendix 5.

PACKAGING STORAGE & SHIPPING

Packing, shipping storage requirements are defined in Appendix 7.

SOUND CONTROL REQUIREMENTS

Sound levels shall be less than 85 dBA at three feet from motor boundary.
Sound levels shall be determined in accordance with IEEE 85.

MATERIALS & WELDING

****

Fill in as required

****

PERFORMANCE GUARANTEES

****

Fill in Appendix 3 as required

****

CLEANING, PAINTING & COATING

****

Fill in as required

****

APPENDICES TO SPECIFICATION

****

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.

****

1. DELIVERABLES
2. PROPOSAL DATA REQUIREMENTS
3. PERFORMANCE GUARANTEES
4. SITE CONDITIONS AND REFERENCE MATERIALS
5. QA/QC (Including Inspection Test Plans)
6. STARTUP, TESTING, AND COMMISSIONING
7. PACKAGING, SHIPPING, AND STORAGE
8. ACCEPTABLE MANUFACTURERS

APPENDIX 1

DELIVERABLES

****
The following is a list of minimum suggested deliverables and deliverable information. Revise per project requirements as required:
****

Manufacturer drawings:

1. Shipping layout drawings
2. Installation instructions/details including rigging information and equipment loadings
3. Nameplate schedule and details
4. Dimensioned motor outline drawings
5. Motor wiring diagrams
6. Motor data sheets

Test data:

1. Factory and field test data/test report. See Appendix 6 for details.

Operation and Maintenance Manuals:

1. Operation and maintenance (O&M) manuals shall include the following minimum information:
    a. Installation instructions.
    b. Operating instructions.
    c. Maintenance instructions.
    d. Nameplate data.
    e. Assembly drawings.
    f. Bill of Material with vendor part numbers
    g. Cut sheets and brochure data
    h. Recommended spare parts list
    i. Certified (final) test reports
    j. Storage and Handling instructions.
    k. Special tools required for installation, operation and/or maintenance
    l. Warranty information

APPENDIX 1

DELIVERABLES

QA/QC:

1. Seller's QA/QC Inspection and Test Plan (ITP)

****
Include project-specific requirements for the following:
****

- Seller Deliverable Schedule
- Deliverable Format
- Deliverable Quantities

APPENDIX 2

PROPOSAL DATA REQUIREMENTS

MEDIUM VOLTAGE MOTOR DATA SHEET

Seller shall provide the following minimum technical data applicable to the equipment in the proposed scope of supply.

****

In addition to revising this spec to correspond to project-specific requirements, update all highlighted areas with project-specific data.

****

MEDIUM VOLTAGE MOTORS	UNITS	REQUIREMENTS	SELLER RESPONSE
Manufacturer			
City & Country of Manufacture			
Motor Voltage	kV		
Motor Frame Size			
Nameplate horsepower	HP		
Service Factor (SF)			
Frequency	Hz		
Poles			
NEMA design letter			
Insulation Class			
Duty Rating			
Enclosure type			
Mounting			
Rotor construction			
Rotor material			
Rotor weight	lb		
MEDIUM VOLTAGE MOTORS	**UNITS**	**REQUIREMENTS**	**SELLER**

			RESPONSE
Motor X/R ratio			
Temperature rise at service factor load	°C		
Temperature rise at rated load	°C		
Stator winding connection (Wye or Delta)			
Full load current at rated voltage	A		
Full load speed at rated voltage	RPM		
Locked rotor kVA/HP at rated voltage	kVA/HP		
Locked rotor current at rated voltage	A		
Locked rotor kVA letter			
Guaranteed efficiency at full load	%		
Guaranteed efficiency at 75% load	%		
Guaranteed efficiency at 50% load	%		
Efficiency test method	IEEE 112		
Power Factor basis (Test or Calculation)			
Torque at rated voltage:			
Starting torque	lb-ft		
Breakdown torque	lb-ft		
Full-load torque	lb-ft		
Acceleration time, including driven equipment:			
At rated voltage	sec		
At 85% voltage	sec		
MEDIUM VOLTAGE MOTORS	**UNITS**	**REQUIREMENTS**	**SELLER**

			RESPONSE
Safe stall time:			
Motor at SF load operating temperature	sec		
Motor at max ambient temperature	sec		
Consecutive Starts:			
Motor at SF load operating temperature			
Motor at max ambient temperature			
Cooling period at max number of consecutive starts:			
Motor operating at SF			
Motor operating w/driven equipment unloaded			
Down thrust rating:			
Continuous	lb		
Momentary	lb		
Up thrust rating			
Continuous	lb		
Momentary	lb		
Rotor inertia	lb-ft^2		
Thrust bearing type			
Thrust bearing lubrication (oil/grease)			
Lower guide bearing type			
Lower guide bearing lubrication (oil/ grease)			
Space heater rating, (watts/ volts/ phase)			
MEDIUM VOLTAGE MOTORS	**UNITS**	**REQUIREMENTS**	**SELLER**

			RESPONSE
Sound level	dBA		
Reed natural frequency	Hz		
Dimensions: bottom of flange to center of gravity	inches		
Overall dimensions including shaft extension	inches		
Shaft extension	inches		
Rotor removal clearance	inches		
Weight	lb		
Stator RTD type			
Stator RTD quantity			
Bearing Temperature device type			
Bearing Temperature device quantity			

****

The following additional information shall also be included with proposals:

1. Seller variances or exceptions to the specification.
2. Seller's test report for electrically duplicate or prototype motor.
3. Seller's motor efficiency test method description including assumptions and accuracy.
4. Typical motor outline drawing.
5. Motor speed torque at rated voltage.
6. Motor speed torque at 85% rated voltage.

****

APPENDIX 3

PERFORMANCE GUARANTEES

****
Insert project-specific performance guarantee requirements in this Appendix.
****

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

****

In addition to revising this spec to correspond to project-specific requirements, update all Appendix highlighted areas with project-specific data.

****

SITE CONDITIONS

LOCATION

Xcel Energy's Cherokee Station site is located in Adams County, CO at 6198 Franklin St. Denver, CO 80216.

METEOROLOGICAL DATA

Table 1 below lists the major site conditions which are based on ambient weather conditions taken from several data references. The following abbreviations apply to this table:

DBT:	Dry Bulb Temperature
MCWB:	Mean coincident wet bulb for a given dry bulb temperature
AMSL:	Above Mean Sea Level
IBC:	International Building Code

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

TABLE 1 – MAJOR SITE CONDITIONS

PARAMETER	DATA
Site Elevation	5131 feet AMSL
Site Ambient Conditions	
Record low dry bulb temperature: MCWB for record low DBT:	-29°F -29°F
99% winter design dry bulb temperature: MCWB for 99% winter design DBT:	-5°F -8°F
Average winter dry bulb temperature: MCWB for average winter DBT:	-35°F -29°F
Annual average dry bulb temperature: MCWB for annual average DBT:	50°F 39°F
Summer 1% dry bulb temperature: MCWB for summer design 1% DBT: (Comparable to ASHRAE cooling, 0.4% occurance)	95°F 70°F
Record high dry bulb temperature: MCWB for record high DBT:	105°F 72°F
Dry bulb temperature for ISO System Accrediation: MCWB for ISO System Accrediation DBT:	95°F 70°F
Relative Humidity Range	0% to 100%
Annual Average Percipitation	18 inches
Maximum 24 Hour Rainfall Total	3 inches
Annual Average Snowfall	60 inches
Maximum 24 Hour Snowfall Total	48 inches

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

WIND LOADING

Wind loads shall be in accordance with the IBC. Basic wind design parameters are as follows:

DESCRIPTION	CHEROKEE	NOTES
Classification of Structure Category	III	Ref. ASCE 7-05, Section 1.5
Exposure	C	Ref. ASCE 7-05, Section 6.56
Wind Importance Factor	1.15	
Reference Wind Velocity, V	90 mph	3 sec. gust @ 33 ft. above ground. Ref. ASCE 7-05

SEISMIC CRITERIA

Structures shall be designed using the seismic criteria in the IBC as applicable to Colorado. Basic seismic parameters, per the IBC, are as follows:

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration at a short period (0.2 seconds), S_s = 0.217g.

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration a 1 second period), S_s = 0.056g.

Seismic Importance Factor, I_E = 1.25.

Based on the information presented in the Geotechnical Report, the project site has been assigned to Site Class D, to be verified by a site-specific geotechnical report.

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

REFERENCE MATERIALS

The following drawings contain additional scope requirements as part of this specification:

- General Arrangements
- One-Line Diagrams
- Three-Line Diagrams
- Schematic Diagrams
- Wiring Diagrams

****

For motor replacement projects, consult with Mechanical for existing driven equipment requirements and update this section with mechanical drawings as applicable.

****

APPENDIX 5

QA/QC (Including Inspection Test Plans)

****
Revise this Appendix accordingly per project-specific requirements.
****

QA/QC

INSPECTION AND TEST PLANS

Seller shall submit their standard Inspection and Test Plan (ITP) for approval in accordance with Appendix 1 requirements.

QA/QC INSPECTIONS/REPORTING

****
Determine frequency of Xcel inspections of Seller's facilities during fabrication, prior to delivery, etc. and add requirements to this section as required. Review Xcel Intranet QA/QC Toolbox for various tools and templates for the following, as project requirements dictate:

- Shop inspection reports
- Non-conformance reports
- Release for shipment, etc.

Add these documents to this Appendix as required.
****

APPENDIX 6

STARTUP, TESTING AND COMMISSIONING

****
The following are minimum suggested testing requirements. Revise per project requirements as required:
****

TESTING

Factory Testing:

1. Perform factory tests in accordance with IEEE/ANSI and NEMA standards.
2. Motor testing shall be performed with motor terminal housing installed on motor.
3. Factory tests shall include the following minimum tests:
   a. No-load running current
   b. No-load speed
   c. Insulation resistance
   d. Winding resistance
   e. Mechanical balance
   f. Locked rotor current
   g. Motor efficiency
4. Submit test data/test reports in accordance with Appendix 1.

Shop Tests:

1. Perform standard shop tests in accordance with NEMA and IEEE standards.

****
Depending on project requirements, determine the level of factory field support required for startup/commissioning.

****

APPENDIX 7

PACKAGING, SHIPPING AND STORAGE

PACKAGING, SHIPPING AND STORAGE

Seller shall prepare equipment for shipment following successful completion of factory testing and resolution of QA/QC non-conformances (see Appendix 5 for additional details.

Seller shall prepare equipment to withstand any possible damage or loss due to rough handling or exposure to weather during transit or extended outdoor storage (up to two (2) years).

Seller shall install all required covers to protect equipment from rain, hail, wind, dust, snow and environmental conditions detrimental to the equipment.

Equipment shall be adequately sealed and protected during shipment to prevent corrosion, foreign matter egress and freeze damage which could result from the presence of residual water.

Lifting points and centers of gravity shall be clearly marked on the shipped equipment.

Shipping structural bracing shall be installed as required to allow for field handling, skidding and hoisting.

Equipment supplied with space heaters shall have heater leads accessible without requiring disassembly of shipping containers.

Threaded outlets shall have plugs or caps installed prior to shipping.

Ancillary materials which are “shipped loose” shall be in separately boxed and re secured to the main equipment containers.

Seller shall provide the following minimum unloading/handling information:

- Shipping weight and dimensions of each article
- Pick points
- Rigging requirements
- Weight distribution
- Center of gravity
- Sensitivities
- Hazards

A QA/QC inspection certification, signed by the Seller shall be issued to the company prior to shipment. A copy of this certificate shall be included with the Bill of Lading.

APPENDIX 7

PACKAGING, SHIPPING AND STORAGE

Shipping documentation shall include the following minimum information:

- Company Destination (Plant, Unit)
- Company Agreement number
- Sellers order number
- Date shipped
- Shipping origin
- Company equipment tag information
- Seller's equipment identification information
- Shipment tracking information
- Shipment description
- Shipment quantity
- Gross weight
- Special handling requirements
- Identification of spare equipment
- Barcode, RFID, or similar material control information

Seller shall coordinate all deliveries with Company prior to shipment. Coordination shall include resolution of QA/QC non-conformances, delivery schedule, unloading/handling requirements, and storage requirements.

APPENDIX 8

ACCEPTABLE MANUFACTURERS

****
The following list contains the typically preferred manufacturers. Coordinate with Xcel Sourcing to determine final bid list:
****

Acceptable manufacturers are as follows:

- General Electric
- Louis Allis
- Seimens
- TECO Westinghouse
- Toshiba
- US Motors/Nidec
- WEG

MASTER SPECIFICTION
FOR

Metal-Clad Switchgear (MV)

Revision 1.0

REVISION HISTORY

Date	Revision	Change Description
3-4-2015	1.0	Enhancements; Required Format

****

In addition to revising this spec to correspond to project-specific requirements, update all highlighted areas with project-specific data.
****

GENERAL

DESCRIPTION

****
Insert project-specific description items (i.e. new construction project, replacement project, project location, etc.)
****

SUMMARY

This specification details the requirements for medium voltage (MV) switchgear which is comprised of MV circuit breakers.

****
Note for MV switchgear replacement projects: Revise appropriate sections below, and Appendix 4, to include details regarding existing plant conditions that will affect switchgear design. Minimum existing plant condition items to consider:

- Existing space constraints
- Existing switchgear orientation
- Existing stub-up locations
- Existing bus duct connection points
- Arc Flash ductwork routing obstructions within existing space (if applicable)
- Breaker removal space impact of new gear dimensions

****

Reference Drawings

The following drawings, included in Appendix 4, contain additional scope requirements as part of this specification:

- General Arrangements
- One-Line Diagrams
- Three-Line Diagrams
- Relaying/Protective Device Schematics
- Bus Duct Connection Info

Technical Proposal Documentation

See Appendix 2 for technical proposal requirements.

APPLICABLE CODES AND STANDARDS

- State and local codes, laws, ordinances, rules and regulations
- ANSI - American National Standards Institute
- ASTM - American Society for Testing and Materials
- ICEA - Insulated Cable Engineers Association
- IEEE - Institute of Electrical and Electronic Engineers
- NEMA - National Electrical Manufacturer's Association
- NFPA - National Fire Protection Association
- OSHA - Occupational, Health and Safety Administration
- UL Underwriter's Laboratories

In the event of conflict or disagreement between codes and standards, the more stringent conditions shall govern.

TECHNICAL REQUIREMENTS

DESIGN & CONSTRUCTION FEATURES

1. **Environmental**

   MV switchgear shall be manufactured to withstand site environmental conditions. See Appendix 4 for site specific environmental conditions.

2. **Ratings**

   MV switchgear ratings shall be as specified in Appendix 2 Data Sheets.

SWITCHGEAR CONSTRUCTION

1. Switchgear shall be metal-clad and mounted in one-high or two-high vertical sections fabricated of steel and assembled to provide rigid self-supporting, completely enclosed structures.
2. Switchgear shall include all gas ductwork required to exhaust arc flash gasses from the switchgear to building exterior.
3. Switchgear breakers shall be removable from the front.
4. All live parts shall be completely enclosed. Grounded removable steel barriers shall be provided between adjacent sections and solid removable metal barriers shall isolate the major primary sections of each circuit.
5. MV switchgear shall be provided with closed-door racking and closed-door remote racking.
6. Each breaker cubicle shall have individual back panels to allow rear access to associated cables etc. and shall be able to be opened without exposure to adjacent breaker live parts.
7. The switchgear shall be capable of extension from either end without modification to existing structural members.
8. If louvers are furnished as part of the switchgear enclosure they shall be provided with air filters.
9. The depth of cable entries shall allow for entrance, bending, and termination of power cables, including stress cones, and shall have a minimum of 24 inches of

clearance between the terminal pads and the cable entrance point to the cubicle.

10. Cable supports shall be provided every 24 inches to support cables for lugs not located near the cable entrance.
11. Switchgear sections shall allow top and bottom entry of power, control and instrumentation cables.

INFRARED INSPECTION PORTS

1. Infrared (IR) inspection ports shall be installed to permit thermography inspection of all line and load connections.
2. IR inspection port NEMA rating shall be equal to, or greater than, that of the enclosure in which it is installed.
3. IR inspection ports shall be NFPA 70E compliant.
4. IR inspection ports shall be 3 inch minimum diameter and shall consist of reinforced polymeric optic material.

SPACE HEATERS

1. Each vertical switchgear section shall be provided with thermostatically-controlled anti-condensation space heaters.
2. Heaters shall be rated for 240 VAC and energized and sized for application at 120 VAC.

GROUND BUS

1. A non-insulated, predrilled, copper bar ground bus shall extend the entire length of each switchgear lineup and to each cubicle.
2. Copper ground bar minimum size shall be 1/4 inch by 2 inches.

BUS CONSTRUCTION

1. Switchgear bussing shall consist of electrical grade high-conductivity copper bars, silver-plated at all contact surfaces and shall be designed to continuously carry rated design current.
2. Bussing shall be braced with rigid, tracking-resistant, fire-resistant, and moisture-resistant insulating supports capable of withstanding the mechanical forces imposed by short-circuit currents equal to the momentary current rating of the largest circuit breaker in the assembly.
3. Bussing shall have fluidized bed epoxy, flame resistant, non-hygroscopic insulation with a continuous current rating. The bus bar insulation shall be flame resistant and shall be flame resistant in accordance with ANSI/IEEE standards.
4. Bus joints shall have insulated boots that can be easily removed and reinstalled to allow inspection of the joints.
5. Phase sequencing for power connections and main bus shall be left-to-right, top-to-bottom, front-to-back (phase A-B-C) when facing the front of the switchgear. All bussing shall have phase identification installed.

MV CIRCUIT BREAKERS

1. The switchgear shall be furnished with draw-out medium voltage power circuit

breakers. The power circuit breakers shall be vacuum type.

2. Each breaker shall have three (3) positions: operate, test, and disconnected. Breaker position shall be indicated on the breaker.
3. The power circuit breaker operating mechanism shall be fully mechanically and electrically trip-free in any position. The main contacts of the power circuit breakers shall not touch or arc across into a faulted circuit when a breaker close signal is received while a trip signal is being applied.
4. Each breaker shall be furnished with a manual trip push button, which mechanically trips the breaker. The manual trip push button and its associated breaker trip linkage shall have no common components with the electrical trip mechanism, except the final breaker release device.
5. Each circuit breaker shall be capable of being padlocked in the disconnected position.

SHUTTERS

1. Grounded automatic metal safety shutters shall be provided which isolate the primary connections in power circuit breaker or voltage transformer (VT) compartment when circuit breakers or VTs are withdrawn from the connected position.
2. Shutters shall automatically operate when the power circuit breaker or voltage transformer is racked in or out.

AUXILIARY SWITCHES

1. Breaker Draw-out Auxiliary Position Switches (52/a/b):
    a. Each power circuit breaker shall be furnished with breaker-mounted auxiliary position switches mounted on the breaker frame.
    b. The breaker-mounted auxiliary position switches shall provide breaker opened or closed indication only when the breaker is in the fully “in-service” and “test” position.
    c. A minimum of two (2) normally-open (“a”) and two (2) normally-closed (“b”) contacts shall be furnished for Company’s use in addition to those required by the Seller’s design.
2. Breaker Stationary Position Switches (52S/a/b):
    a. Each breaker shall be furnished with stationary auxiliary position switches mounted in the breaker cell compartment.
    b. The breaker stationary auxiliary position switches shall provide breaker opened or closed indication only when the breaker is in the fully “in-service” position. When the breaker is not in the “in-service” position (e.g. in the “test” position or “disconnected” positions) the breaker stationary auxiliary position switches shall indicate the breaker is open at all times.
    c. A minimum of two (2) normally-open (“a”) and two (2) normally-closed (“b”) contacts shall be furnished for Company’s use in addition to those required by the Seller’s design.
3. Breaker Truck Position Switches (52H):
    a. Each breaker shall be furnished with truck position switches mounted in the breaker cell compartment. Each switch shall be field convertible to be either normally open or normally-closed.
    b. The breaker truck position switches shall provide breaker “in-service”/“not in-service” indication. The switches shall indicate that the breaker is “in-

service” only when the breaker is fully racked in to the “in-service” position.

c. A minimum of two (2) normally-open (“a”) and two (2) normally-closed (“b”) contacts shall be furnished for Company’s future use in addition to those required by the Seller’s design.

INSTRUMENTATION AND CONTROL

1. MV switchgear and motor controllers shall be controlled and monitored by Owner’s Distributed Control System (DCS).
2. Interposing relays shall be provided for interfacing with the DCS controls as required. Seller shall coordinate with Owner regarding DCS I/O requirements to determine the necessity and type(s) of interposing relays.

INSTRUMENT AND CONTROL WIRING

1. Instrumentation and control (I&C) wiring shall be stranded Type SIS, VW-1, extra flexible, insulated to 600 V with XLPE or EPR insulation.
2. The wiring shall have the following minimum sizes:
   a. Current Transformer circuits: 10 AWG
   b. Power circuits 12 AWG
   c. All other I&C circuits: 14 AWG
3. I&C wiring shall be installed and tested at the factory.
4. I&C wiring shall be installed in wiring gutters or conduit and secured with nylon ties.
5. I&C wiring shall be protected from contact with sharp edges with grommets.
6. Flexible wire guards shall be installed for wiring which cross hinge points.
7. Heat-shrinkable wire markers shall be installed at each end of each wire. Wire markers shall identify the wire’s respective termination points.

TERMINAL BLOCKS

1. All terminal blocks shall be one-piece UL94-VO material terminal blocks with strap-screw connectors and a minimum rating of 600 V, 30 amperes.
2. All current transformer circuits shall be wired to shorting-type terminal blocks.
3. All terminal blocks and terminals on terminal blocks shall have legible machine lettering.
4. No more than two (2) wires shall be terminated at any one (1) terminal point.
5. One (1) side of each terminal block used for external connections shall be reserved solely for external connections.
6. Current transformer circuits shall be wired to shorting terminal blocks

TERMINATIONS

1. Terminal blocks shall be provided with a minimum of 20% spare terminals.
2. When compatible with Manufacturer’s standard supply, all circuits shall be terminated with ring-type connectors.
3. All spare contacts shall be wired to terminal blocks.

CONTROL POWER

1. A common 125 VDC bus shall be wired throughout each switchgear lineup to provide power for breaker control, charging motor, protective relaying, and other auxiliary components.
2. The common 125 VDC bus shall have one (1) supply point in each switchgear lineup. A single, visible break disconnecting device shall be provided to disconnect both the closing and tripping circuits.
3. Breaker close and trip circuits shall be fused separately in each breaker cubicle. Control or protective devices that are common to more than one (1) breaker shall be fused on separately fused circuits. Minimum trip circuit fuse rating shall be 30 A.
4. Breaker close circuit power shall be sub-fused from the trip circuit power supply.

PROTECTIVE RELAYING AND METERING

1. Seller shall furnish and install protective relaying and metering as shown in Appendix 4 reference drawings.
2. Relaying and metering test switches shall be provided for all trip, current transformer (CT) and voltage transformer (VT) circuits. See Appendix 4 drawings for additional requirements. Test switches shall be ABB FT-1 or States Type FMS. Test switches shall have black handles for current and voltage poles, red handles for trip poles.
3. Control switches shall be furnished and installed for each breaker. The switches shall be configured such that the breakers cannot be closed with the breakers racked in to the “in-service” position.
4. Lock-out relays (LOR) shall be manual reset Electroswitch Series 24, lighted target nameplate with (2) LEDs and mechanical trip target.
5. Breaker position indicating lights shall be provided for each breaker adjacent to their respective control switches. Indicating lights shall be long-life LED type with push-to-test feature. Red lights shall indicate breaker in CLOSED position green lights shall indicate breaker in OPEN position.
6. Coil monitoring relays shall be furnished and installed. Relays shall be flush-mounted on the cubicle door front such that coil healthy indicating light is visible.
7. Optical arc flash detection relays shall be installed in all medium voltage switchgear cubicles. Optical relays shall coordinate with protective devices specified herein and are intended to reduce personnel arc flash hazard levels.
8. Metering shall be provided in accordance with Appendix 4 drawings.
9. Switchgear metering shall be factory calibrated have factory installed parameter settings.

CURRENT TRANSFORMERS

1. Current transformer (CT) shall be designed to allow maintenance or replacement of the CTs without damage. CTs shall be mechanically braced to withstand rated breakers/contactor short circuit currents.
2. Current transformer mechanical and thermal limits shall be coordinated with the momentary and short time ratings of their associated breakers/contactors.
3. All spare breakers and equipped spaces shall be furnished with multi-ratio

current transformers as shown on Appendix 4 drawings.

4. Unless otherwise specified, CT polarity marks shall be toward the breaker.

VOLTAGE TRANSFORMERS

1. Voltage transformers (VT) shall be mounted on draw-out type removable units which isolate and ground the potential circuits when the unit is in the fully withdrawn position.
2. Each VT shall be provided with current limiting primary fuses. Secondary fusing shall be fast-acting type and selected to fully coordinate with the primary fuses for a fault on the secondary control circuits.

NAMEPLATES

1. Engraved nameplates shall be furnished on the outside of each switchgear lineup and individual switchgear section.
2. Switchgear nameplates shall be 1/16 inch laminated phenolic resin with white background and black core. Nameplates shall indicate the following minimum information:
    a. Equipment description/name
    b. Equipment tag number
    c. NEMA equipment ratings
3. Engraved nameplates shall also be furnished for auxiliary devices and terminal blocks mounted inside compartments.
4. Nameplates shall be mounted using stainless pan-head self-tapping screws.

SPARE PARTS AND TOOLS

1. Each switchgear lineup shall be furnished with the following minimum spare parts, maintenance and operating equipment:
    a. One (1) portable lift truck for breaker installation and removal.
    b. One (1) ground and test device.
    c. Manual lever or crank for moving the breaker elements into and out of the operating position.
    d. Manual spring charging handle for circuit breaker.
    e. Remote racking device.
    f. Remote test station for testing the circuit breaker outside the cubicle and in the test position.
    g. Special tools required for operation or maintenance.
    h. Test modules, test devices, test equipment, software, and software licenses for testing and setting relays and associated protective devices.
    i. Provide 50% spare set of fuses for each size and type of fuse furnished and 10% spare set of indicating lights and lenses.

TESTING

Testing requirements are defined in Appendix 6.

DELIVERABLES

Deliverable requirements are defined in Appendix 1.

PROPOSAL DATA REQUIREMENTS

Seller shall provide proposed equipment data in accordance with Appendix 2.

SITE CONDITIONS

Site conditions are defined in Appendix 4.

QUALITY ASSURANCE

QA/QC requirements are defined in Appendix 5.

PACKAGING STORAGE & SHIPPING

Packing, shipping storage requirements are defined in Appendix 7.

MATERIALS & WELDING

****
Fill in as required
****

PERFORMANCE GUARANTEES

****
Fill in Appendix 3 as required
****

SOUND CONTROL REQUIREMENTS

****
Fill in as required
****

CLEANING, PAINTING & COATING

****
Fill in as required
****

APPENDICES TO SPECIFICATION

****

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.
****

1. DELIVERABLES
2. PROPOSAL DATA REQUIREMENTS
3. PERFORMANCE GUARANTEES
4. SITE CONDITIONS AND REFERENCE MATERIALS
5. QA/QC (Including Inspection Test Plans)
6. STARTUP, TESTING, AND COMMISSIONING
7. PACKAGING, SHIPPING, AND STORAGE
8. ACCEPTABLE MANUFACTURERS

APPENDIX 1

DELIVERABLES

****
The following is a list of minimum suggested deliverables and deliverable information. Revise per project requirements as required:
****

Manufacturer drawings:

1. Shipping layout drawings
2. Installation instructions/details including rigging information and equipment loadings
3. Dimensioned switchgear lineup (overall and cubicle) plan, elevation and detail drawings including cubicle cross sections, bus arrangements, weights, grounding details.
4. Switchgear Bill of Material
5. Bus duct connection details
6. Arc flash ductwork plan, elevation and detail drawings
7. Nameplate schedule and details
8. Switchgear one-line drawings
9. Switchgear three-line drawings
10. Control and relaying/protective device schematics and wiring diagrams
11. Current transformer excitation curves

Test data:

1. Factory and field test data/test report. See Appendix 6 for details.

Operation and Maintenance Manuals:

1. Operation and maintenance (O&M) manuals shall include the following minimum information:
    a. Installation instructions.
    b. Operating instructions.
    c. Maintenance instructions.
    d. Nameplate data.
    e. Assembly drawings.
    f. Bill of Material with vendor part numbers
    g. Cut sheets and brochure data for all transformer auxiliary equipment including relay manufacturer's O&M information
    h. Recommended spare parts list
    i. Certified (final) test reports
    j. Storage and Handling instructions.
    k. Special tools required for installation, operation and/or maintenance
    l. Warranty information

APPENDIX 1

DELIVERABLES

QA/QC:

1. Seller's QA/QC Inspection and Test Plan (ITP)

****
Include project-specific requirements for the following:
****

- Seller Deliverable Schedule
- Deliverable Format
- Deliverable Quantities

APPENDIX 2

PROPOSAL DATA REQUIREMENTS

METAL-CLAD SWITCHGEAR (MV) DATA SHEET

Seller shall provide the following minimum technical data applicable to the equipment in the proposed scope of supply.

****

In addition to revising this spec to correspond to project-specific requirements, update all highlighted areas with project-specific data.

****

METAL-CLAD SWITCHGEAR (MV)	UNITS	REQUIREMENTS	SELLER RESPONSE
Manufacturer		Seller	
City & Country of Manufacture		Seller	
MV BREAKER SWITCHGEAR			
Bus Conductor Material		Copper with silver-plated contact surfaces	
Switchgear Configuration		3-Phase, 3W, Low-Impedance Gnd	
Switchgear Bus Rating	A	4000	
Rated Nominal Voltage	kV	4.16	
Rated Maximum Voltage	kV	4.76	
Operating Frequency	Hz	60	
Insulation Level (Frequency)	kV, RMS	19	
Insulation Level (Impulse)	kV, Crest	60	
Rated Short Circuit and Short Time Current (@ rated max kV)	kA, RMS	50	
Max Symmetrical Interrupting Capability	kA, RMS	50	
Rated Interrupting Time	cycles	5	
Rated Permissible Tripping Delay	seconds	2	
Installation Location		Indoors	
Enclosure NEMA type		Type 1	

Switchgear Type		Metal-Clad	
Arc-Resistance Type		Type 1	
Breaker Type		Vacuum, Draw-out	
Control Voltage	VDC	125	

****

The following additional information shall also be included with proposals:

1. Seller variances or exceptions to the specification.
2. Itemization of proposed estimated materials.
3. Add/deduct pricing for breaker type/rating, contactor type/rating, etc.
4. Recommended spare parts list with pricing.

****

APPENDIX 3

PERFORMANCE GUARANTEES

****

Typically, switchgear systems do not have performance guarantees associated with them. However, consider all project-specific requirements to determine the applicability of this Appendix.

****

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

****

In addition to revising this spec to correspond to project-specific requirements, update all Appendix highlighted areas with project-specific data.

****

SITE CONDITIONS

LOCATION

Xcel Energy's Cherokee Station site is located in Adams County, CO at 6198 Franklin St. Denver, CO 80216.

METEOROLOGICAL DATA

Table 1 below lists the major site conditions which are based on ambient weather conditions taken from several data references. The following abbreviations apply to this table:

DBT:	Dry Bulb Temperature
MCWB:	Mean coincident wet bulb for a given dry bulb temperature
AMSL:	Above Mean Sea Level

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

TABLE 1 – MAJOR SITE CONDITIONS

PARAMETER	DATA
Site Elevation	5131 feet AMSL
Site Ambient Conditions	
Record low dry bulb temperature: MCWB for record low DBT:	-29°F -29°F
99% winter design dry bulb temperature: MCWB for 99% winter design DBT:	-5°F -8°F
Average winter dry bulb temperature: MCWB for average winter DBT:	-35°F -29°F
Annual average dry bulb temperature: MCWB for annual average DBT:	50°F 39°F
Summer 1% dry bulb temperature: MCWB for summer design 1% DBT: (Comparable to ASHRAE cooling, 0.4% occurance)	95°F 70°F
Record high dry bulb temperature: MCWB for record high DBT:	105°F 72°F
Dry bulb temperature for ISO System Accrediation: MCWB for ISO System Accrediation DBT:	95°F 70°F
Relative Humidity Range	0% to 100%
Annual Average Percipitation	18 inches
Maximum 24 Hour Rainfall Total	3 inches
Annual Average Snowfall	60 inches
Maximum 24 Hour Snowfall Total	48 inches

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

WIND LOADING

Wind loads shall be in accordance with the IBC. Basic wind design parameters are as follows:

DESCRIPTION	CHEROKEE	NOTES
Classification of Structure Category	III	Ref. ASCE 7-05, Section 1.5
Exposure	C	Ref. ASCE 7-05, Section 6.56
Wind Importance Factor	1.15	
Reference Wind Velocity, V	90 mph	3 sec. gust @ 33 ft. above ground. Ref. ASCE 7-05

SEISMIC CRITERIA

Structures shall be designed using the seismic criteria in the IBC as applicable to Colorado. Basic seismic parameters, per the IBC, are as follows:

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration at a short period (0.2 seconds), S_s = 0.217g.

Mapped Maximum Considered Earthquake (MCE), 5% damped, spectral response acceleration a 1 second period), S_s = 0.056g.

Seismic Importance Factor, I_E = 1.25.

Based on the information presented in the Geotechnical Report, the project site has been assigned to Site Class D, to be verified by a site-specific geotechnical report.

APPENDIX 4

SITE CONDITIONS AND REFERENCE MATERIALS

REFERENCE MATERIALS

The following drawings contain additional scope requirements as part of this specification:

- General Arrangements
- One-Line Diagrams
- Three-Line Diagrams
- Control and Relaying/Protective Device Schematic Diagrams
- Bus Duct Layouts Connection Info

APPENDIX 5

QA/QC (Including Inspection Test Plans)

****
Revise this Appendix accordingly per project-specific requirements.
****

QA/QC

INSPECTION AND TEST PLANS

Seller shall submit their standard Inspection and Test Plan (ITP) for approval in accordance with Appendix 1 requirements.

QA/QC INSPECTIONS/REPORTING

****
Determine frequency of Xcel inspections of Seller's facilities during fabrication, prior to delivery, etc. and add requirements to this section as required. Review Xcel Intranet QA/QC Toolbox for various tools and templates for the following, as project requirements dictate:

- Shop inspection reports
- Non-conformance reports
- Release for shipment, etc.

Add these documents to this Appendix as required.
****

APPENDIX 6

STARTUP, TESTING AND COMMISSIONING

****
The following are minimum suggested testing requirements. Revise per project requirements as required:
****

TESTING

Factory Testing:

1. Perform factory tests in accordance with IEEE/ANSI and NEMA standards.
2. Factory tests shall include the following minimum tests:
   a. Bus high potential and insulation resistance
   b. Voltage withstand
   c. Point-to-point wiring checks
   d. Relay injection testing
   e. Standard breaker tests
   f. Standard contactor tests
   g. CT and VT ratio, excitation and polarity tests
   h. Shutter operational tests
3. Submit test data/test reports in accordance with Appendix 1.

Shop Tests:

1. Perform standard shop tests in accordance with IEEE standards.

****
Depending on project requirements, determine the level of factory field support required for startup/commissioning. Minimum commissioning considerations are as follows:

- Construction/installation inspections
- International Electrical Testing Association (NETA) standard field tests (e.g. bus high potential testing, megger, etc.)
- Breaker operation testing

****

APPENDIX 7

PACKAGING, SHIPPING AND STORAGE

PACKAGING, SHIPPING AND STORAGE

Seller shall prepare equipment for shipment following successful completion of factory testing and resolution of QA/QC non-conformances (see Appendix 5 for additional details.

Seller shall prepare equipment to withstand any possible damage or loss due to rough handling or exposure to weather during transit or extended outdoor storage (up to two (2) years).

Seller shall install all required covers to protect equipment from rain, hail, wind, dust, snow and environmental conditions detrimental to the equipment.

Equipment shall be adequately sealed and protected during shipment to prevent corrosion, foreign matter egress and freeze damage which could result from the presence of residual water.

Lifting points and centers of gravity shall be clearly marked on the shipped equipment.

Shipping structural bracing shall be installed as required to allow for field handling, skidding and hoisting.

Equipment supplied with space heaters shall have heater leads accessible without requiring disassembly of shipping containers.

Threaded outlets shall have plugs or caps installed prior to shipping.

Ancillary materials which are “shipped loose” shall be in separately boxed and re secured to the main equipment containers.

Seller shall provide the following minimum unloading/handling information:

- Shipping weight and dimensions of each article
- Pick points
- Rigging requirements
- Weight distribution
- Center of gravity
- Sensitivities
- Hazards

A QA/QC inspection certification, signed by the Seller shall be issued to the company prior to shipment. A copy of this certificate shall be included with the Bill of Lading.

APPENDIX 7

PACKAGING, SHIPPING AND STORAGE

Shipping documentation shall include the following minimum information:

- Company Destination (Plant, Unit)
- Company Agreement number
- Sellers order number
- Date shipped
- Shipping origin
- Company equipment tag information
- Seller's equipment identification information
- Shipment tracking information
- Shipment description
- Shipment quantity
- Gross weight
- Special handling requirements
- Identification of spare equipment
- Barcode, RFID, or similar material control information

Seller shall coordinate all deliveries with Company prior to shipment. Coordination shall include resolution of QA/QC non-conformances, delivery schedule, unloading/handling requirements, and storage requirements.

APPENDIX 8

ACCEPTABLE MANUFACTURERS

****
The following list contains the typically preferred manufacturers. Coordinate with Xcel Sourcing to determine final bid list:
****

Acceptable manufacturers are as follows:

- ABB
- Eaton
- Powell
- Siemens
- Square-D

TECHNICAL SPECIFICATION

4160 VOLT NON-SEGREGATED PHASE BUS DUCT

Prepared by:

NAME OF A/E FIRM ENGINEERING PROJECT

Rev.	Date	Issued for	Prepared By	Technical Approval	Project Approval

4160 VOLT NON-SEGREGATED PHASE BUS DUCT

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EXHIBIT A

4160 VOLT NON-SEGREGATED PHASE BUS DUCT

PART 1 SCOPE

1.01 GENERAL

A. Description

1. The 4160 V non-segregated phase bus duct shall be designed and constructed for use on a 4160 V, 3-phase, 60 hertz, 3 wire, resistance grounded (2.4 ohm) system.

2. All indoor and outdoor bus duct, including fittings, bus duct supports, and conductor flexible connectors shall be furnished in accordance to these Specifications.

3. One 4160 V bus duct shall be required from each auxiliary power transformer secondary flange connection of each unit auxiliary power transformer.

B. Bus Duct Layout

1. Refer to site layout and powerhouse layout drawings for location and orientation of powerhouse and auxiliary power transformer equipment.

2. The following estimated bus duct lengths, number of supports, and fittings may be used for bidding purposes (per bus duct run).

a. Outdoor bus duct length/run -

b. Indoor bus duct length/run -

c. Fittings (quantity) -

d. Outdoor supports(quantity)/run -

3. Include separate additional add/deduct pricing in proposal for elbows and a cost per foot of bus for final price adjustments.

C. Reference Drawings

The following drawings are being submitted as part of this specification:

Bus Layout

One-Line Diagram

Site Layout

Aux Transformer Outline

5kV Non-Seg Bus Auxiliary Transformer

D. Technical Proposal Documentation

1. The following information shall be included with the bid proposal:

e. Any variances or exceptions which the Manufacturer has to this and referenced specifications.

f. Attached data sheets to be filled out as completely as possible.

g. Estimated materials.

h. Manufacturer's sales literature pertinent to proposed equipment.

E. Approved Manufacturers

Delta-Unibus

Calvert

Cutler-Hammer

ABB

1.02 WORK TO BE PROVIDED BY SELLER

FILL IN AS REQUIRED

1.03 WORK TO BE PROVIDED BY PURCHASER

FILL IN AS REQUIRED

PART 2 CODES, STANDARDS & REGULATIONS

A. State and local codes, laws, ordinances, rules and regulations

B. ANSI - American National Standards Institute

C. ASTM - American Society for Testing and Materials

D. ICEA - Insulated Cable Engineers Association

E. IEEE - Institute of Electrical and Electronic Engineers

F. NEMA - National Electrical Manufacturer's Association

G. NFPA - National Fire Protection Association

H. OSHA - Occupational, Health and Safety Administration

I. UL Underwriter's Laboratories

In case of conflict or disagreement between codes and standards, the more stringent conditions shall govern.

PART 3 TECHNICAL REQUIREMENTS

3.01 PERFORMANCE REQUIREMENTS & GUARANTEES

FILL IN AS REQUIRED

3.02 DESIGN & CONSTRUCTION FEATURES

A. Environmental

1. The following ambient and site conditions shall be used in the designed of all furnished equipment.

a. Site Location

b. Site Elevation, Feet (above mean sea level)

c. Atmospheric Pressure (psia)

d. Maximum Design Temperature, degrees F

e. Minimum Design Temperature, degrees F

f. Design Wind Speed, per ANSI C2 (MPH)

g. Snow Load (pounds per square foot)

h. Seismic Zone (UBC)

i. Electrical Classification

2. Considerations shall be given to the exposure to solar heat in the areas of outdoor installation.

B. RATINGS

1. Bus duct shall be furnished with the following voltage ratings:

a.	Nominal voltage:	4.16 kV rms
b.	Rated maximum voltage:	4.76 kV rms
c.	Rated power frequency dry 1 minute withstand voltage:	19 kV rms
d.	Rated impulse withstand voltage:	60 kV peak

2. Bus duct shall be furnished with the following current and short circuit ratings:

a.	Continuous rated current:	2,000 amps rms
b.	Short-circuit withstand, asymmetrical (10 cycle rating): 65,000 amps rms or greater	

C. BUS CONSTRUCTION

1. Bus duct construction shall be in accordance to ANSI standard C37.23; and other applicable requirements of Codes and Standards stated in these Specifications.

2. Bus duct shall be furnished as a complete assembly of rigidly

supported conductors, housed in a 3-phase enclosure without barriers between the phase conductors.

3. The bus conductors shall be copper or aluminum alloy and shall be designed to carry rated continuous current without exceeding temperature rise requirements specified in IEEE and NEMA standards. The current carrying capacity shall be based on actual service conditions including skin and proximity effects, and the effects of the bus insulation, the bus duct enclosure, and the ambient temperature.

4. The bus shall be installed with rigid, non-tracking, fire-resistant, and nonhygroscopic insulating supports capable of withstanding the mechanical forces imposed by short-circuit currents equal to the momentary current.

5. All bus conductor connections shall be completed by bolting. These connections shall be silver-plated for copper bus and tin-plated for aluminum. Provisions shall be made for bus expansion, to prevent undesirable or destructive mechanical strains in the bus supports and connections, through the ambient temperature range from 20°F to 100°F. Expansion joints shall be furnished where required.

6. Except at bolted terminations and connection points, all phase conductors in bus duct shall have a "Noryl" or equal sleeve type insulating material. All bolted joints; expansion joints; and bus connections, factory or field; and connections between the bus conductors and transformer terminals shall be insulated with removable boots. Removable boots shall be designed to overlap permanent insulation on each conductor in the connection insulated by the boot. The length of overlap on each conductor shall not be less than 2 inches at expansion joints, and not less than 1 inch at other connections. The insulation rating of bus, joint, connection, and termination insulation shall be not less than the voltage rating of the equipment.

7. Taps or connections shall be provided, as required, to accommodate auxiliary equipment such as lightning and surge protection, generator controls, metering and relaying, and current and potential transformers.

8. Removable covers shall be provided to permit access to the interior of the enclosure.

D. BUS ENCLOSURE

1. Indoor sections of bus duct shall be furnished with non-ventilated dust-tight enclosures. Outdoor sections of bus duct shall be furnished with non-ventilated weatherproof enclosures.

2. The bus enclosures shall be fabricated from aluminum not less than 1/8 inch thick.

3. Wall flanges and airtight vapor barriers shall be furnished at each transition from indoor to outdoor bus duct. In addition, a fire barrier, with 2 hour rating, shall be provided when penetrating firewalls.

4. After fabrication, all metal work of the enclosures shall be thoroughly cleaned and any steel work shall be phosphorized, or equivalent, and shall be painted with gray ANSI 61, or equivalent, gray paint.

E. SPACE HEATERS

2. Outdoor bus duct sections shall be furnished with space heaters to prevent condensation of moisture within the bus duct.

3. The heaters shall be located and thermally insulated such that no painted surface or bus insulation shall be damaged or discolored. Space heater capacity shall be as required to maintain the compartment and the bus duct internal temperature above the dew point. Voltage normally applied to the space heaters will be 120 V.

4. Space heater voltage rating shall be 240 V. Space heaters shall be controlled by an adjustable thermostat, factory set at manufacturer's recommended setpoints.

F. GROUND BUS

1. A ground bus shall be furnished which will electrically connect together all equipment connected to the bus duct. The ground bus shall be capable of carrying rated bus short-circuit current.

2. If the bus duct enclosure is so constructed and connected that it provides a continuous path for ground current equal in magnitude and duration to that specified in Subsection 2.2B, it may serve as the ground bus. If the enclosure is used as the ground bus, a tooth type lock washer shall be furnished under each bolt head and each nut at connections between sections of bus duct. Bolts, nuts, and

lock washers shall be stainless steel.

3. Provisions shall be made at each transition from indoor to outdoor bus duct to connect the enclosure to the station grounding system.

G. OUTDOOR BUS DUCT SUPPORTS

1. Supports shall be designed for the Seismic Zone and wind speeds as specified in Subsection 2.1. Support spans shall be 12 feet or less.

2. Finish

   a. Supports shall be galvanized steel in accordance with ASTM A36.

   b. Structures shall be galvanized by the hot dip process in accordance with ASTM A-123 except that all shapes shall receive 3.0 ounces of zinc per square foot of surface area. Structures are to be galvanized both inside and out after all cutting, punching, welding and cleaning have been completed.

   c. Finished galvanized surfaces must be uniform in color, appearance and texture and must be free of excessive roughness, pimples, lumpiness and runs.

3. Each support shall have a standard NEMA (2 hole) ground pad located at its base.

4. Manufacturer shall consider equipment maintenance access when locating supports. Support locations shall be at least 3 feet from equipment to allow room for equipment maintenance.

H. INDOOR BUS SUPPORTS

1. Indoor supports shall be galvanized steel and designed for hanging supports from building overhead steel. Support spans shall be 12 feet or less.

I. EQUIPMENT TERMINATIONS

1. Manufacturer shall furnish all flexible connectors and bus termination fittings for equipment terminations, for the termination of the busbars to the transformers and switchgear.

3.03 SEISMIC REQUIREMENTS

FILL IN AS REQUIRED

3.04 SOUND CONTROL REQUIREMENTS

FILL IN AS REQUIRED

3.05 ELECTRICAL REQUIREMENTS

FILL IN AS REQUIRED

3.06 INSTRUMENTATION & CONTROL REQUIREMENTS

FILL IN AS REQUIRED

3.07 MATERIALS & WELDING

FILL IN AS REQUIRED

3.08 CLEANING, PAINTING & COATING

FILL IN AS REQUIRED

3.09 PACKAGING & SHIPPING

FILL IN AS REQUIRED

3.10 STORAGE & HANDLING PROCEDURES

FILL IN AS REQUIRED

3.11 SPARE PARTS

FILL IN AS REQUIRED

3.12 QUALITY ASSURANCE

FILL IN AS REQUIRED

PART 4 TESTING

4.01 MATERIAL TESTING & INSPECTION

A. Factory Tests

1. Perform standard factory tests in accordance to ANSI C37.23.

2. Include certified test reports in instruction books.

4.02 SHOP TESTS

FILL IN AS REQUIRED

4.03 FIELD TESTING

FILL IN AS REQUIRED

PART 5 INSTALLATION

A. Contractor shall install bus duct and outdoor supports in accordance to Manufacturer's instructions and drawings.

B. Install power wiring to bus duct space heater circuits from 120/208 volt distribution panel.

PART 6 SELLER'S DATA SUBMISSION SCHEDULE

6.01 GENERAL

FILL IN AS REQUIRED

6.02 DRAWINGS

A. SUBMITTALS

Submit approval drawings, final drawings, instruction books, and technical proposal per Section 01300.1.6 FACTORY TESTS

1. Perform standard factory tests in accordance to ANSI C37.23.

2. Include certified test reports in instruction books.

B. Approved Drawings

1. Shop approval drawings shall include at least the following drawings:

    a. Bus duct layout and arrangement showing phasing arrangement, weight, and detailed dimensions.

    b. Bus duct support details, anchor bolt plan, and support locations.

    c. Bus duct ratings

    d. Schematics and wiring diagrams showing customer connections for bus duct heaters.

    e. Bus duct connection details

C. Final Drawings and Manuals

1. Submit final "as-built" drawings and manuals.

2. The instruction books shall include, but not limited to:

    a. Complete service and repair manuals

    b. Complete parts list with vendor part numbers and a recommended spare parts list.

    c. Bill of materials

    d. Certified test reports

    e. Storage and Handling instructions

    f. Installation instruction

    g. Complete information for tightening of all electrical connections secured with bolts or studs shall be included on erection and assembly drawings. The information furnished shall include torque wrench settings or complete details of other tightening procedures recommended for bus joints and connector attachments.

D. TECHNICAL PROPOSAL DOCUMENTATION

1. The following information shall be included with the bid proposal:

a. Any variances or exceptions which the Manufacturer has to this and referenced Specifications.

b. Attached data sheets to be filled out as completely as possible.

c. Estimated materials

d. Manufacturer's sales literature pertinent to proposed equipment.

6.03 DATA SUBMISSION SCHEDULE

FILL IN AS REQUIRED

EXHIBIT B

PART 7 TECHNICAL DATA

7.01 SITE DATA

FILL IN AS REQUIRED

7.02 TECHNICAL DATA BY PURCHASER

FILL IN AS REQUIRED

7.03 TECHNICAL DATA BY SELLER

FILL IN AS REQUIRED

APPENDICES

NONSEGREGATED BUS DUCT DATA SHEET

Manufacturer shall provide the following data applicable to the equipment in the proposed scope of supply.

Manufacturer/Model Number	_____ / _____
Bus insulation	_____
Bus continuous rating	_____
Nominal voltage rating, kV rms	_____
Rated maximum voltage, kV rms	_____
Rated power frequency dry 1 minute	_____
Withstand voltage, kV rms	_____
Rated impulse withstand voltage, kV rms	_____
Rated low frequency withstand voltage, kV rms	_____
Size / rating of ground bus	_____
Rated momentary asym current, amperes rms (10 cycle rating)	_____

Exceptions to Specification:

_____

_____

_____

_____

MASTER SPECIFICTION
FOR
GENERATOR STEP-UP (GSU) TRANSFORMER

Revision _0_
Date 20131212

Responsible Technical Specialist _____

Author: John J Howard Jr	Revision No.:	Specification Approval:

GENERATOR STEP-UP (GSU) TRANSFORMER

GENERAL

Scope of Work

1. Seller shall design, test and deliver _____, < 3 >-phase, 60 Hz, oil-filled GSU transformer(s). Transformers shall be equipped with a high voltage no-load tap changer. Transformer MVA ratings shall be as specified in Appendix 2 Data Sheets. Maximum winding temperature (hot spot) rise shall not exceed < 80 > ºC and maximum liquid oil temperature rise shall not exceed < 65 > ºC when the generator is running at the maximum gross MW output, 24 hours, at the specified altitude in the specified location. The high voltage neutral shall be brought out and grounded through a bushing.
2. Seller shall be responsible for the following:
   a. Design, testing and delivery of GSU transformers as specified herein
   b. Delivery of transformer oil
   c. Field assembly
   d. Oil drying and vacuum oil filling
   e. GSU field testing
   f. GSU operation and maintenance training for site personnel
3. Company shall be responsible for the following:
   a. GSU foundation(s)
   b. GSU unloading and setting
   c. GSU electrical connections (primary, secondary, and control voltages)
   d. GSU grounding connections
4. Seller shall allow Company personnel access to its factory during transformer assembly and for witness testing. Seller shall provide transformer manufacturing schedule and updates to the schedule to the Company. Travel costs for Company personnel for site factory visits are the responsibility of the Company.

Specifier – Add discussion of options and criteria that must be addressed

---

B. Bus Duct Layout

1. *Refer to site layout and powerhouse layout drawings for location and orientation of powerhouse and auxiliary power transformer equipment.*
2. *The following estimated bus duct lengths, number of supports, and fittings may be used for bidding purposes (per bus duct run).*

Outdoor bus duct length/run
Indoor bus duct length/run
Fittings (quantity)
Outdoor supports(quantity)/run

3. *Include separate additional add/deduct pricing in proposal for elbows and a cost per foot of bus for final price adjustments.*

C. Reference Information
See Attachment 4

D. Technical Proposal Documentation
See Attachment 1

E. Approved Manufacturers
See Attachment 8

SUMMARY: Seller shall provide _____ Generator Step-Up (GSU) transformer**( )** for the _____ Plant located in _____.

APPLICABLE CODES AND STANDARDS

A. State and local codes, laws, ordinances, rules and regulations
B. ANSI - American National Standards Institute
C. ASTM - American Society for Testing and Materials
D. ICEA - Insulated Cable Engineers Association
E. IEEE - Institute of Electrical and Electronic Engineers
F. NEMA - National Electrical Manufacturer's Association
G. NFPA - National Fire Protection Association
H. OSHA - Occupational, Health and Safety Administration
I. UL Underwriter's Laboratories

In case of conflict or disagreement between codes and standards, the more stringent conditions shall govern.

TECHNICAL REQUIREMENTS

PERFORMANCE REQUIREMENTS & GUARANTEES
See Appendix 3

DESIGN & CONSTRUCTION FEATURES

A. Environmental
1. The following ambient and site conditions shall be used in the designed of all furnished equipment.
See Appendix 4
2. Considerations shall be given to the exposure to solar heat in the areas of outdoor installation.
3. The generator step-up (GSU) transformers shall be rated **< 65 >** °C rise to limit temperature to a maximum rise above

temperature ranges indicated in Appendix 4 Site Conditions. Winding and hot spot temperature rise shall be per ANSI Standards. Transformer cooling class shall be in accordance with Appendix 2 Data Sheets.

B. RATINGS

1. Transformer ratings shall be as specified in Appendix 2 Data Sheets.
2. Nameplate information shall be per the ANSI-C57.12.00 requirements.
3. Low Voltage (X) Primary: 3-phase, 60 Hz, **< delta >** connected.
4. High Voltage (H) Secondary: **< Grounded-Wye >** connected.
5. Taps: **< Two (2) 2.5% >** full capacity taps above nominal rated high voltage, **< Two (2) 2.5% >** full capacity taps below nominal rated high voltage, arranged for de-energized operation.
6. Vector Relationship: High voltage **< leading >** low voltage by **< 30 >** degrees.
7. Winding BIL rating: as specified in Appendix 2 Data Sheets.
8. Transformer impedance shall be measured per ANSI C57.12.90. Impedance tolerance shall be per ANSI standard. The zero sequence impedance shall be equal to or less than the positive sequence impedance.
9. Sound Levels shall be in accordance with NEMA TR1 Table O-2.

C. SHORT CIRCUIT & OVER-VOLTAGE CAPACITY

1. The transformer shall be capable of withstanding, without damage, the mechanical and thermal stresses caused by short circuits on the external terminals of any winding or windings, with 105% rated voltage maintained across the terminals of any other winding connected to an energy source for two seconds.
2. The transformer will be directly connected to the generator in such a way that it may be subjected to load rejection conditions which result in an abnormally high voltage from the generator. Therefore, the transformer shall be designed to withstand, as a minimum, the resulting voltage stresses with 1.4 times rated voltage for 5 seconds, applied at the transformer terminals.
3. The transformer shall be capable of operating at 100% duty cycle at 10% above rated voltage at full load and 15% above rated voltage at no load.
4. The transformer shall be capable of being back-fed from the **< ___ >** kV switchyard to serve auxiliary

loads while the generator is disconnected.

D. LOSSES

1. The transformer kW losses as a percentage of the base rating shall be evaluated based on no load losses, load losses at maximum nameplate rating, and cooling equipment power requirements at nameplate rating.
2. The loss evaluation factors shall be as follows: No Load (core losses): $2,000/kW; Load (copper losses): $2,000/kW; Cooling System (fan losses): $2,000/kW.
3. If Seller's actual losses at full load are higher than their guaranteed losses, the difference shall be deducted from the order price at a rate of $2,000 /kW.

E. HIGH VOLTAGE BUSHINGS

1. High voltage bushings shall be cover mounted, oil-filled, porcelain-clad, with liquid level indicators, the voltage class and BIL shall be as specified in Appendix 2 Data Sheets. Draw lead connections with silver plated threaded studs are preferred.
2. Transformer high voltage bushing terminals shall be designed and constructed for connection to an overhead line via NEMA four-hole flat pads.
3. Each high voltage bushing shall have bushing current transformers as specified in Appendix 2 Data Sheets.
4. The transformer design shall not utilize reduced clearance capabilities specific only to one (1) bushing manufacturer. The transformer design shall allow for interchangeability of all approved manufacturer's bushings in accordance with ANSI C57.19.00.

F. LOW VOLTAGE BUSHINGS

1. Low voltage phase bushings shall be oil-filled, porcelain-clad as specified in Appendix 2 Data Sheets.
2. Low voltage bushings shall be designed for connection to **< iso-phase bus >**.
3. Low voltage bushings shall be rated for connection to the **< bus >** operating at 105°C.
4. Each low voltage bushing shall have current transformers as specified in Appendix 2 Data Sheets.
5. Three (3) IEEE C62.11 station-class, metal oxide surge arrestors shall be provided (one for each high voltage phase). Surge arrestors shall be manufactured by General Electric, Cooper Industries, Ohio Brass, or ABB.

G. SURGE ARRESTERS

1. Three (3) IEEE C62.11 station-class, metal oxide surge arrestors shall be provided (one for each high voltage phase). Surge arrestors shall be manufactured by General Electric, Cooper Industries, Ohio Brass, or ABB.

2. A copper ground loop connecting the three surge arresters to two (2) separate ground pads at separate corners of the tank shall be furnished. Arrester rating shall be as specified in Appendix 2 Data Sheets.
3. Surge arrester line terminals shall be tin-plated.

H. NEUTRAL BUSHING

1. The high voltage neutral bushing shall be equipped with a current transformer as specified in Appendix 2 Data Sheets.
2. The Seller shall furnish an appropriately sized, permanently installed copper ground bus. This bus shall be connected to a grounding pad located on the transformer cover adjacent to the neutral bushing, and shall be routed down the side of the transformer to a second grounding pad located 6 inches from the bottom of the transformer base. Each grounding pad shall have four (4) ½-inch tapped holes located on 1 ¾-inch centers. The Seller shall furnish a removable, semi-rigid or flexible connection between the cover mounted grounding pad and the neutral bushing.

I. GROUNDS

1. Tank Grounds: Two (2) stainless steel, NEMA four-hole ground plates on opposite corners, one (1) stainless steel, NEMA four-hole ground plate located on the top of the transformer near the H0/X0/Y0 bushing(s), and stainless steel, NEMA two-hole hole ground plates adjacent to each core ground bushing.
2. Core Ground: The core ground shall be brought through the tank wall using a bushing of appropriate ampacity. Ground connection shall be made to a NEMA drilled and tapped, copper faced, steel ground pad located near the bushing. The transformer core ground connection shall be accessible from a manhole without removing any oil from the transformer tank or climbing into the tank. Bushings shall have a protective cover with a permanent non-rusting metal nameplate with the words “CORE GROUND ACCESS” engraved with 1/2” letters into the nameplate.
3. Grounding Brackets: Two (2) grounding brackets for portable grounds shall be provided per high and low voltage side of the transformer for a total of four (4) grounding brackets. The brackets shall be made of copper or stainless steel and shall be brazed if copper or welded if stainless-steel to the tank near each corner on both the high and low voltage sides. Appropriate procedures for brazing copper or welding stainless steel to the tank shall be used to ensure both good electrical conductivity and mechanical strength. The brackets shall not be painted. Grounding brackets shall be in accordance with Exhibit D, Personal Protective

Grounding Bracket Detail.

4. High Voltage Grounding Brackets: Three high voltage porcelain insulators shall be provided with provisions for grounding the transformer. Steel supporting brackets shall be supplied that extend from the high voltage side of the transformer and support the (3) insulators and (3) surge arrestors. Insulators shall be located furthest from the high voltage bushing and adjacent to the surge arrestor. Insulators shall be supplied with a copper bracket extending from the insulator. Copper bracket and insulator shall be of suitable for use in attaching Company-supplied grounding balls and grounding cables (for connecting safety grounds between the high voltage line source, and ground).

J. CORE & COILS

1. Cores and coils shall be braced to withstand short-circuit forces limited only by the transformer impedance without damage or displacement of the coil on the core under conditions described in this Specification, and to withstand normal moving and handling without the use of special shipping braces.
2. Transformer coils shall be copper. The coils shall be insulated from the core and from each other with sufficient insulation to withstand the standard impulse and low frequency tests for transformers of the designed voltage class. Insulation materials shall be asbestos-free.
3. Rectangular windings are not acceptable for main or tap windings.
4. Transformer windings shall be designed to be free-buckling and shall not rely on winding tubes for short circuit strength.
5. Core and coil assembly and all other internal components shall be dried by vapor-phase process to assure proper dryness of the insulation material.
6. The core legs shall have a solid support from the bottom to the top clamp to prevent sideways deformation and bulging of the outermost laminations. The core shall be adequately braced to the core clamping structure, so that it cannot move in any direction. The windings shall be tight to prevent sideways movements. The core and coil assembly and other internal components shall be supported by permanent bracing to the interior of the tank.

K. OIL PRESERVATION SYSTEM

1. The oil preservation system shall be a sealed conservator with flexible bladder to prevent contact with the atmosphere and allow expansion and contraction of the oil volume as the temperature changes. The conservator shall have a capacity between highest and lowest levels that are

adequate for full range of oil temperature. All conservator alarm contacts shall be wired to the main control cabinet

2. The system shall include a Buchholz gas detector relay and a sampling valve located at ground level. Access opening shall be provided at the conservator for cleaning and inspection purposes. A working platform with access ladder shall be provided for inspection and maintenance of the conservator and associated Buchholz relay. The relay shall be located in the piping between the main tank and the conservator.
3. All tanks and enclosures subject to operating pressures of the oil preservation system shall be designed to withstand 125% of the maximum operating pressures. In addition, the transformer tank and equipment shall be designed with sufficient bracing and strength to permit full vacuum filling with insulating liquid.

L. COOLING EQUIPMENT

1. Integrally mounted equipment shall be furnished to provide the cooling capacity necessary to maintain the transformer rating. Temperature control shall be provided by an assembly of devices arranged and designed to automatically vary the transformer cooling equipment capacity in steps proportional to transformer load and temperature.
2. Cooling fan motors shall be 480V, 3-phase, 60 Hz. Motors shall be totally enclosed, non-ventilated, with sealed, pre-lubricated ball bearings with bearing wear indicator, and rated for all-weather outdoor operation. Non-metallic bearings for fan motors are not acceptable.
3. Controls
4. The transformer cooling equipment control shall be via Electronic Temperature Monitor (ETM). The ETM shall monitor winding hot spot temperature and top oil temperature. The ETM shall be mounted onto the outside of the transformer in a self-contained corrosion and weatherproof enclosure.
5. The transformer cooling equipment control system shall utilize control contacts furnished on the winding temperature indicator. Where multiple thermal relays are provided, thermal relay temperature control contacts shall be wired for parallel control of the cooling equipment
6. Controls shall be provided for manually alternating the cooling fan operation sequence. Manual control switches shall be provided in the control cabinet to allow testing and maintenance of the cooling fans.
7. Cooling equipment shall be interruptible by an 86 (Lockout relay) type device such as an 86T, 86U or by fire detection.

8. Suitable alarm actuating devices with form C contacts shall be provided to indicate failure of any or all motors and loss of power.
9. Transformer cooling equipment shall be designed and arranged to allow individual radiators to be removed from the transformer without removing the transformer from service, draining oil from any other transformer component, or loss of oil past valve with 5 psi positive pressure on main tank.
10. Manually operated shutoff valves shall be provided, as required, for cooling equipment removal. All shutoff valves shall be bolted-flange mounted, and shall have provisions for padlocking in the open or closed position.
11. Each removable radiator shall be furnished with vent and drain valves for evacuation and oil filling.
12. The design of the radiators shall accommodate significant amounts of dust/ash particles in the air, and shall operate without clogging. Integrally mounted equipment shall be furnished to provide the cooling capacity necessary to maintain the transformer rating.
13. Spare flanges shall be installed for the tank on the addition of future radiators.

M. TRANSFORMER BANK

1. All tanks, bases, radiators, covers, junction boxes when required, and any other attached compartments shall be fabricated from steel of sufficient strength to withstand normal service stresses and vacuum filling without distortion or damage to any part. The base shall be extra heavy (3/4-inch minimum thickness) and suitable for rolling or skidding in any direction.
2. All joints in transformer tanks, radiators, bases, etc., shall be made gas-tight and oil-tight by welding, except that the connections between oil coolers, pumps, and tanks shall be provided with gasketed, bolted flanges. All covers shall be welded in place.
3. Transformers shall be equipped with welded cover lifting lugs, jack bosses (located not less than 16 inches above the base and shall provide a minimum unobstructed jack clearance of 6 inches from tank wall or other obstruction), pulling eyes, skids, and jacking pads to accommodate rollers.
4. The tank finish color shall be **< ANSI Z55.1 No. 70, grey >**. Seller's surface preparation, painting procedures and materials used shall be submitted with bid proposal for Company review. Products containing lead are not acceptable.
5. All interiors and exteriors of tanks, enclosures, cabinets and

other metal parts which are not galvanized, stainless steel or of corrosion resistant material and are exposed to oil and weather shall be thoroughly cleaned and painted as required

6. The interior color of the transformer tank and control cabinet(s) shall be white and shall be fully capable of withstanding transformer operating conditions without degradation such as chipping, cracking, or peeling.
7. The top of the transformer tank shall be covered with skid resistant paint, which is the same color as the exterior tank walls.
8. Tank side seams and the connection point of the tank sides to the tank bottom shall be welded both inside and outside.
9. A minimum of two (2) 24-inch diameter manholes shall be provided on top of the transformer tank. One (1) of the required manhole covers shall include a 1-inch threaded nipple and a flanged vacuum fitting for a connection of a 4-inch diameter vacuum hose. The 4-inch (nominal) vacuum fitting shall have eight (8) 3/4-inch diameter bolt holes, equally spaced on a 7 1/2-inch diameter bolt circle. The vacuum-fitting flange shall be mounted sufficiently high off of the manhole cover to allow for easy access for removing and replacing bolts and nuts.
10. All piping connections for Owner use shall be American standard threads or flanges.
11. Gaskets and gasketed joints shall be designed so that the gasket shall not be exposed to the weather or standing water, and shall be provided with mechanical stops to prevent crushing.

N. WIRING

1. All wire shall be stranded, tinned copper conductor with 600V flame-retardant, cross-linked synthetic polymer insulation, type XHHW or equal. The minimum wire size for control and alarm functions shall be stranded No. 14 AWG. The minimum wire size for motor circuits, power circuits, and CT circuits shall be No. 12 AWG.
2. Wiring shall not be spliced or tapped. All interconnections shall be made and identified with wire markers at equipment terminals or terminal blocks.
3. All control wiring, including CT circuits, shall be terminated with non insulating, seamless barrel ring tongue lugs (Burndy type YAV HYLUG is preferred)
4. All CT secondary leads shall be terminated to short-circuiting type terminal blocks located in the control cabinet. CT terminal blocks shall be 6 point, shorting type 600V, 30A class minimum, Marathon type 1506, GE type EB-27, or Penn union type 606.

5. All CT secondary leads shall be brought to terminal blocks mounted in a junction box outside the transformer tank. CT terminal blocks shall be 6 point, shorting type 600V, 30A class minimum, Marathon type 1506, GE type EB-27, or Penn union type 606.
6. Control terminal blocks shall be 12-point, 600V, 30A class minimum, Marathon type 1512, GE type EB-25, or Buchanan type 2B112.
7. DC power Blocks shall be 600V class GE type EB-1 or equivalent.
8. Terminals shall be labeled with white terminal identification marking strips. Terminal blocks shall be mounted on the sides or back walls of the transformer control cabinet, and shall be easily accessible with normal tools.
9. Rigid galvanized steel conduit shall be used for all power, control, and alarm external wiring. When the wiring terminates at an externally tank-mounted power, control, or alarm device, rigid conduit shall be provided to a suitable location near the device. Wiring may be routed through tank support channels as an alternate to rigid conduit.
10. Liquid-tight, flexible, metal conduit may be provided from a point near the device to the device itself.
11. Associated terminal blocks shall be grouped together to facilitate the use of multi-conductor cables for interconnecting equipment. Common voltage rated control and power terminal blocks shall be grouped together (i.e. 480VAC terminal blocks and wiring physically separated from 120VAC or 125VDC control terminal blocks and wiring; 120VAC control terminal blocks and wiring physically separated from 125VDC control terminal blocks and wiring). A minimum of 10% spare terminal blocks shall be provided, and shall be grouped and reserved for Company's use only.
12. The transformer control cabinet shall be designed such that all exposed 480VAC points of contact are contained in a separate compartment with a dead front metal door or panel. Physical separation of 480VAC from lower voltage (DCS contact indication, 120VAC, or 125VDC) control circuits shall be maintained.
13. Plastic self-locking tie wraps shall not be an acceptable material for lead support.
14. All conduit, cable, and fittings shall be weatherproof, and securely fastened to the transformer at regular intervals. Rubber covered cable is acceptable for fans and gauges, and external wiring runs of less than 4 feet, however, its use shall be limited.
15. No more than two (2) wires are permitted to terminate at a

given terminal.

M. AUXILIARY EQUIPMENT & ACCESSORIES

1. Each transformer shall be equipped with a high voltage, de-energized tap changer with an external operating mechanism located on the side of the transformer tank. The tap changer handle shall have provisions for padlocking in any position, and shall provide visible indication of the tap position without unlocking.
2. A single weatherproof control cabinet shall be provided for all external conduit/cable connections, control components. The cabinet shall be accessible from ground level, and shall be sized large enough to house all forced air-cooling equipment control components.
    a. The control cabinet shall be supplied with thermostatically controlled space heaters to prevent condensation. Space heaters shall be rated 240 VAC, but shall be sized for a normal operating voltage of 120 VAC. Space heater circuits shall be individually protected with molded case circuit breakers. Molded case circuit breakers shall be manufactured by General Electric, Square D, or Cutler-Hammer.
    b. The cabinet shall include vertically hinged doors arranged to permit ready access to the cabinet from the ground level. A locking device shall be provided to hold the doors in the fully open position. Should design of cabinets be such that door width is in excess of 30 inches, double doors shall be provided and the doors shall be hinged for center opening. Hinge material shall be stainless steel.
    c. Doors shall have three-point latches for the closed position and shall include provisions for attaching padlocks. Bolts or screws to secure the door shall not be used.
    d. The top of the control cabinet shall not be more than 7 feet above the bottom of the tank. The bottom of the control cabinet shall be located a minimum of 2.5 feet above the bottom of the tank.
    e. A removable, gasketed plate, minimum size 12 inches by 16 inches, shall be provided in the bottom of the control cabinet to permit field drilling and installation of control system conduits. The Contractor shall not place the plate directly under any device within the control cabinet that would encumber the pulling of control conductors into the cabinet.
    f. Each auxiliary equipment branch circuit shall be

protected by an individual molded case circuit breaker properly coordinated with the Control Power Transformer (CPT) breakers. Molded case circuit breakers shall be manufactured by General Electric, Square D, or Cutler-Hammer.

g. The control cabinet shall be provided with a 120 VAC, duplex (3-wire) with ground fault interruption (GFI) receptacle and switched cabinet light, wired to a 20 amp, molded case circuit breaker. The circuit breaker line side shall be wired to control cabinet terminal blocks. Molded case circuit breakers shall be manufactured by General Electric, Square D, or Cutler-Hammer.

h. The control cabinet shall be equipped with a Seekirk Inc. Model B1002BNC-S33 annunciator (125 VDC, feed thru, LED, NC contacts (open to alarm)). Two (2) form C contacts rated for operation at 125 VDC shall be provided for a common output alarm. The normally closed contacts shall be wired in series and wired out to a terminal block in the control cabinet.

i. The control voltage for the annunciator, transformer protective relays and associated equipment shall be 125 VDC.

j. The control cabinet shall be equipped with a “Loss of DC Alarm Voltage” alarm relay, with alarm and trip contacts wired to a terminal block in the cabinet.

k. All control relays shall have enclosed, dust tight contacts.

l. All devices and terminal blocks mounted in the control cabinet shall be clearly labeled with a designation. This label shall be located on or near the device and be affixed in such a manner that they will not become detached during the life of the transformer (Dymo Tape or similar embossed plastic tapes are not acceptable).

m. A metal oxide arrestor (MOV) surge suppressor shall be mounted across the 125 VDC supply terminal within the control cabinet. The MOV shall be rated for a minimum of 10 kA, 200 joules capability with a maximum peak discharge voltage of 500V.

n. All control devices, controllers, and control systems and assemblies shall be in accordance with NEMA ICS 1 and 2 and shall meet the requirements of this Standard.

o. For each transformer, an automatic voltage seeking transfer switch shall be provided to supply power to

the transformer auxiliary equipment. Two (2) sources of nominal 480V, 3-phase, 3-wire, 60 Hz power to feed this switch will be provided. The automatic transfer equipment shall be of sufficient capacity to transfer the total cooling equipment, control circuit, and space heater load from the normal source to the standby source upon failure of the normal source voltage. Voltage failure relays shall be installed in order to monitor normal and standby source voltages. Each relay shall provide a contact closure on loss of voltage. The contacts shall be wired to terminal blocks in the control cabinet. Control power for the transfer controls shall be 120 VAC.

p. Alarm Requirements. The following minimum alarm points shall be provided:
   1. Top Oil Temperature – (26Q).
   2. Winding Temperature – Monitor One Winding (49T)
   3. Liquid Level Indicator – Main Tank/Conservator – Normal High (71Q-1(MT)/HA)
   4. Liquid Level Indicator – Main Tank/Conservator – Normal Low (71Q-1(MT)/LA)
   5. Liquid Level Indicator – Main Tank/Conservator – Emergency Low (71Q-3(MT)/LT)
   6. Transformer Gas Detection – Buchholz Relay (71GD(MT))
   7. Pressure Relief Device – Main Tank (63P-1(MT))
   8. AC Supply – Loss of Main AC Supply (27-1)
   9. Stage 1 Cooling – Loss of AC (27-2)
   10. Stage 2 Cooling – Loss of AC (27-3)
   11. Loss of Cooling Control Voltage – AC (27-4)
   12. Loss of DC Control Voltage – DC (27-6)

q. Tank cover pressure relief devices shall be supplied for each oil-filled compartment. Each device shall be equipped with form C alarm contacts, a manual reset, and mechanically operated flag, to indicate that the relief device has operated. Released oil shall be directed away from all control cabinets or where personnel may be standing. Alarm contacts shall be wired to terminal blocks in the control cabinet. Pressure relief device shall be Qualitrol 213 series.

r. Liquid level indicators (main tank and all other oil filled compartments) shall be provided with all alarm contacts wired to terminal blocks located in control cabinets:

1. The main tank shall either have a single, magnetic-type level indicator with two (2) low level and one (1) high level alarm contacts or two (2) separate, magnetic-type level indicators. All contacts shall be Form “C” contacts.
2. All other oil filled compartments shall have single indicators with Form “C” contacts at the lowest level considered safe for continued operation of the transformer and wired to terminal blocks in the main control cabinet.
3. All liquid level indicators shall be readable from ground level**.**

s. An Electronic Temperature Monitor (ETM) shall be provided.
   1. The ETM shall monitor winding hot spot temperature and main tank top oil temperature.
   2. A minimum of six (6) form C dry contact outputs [with auxiliary interposing relays as needed to accommodate a 125 VDC contact make/break rating for four (4) of the six (6) contacts (output contacts used for first and second stage temperature alarm levels on each of the top oil and hot spot winding temperatures), with the other contacts used for controlling the cooling system (responsive to the simulated winding hottest spot temperature)].
   3. Form C alarm and trip contacts shall be wired out and terminated to terminal blocks in the transformer main control cabinet.
   4. The ETM shall be mounted adjacent to or within the transformers main control cabinet, at an approximate height of 5 feet above the base of the transformer for easy viewing from ground level.
   5. Source to the ETM shall be from a 125 VDC input power supply. On loss of DC, all stages of fans shall be triggered to energize.
   6. A minimum of two (2) 0 to 1 mA DC analog (corresponding to 0 to 200°C) SCADA outputs for both top oil temperature and hot spot winding temperature.
   7. Weather-tight NEMA 3R or better enclosure with outdoor-rated display and controls accessible without opening the enclosure’s

front door. A switch or operator accessible front panel menu for manual control of the system. Basic Temperature error (including probe) to be less than 1°C.

8. RS232/485 digital interface and MS Windows-based programming software for setup and monitoring from a PC.
9. Acceptable ETM manufacturers/models are as follows:

Manufacturer	**Model Number**
Weschler Instruments	Transformer Advantage CT - Electronic
Qualitrol	509-100 Series – Electronic

t. Transformers shall be equipped with the following valves and fittings:
   1. A combination drain and lower filter valve shall be provided to drain the oil as completely as possible but to at least within 1 inch of the bottom of the main tank and for outlet to the filtering means. The drain valve shall be 2 inches with a built-in 3/8-inch sampling device.
   2. Lower filter press valve with malleable iron pipe plug.
   3. A 1 ½-inch upper filter press valve with malleable iron pipe plug.
   4. Standard 4-inch bolted round pipe flange with gasketed cover plate for attaching the Company's vacuum valve and hose. The flange shall be located on the corner farthest from the upper filter press valve to insure that oil does not enter the Company's vacuum system.
   5. A shut-off valve shall be provided on each end of the connection piping to the main tank.

u. Transformer shall be equipped with a gas detector relay with seal in coil, mounted in the control cabinet. Gas detector relay shall be a EMB Buchholz Type BF80-10, twin float relay DR80, Model 09-236 with form C contacts wired out to a seal-in relay panel (Qualitrol model 909-200-01 AC/DC Seal-In relay). Seal-in relay panel to be mounted in the control cabinet.

v. Transformer shall be equipped with a GE Hydran M-2 dissolved gas-in-oil intelligent monitor/transmitter.

w. Transformer shall be equipped with the following fall

protection devices:

1. Brackets for mounting of 2-inch diameter pipes for use as safety rails shall be provided at the top of the transformer. Design and fabricate brackets to meet OSHA-required lateral loads at the top of the safety rail. Brackets shall be spaced a maximum of 4 feet apart, with one on each corner of the transformer.
2. A weld-on base shall be provided near the center of the transformer top. It will be used for attaching a 4-foot Company-supplied tether pole to meet OSHA 29 CFR 1926.502(d). The base shall be designed to support a horizontal force of 10,800 lbs at the top of a 4' tether pole. The area above the base should be clear of obstructions as to facilitate attachment of the Company- supplied tether pole.
3. Unique Concepts Ltd. weld-on base, Part Number 10816, shall be installed by the Seller for attachment of a portable fall arrest system provided by the Company. Weld-on bases shall be installed on the transformer cover within three (3) inches of each manhole.

x. Nameplates: All nameplates shall be inked and engraved stainless steel. At least four (4) bolts or rivets shall attach nameplates. Mounting holes shall be provided with rubber grommets or equivalent to decrease vibration noise. Nameplate shall be located to be accessible and readable from grade level with no other equipment blocking or otherwise limiting view of the nameplate

1. A temperature relay nameplate shall be supplied and shall give the recommended temperatures at which the first set of cooling equipment shall be started, the second set of cooling equipment shall be started, and the temperature at which an alarm shall be actuated. All of these shall be calculated on the basis of operation at 65°C winding temperature rise. This information shall also be provided on the wiring diagram. The nameplate shall be mounted on or near to the temperature indicator(s)
2. De-energized tap changer nameplates shall be provided and shall include make and model information. These nameplates shall be

mounted next to the main nameplate or the information may be incorporated into the main nameplate.

N. INSULATING LIQUID

1. Insulating oil shall be Type II and shall meet ANSI C57.106 requirements. It shall be free of PCB's, chemically stable, free from acidity or other corrosive ingredients, and shall contain a suitable oxidation inhibitor. Maximum oxidation inhibitor content shall be 0.3% by weight and transformer nameplates shall indicate that the oil is inhibited. The oil shall contain less than 30 ppm water when tested in accordance with the procedures of ASTM D1533-88 (Karl Fischer method). The dielectric strength of the oil shall be at least 30 kV when tested in accordance with the procedures of ASTM D877-87, or 20 kV when tested in accordance with the procedures of ASTM D1816-84A using a 0.04-inch gap.

SOUND CONTROL REQUIREMENTS

Specifier Note: Additional information required

ELECTRICAL REQUIREMENTS

Specifier Note: Additional information required

INSTRUMENTATION & CONTROL REQUIREMENTS

Specifier Note: Additional information required

MATERIALS & WELDING

Specifier Note: Additional information required

CLEANING, PAINTING & COATING

Specifier Note: Additional information required

PACKAGING & SHIPPING

See Appendix 7

STORAGE & HANDLING PROCEDURES

See Appendix 7

SPARE PARTS

Commissioning spares to be included/supplied with the equipment.

QUALITY ASSURANCE

See Appendix 5

TESTING

See Appendix 5

SELLER'S DATA SUBMISSION SCHEDULE

See Appendix 2

APPENDICES

APPENDICES TO SPECIFICATION

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.
****

1. DELIVERABLES
   A. The Seller shall furnish Manufacturer's approval drawings (**< <u>Two (2)</u> >** full-size hard copies and **< <u>one (1)</u> >** AutoCAD File each), consisting of the following minimum documents:
      1. Manufacturer's approval drawing schedule (submitted with proposal)
      2. Transformer installation instructions/details including unloading rigging information and equipment loadings
      3. Transformer dimensioned outline drawings (English dimension units)
      4. Transformer nameplate drawings
      5. Current transformer saturation curves
      6. Control panel schematics and wiring diagrams
      7. Final test reports.
   B. Seller shall furnish **< <u>three (3)</u> >** Operations & Maintenance (O&M) manuals. In addition to all required information required to operate and maintain furnished equipment O&M manuals shall contain Manufacturer's cut sheets and brochure data for all furnished ancillary equipment (control panel, annunciator, monitoring equipment, fans, etc.).
   C. Seller shall furnish warranty information for all equipment supplied.
   D. Seller shall submit completed "SELLER DATA" as outlined in Appendix 2 Data Sheets. Seller Data shall be submitted with proposal.

2. PROPOSAL DATA REQUIREMENTS

DATA SHEETS

GENERATOR STEP UP TRANSFORMER	**UNITS**	**REQUIREMENTS**	**SELLER RESPONSE**
Manufacturer		Seller	
City & Country of Manufacture		Seller	
Duty Cycle		Continuous	
ELECTRICAL PARAMETERS:			
Capacity	MVA		
Capacity with one section of the cooling inoperative	MVA	Seller	
Temperature Rise	ºC	**65**	
Type of Cooling			
Phase Displacement		**High Voltage leads Low Voltage by 30º**	
Frequency	Hz	60	
Connection - High Voltage Winding		**Wye**	
Connection - Low Voltage Winding		**Delta**	
Voltage Rating - High Voltage Winding	kV		
Voltage Rating - Low Voltage Winding	kV		
No Load Tap Voltages (Full Capacity Taps) – High Voltage Winding	kV	**-____% to +____% @ ____ % Steps**	
No Load Tap Voltages (Full Capacity Taps) - Low Voltage Winding	kV	None	
BIL - High Voltage Winding	kV		
BIL - Low Voltage Winding	kV		
BIL - High Voltage Winding at Neutral Point	kV		
No Load Loss at - 100% of Rated Voltage	kW	Seller	

No Load Loss at - 105% of Rated Voltage	kW	Seller	
No Load Loss at – 110% of Rated Voltage	kW	Seller	
Load Loss at 100% of Rated Voltage, 100% ONAN Loading Of Transformer	kW	Seller	
Load Loss at 100% of Rated Voltage, 100% ONAF Loading Of Transformer	kW	Seller	
Total Cooling System Losses (@ max ONAF Loading).	kW	Seller	
Total Loss (No Load + Load) at 100% of Rated ONAN Loading Of transformer, 100% Voltage.	kW	Seller	
Total Loss (No Load + Load + Cooling) at 100% of Rated max ONAF Loading of transformer, 100% Voltage.	kW	Seller	
Impedance at Rated Capacity (at ONAN rating)	%		
Reactance at Rated Capacity	%	Seller	
Resistance at Rated Capacity	%	Seller	
X/R Ratio		Seller	
Maximum Overvoltage Excitation Capability at Full Load in % of Rated Voltage	%	ANSI	
Exciting Current in % of Full Load Current at Rated Voltage and Frequency	%	Seller	
Three Phase Capacitance to Ground H.V. Side Only	pF	Seller	
MATERIALS			
Color		**ANSI Z55.1 Color 70, Light Gray**	
Tank		Plate steel	
H.V. Windings		Copper	
L.V. Windings		Copper	
Fall Protection Brackets (for railing on top of transformer)		Yes	
Fall Protection Tether Pole Base		Yes	

Fall Arrest Brackets near each Manhole		Yes	
NOISE DATA			
Audible Sound Level @ 100% Load	dBA	NEMA TR1	
Audible Sound Level @ No Load	dBA	NEMA TR1	
APPROXIMATE WEIGHTS			
Core and coils	lb	Seller	
Tank and Fittings	lb	Seller	
Oil	lb	Seller	
Shipping Weight (without oil)	lb	Seller	

APPROXIMATE DIMENSIONS			
Overall height	in	Seller	
Width	in	Seller	
Depth	in	Seller	
Untanking	in	Seller	
Minimum Clearance of Jacking Lugs to base	in	16	
COOLING			
Quantity of Fans		Seller	
Rated Voltage	V	480	
OIL PRESERVATION SYSTEM			
Conservator Tank System		Yes	
High/Low Pressure Gauges & Alarm Contacts		Yes	
Minimum Positive Pressure	PSIG	0.5	
Maximum Positive Pressure	PSIG	5	
Maintenance-Free Dehydrating Breather (High Voltage Supply model 1030-012K)		Yes	

CONTROL CABINET			
Enclosure type	NEMA	4X	
Heater Voltage	VAC	120	
Heater Wattage	Watts	Seller	
Alarm Annunciator		Seekirk (per spec)	
INSTRUMENTATION / ALARMS			
Electronic Temperature Management (ETM) for cooling fan control, High temperature alarms, Hot Spot Winding Temperature (49T), and Top Oil Temperature (26Q)		Qualitrol ETM 509-100 Or Weschler Instruments Transformer Advantage CT – Electronic	
Pressure/Vacuum gage (63P) & bleeder device.		Yes	
Oil Level Indicator (71Q-HA) for Main tank and conservator tank.		Yes	
Oil Level Indicator (71Q-LA) for Main tank and conservator tank		Yes	
Oil Level Indicator (71Q-LT) for Main tank and conservator tank		Yes	
Transformer Gas Detection Relay (Buchholz) (71GD)		Yes	
Combustible Gas Monitor (GE Hydran M-2)		Yes	
Pressure Relief Device (63P-1) w/ trip contact and alarm contact		Yes	
Loss of Main AC Supply (27-1)		Yes	
Stage 1 Cooling – Loss of AC (27-2)		Yes	
Stage 2 Cooling – Loss of AC (27-3)		Yes	
Loss of cooling control voltage – AC (27-4)		Yes	
Loss of DC control voltage (27-5)		Yes	
TERMINAL BUSHINGS			

Manufacturer - High Voltage		ABB	
Manufacturer - Low Voltage		ABB	
Manufacturer - High Voltage Neutral		ABB	
Type/Style - High Voltage		Oil-Filled/Porcelain	
Type/Style - Low Voltage		Oil-Filled/Porcelain	
Type/Style - High Voltage Neutral		Oil-Filled/Porcelain	
Arrangement of Bushings – High Voltage (Sidewall or Cover).		Cover	
Arrangement of Bushings – Low Voltage (Sidewall or Cover).		Cover	
Arrangement of Bushings – High Voltage Neutral (Sidewall or Cover).		Cover	
Creepage Distance - High Voltage	In	Seller	
Creepage Distance - Low Voltage	In	Seller	
Creepage Distance - High Voltage Neutral	In	Seller	
Rated Voltage - High Voltage	kV		
Rated Voltage - Low Voltage	kV		
Rated Voltage - High Voltage Neutral	kV		
Rated Amps - High Voltage	Amps		
Rated Amps - Low Voltage	Amps		
Rated Amps - High Voltage Neutral	Amps		
BIL - High Voltage	kV		
BIL - Low Voltage	kV		
BIL - High Voltage Neutral	kV		
Terminal Bushings Shipped Loose		Yes	
Core Ground Bushing		Yes	
BUSHING CURRENT TRANSFORMERS			
High Voltage Bushing CT Quantity/Bushing			
High Voltage Bushing CT Ratio			
High Voltage Bushing CT Accuracy		**_____ @ C800, _____ @ 0.3-B1.8**	

High Voltage Bushing CT Burden		Seller	
Low Voltage Bushing CT Quantity/Bushing			
Low Voltage Bushing CT Ratio			
Low Voltage Bushing CT Accuracy		**_____ @ C800, _____ @ 0.3-B1.8**	
Low Voltage Bushing CT Burden		Seller	
High Voltage Neutral Bushing CT Quantity/Bushing		1	
High Voltage Neutral Bushing CT Ratio			
High Voltage Neutral Bushing CT Accuracy		C800	
High Voltage Neutral Bushing CT Burden		Seller	
HV SURGE ARRESTERS			
Manufacturer/Model No		ABB, Cooper, GE or Ohio Brass	
Type		Porcelain/MOV	
Rating	kV rms		
Maximum Continuous Voltage Capability, MCOV	kV rms		
GROUND PROVISIONS			
Tank Grounds – Two, NEMA 4-Hole		Yes	
Core Ground – with Bushing / Cover / Ground Pad		Yes	
HO Ground Bus / Pad		Yes	
Surge Arrestor Grounding Cable		Yes	
Grounding Brackets – Four brackets / side of Transformer		Yes	
(3) High Voltage Insulators with Grounding Brackets		Yes	
TERMINAL CONNECTIONS			
High Voltage		**Open Air**	

Low Voltage		**Iso-Phase**	

3. PERFORMANCE GUARANTEES

4. SITE CONDITIONS AND REFERENCE MATERIALS

1.0 Summary

1.1. This Schedule outlines the Site conditions used for the design of all equipment covered under this contract.

2.0 Location

2.1. Xcel Energy's xxxxxx Station site is located xxxxxxxxx.

2.2. The property consists of approximately xxx acres.

2.3. Existing plant site consists of xxxxxx generating units.

3.0 Ambient Design Criteria

3.1. Meteorology

3.1.1. Local meteorological data with long periods of record for xxxxxx is available. Xxxxx data is used for design wet-bulb temperature, dry-bulb temperature, wind, and other design criteria. Contractor is responsible for verifying Meteorological data by obtaining the most recent information available.

3.1.1.1. Temperature and Humidity

- Maximum Summer Extreme Temperature xx°F
- Minimum Winter Extreme Temperature xx°F
- Summer Design Dry Bulb Temperature xx°F
- Summer Design Wet Bulb Temperature xx°F
- Winter Design Dry Bulb Temperature xx°F
- Average Annual Dry Bulb Temperature xx°F
- Average Annual Wet Bulb Temperature xx°F

3.1.1.2. Indoor Temperatures

- Indoor temperatures can be expected to range from xx°F to xx°F.

3.1.1.3. Precipitation and Snow

- Annual precipitation in the site vicinity is expected to average about xx inches. Annual snowfall in the plant vicinity averages about xx inches.
- The snow load for xxxxxx is xx lb/ft2.

3.2. Barometric Pressure

3.2.1. The standard barometric pressure adjusted to the site elevation of xxxxx feet is xx psia..

American National Standards Institute (ANSI/IEEE)

A. C57.12.00 General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

B. C57.12.70 Terminal Markings and Connections for Distribution and Power Transformers
C. C57.12.90 Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers
D. C57.13 Requirements for Instrument Transformers
E. C57.19.00 General Requirements and Test Procedure for Outdoor Power apparatus Bushings
F. C57.93 Guide for Installation of Liquid Immersed Power Transformers
G. C57.115 Guide For Loading Mineral-Oil-Immersed Power Transformers, Rated in Excess of 100 MVA (65oC Winding Rise)
H. C57.116 Guide for Transformers Directly Connected to Generators
I. C62.1 Surge Arresters for Alternating-Current Power Circuits
J. C62.11 Standard for Metal-Oxide Surge Arresters for AC Power Circuits
K. C57.106 Guide for Acceptance and Maintenance of Insulating Oil in Equipment

National Electrical Manufacturers Association (NEMA)
A. LA 1 Surge Arresters
B. TR 1 Transformers, Regulators and Reactors
C. 107 Methods of Measurement of Radio Influence Voltage of High-voltage Apparatus

American Society for Testing and Materials (ASTM)
A. D117 Guide to test Methods and Specifications for Electrical Insulating Oils of Petroleum Origin
B. D3487 Specification for Mineral Insulating Oil Used in Electrical Apparatus

NFPA 70 Latest edition of the National Electrical Code.
ANSI C2 National Electrical Safety Code (NESC).

5. QA/QC (Including Inspection Test Plans)
    1. Transformers shall be tested in accordance with ANSI/IEEE C57.12.00 and ANSI/IEEE C57.12.90.
    2. The following tests shall be performed and certified by the Seller for each transformer:
        a. Resistance measurements on all windings. The test report shall indicate how windings were connected, either series or parallel.
        b. Ratio tests on the rated voltage connection and on all tap connections.
        c. Polarity and phase relation test on the rated voltage connection.
        d. No load loss and exciting current at rated frequency and voltage and at maximum raise and lower tap position.
        e. No load loss and exciting current at rated frequency at 90% rated voltage (0.9 p.u.).
        f. No load loss and exciting current at rated frequency at 110% rated voltage (1.10 p.u.).
        g. Auxiliary losses shall be verified by actual test measurements.
        h. Impedance volts at rated current and at maximum raise and lower tap positions.
        i. Load loss at rated current and at maximum raise and lower tap positions.
        j. Temperature rise test made at the transformer self-cooled KVA rating at rated current.
        k. Applied voltage test.
        l. Induced voltage test for Class II power transformers with radio influence voltage (RIV) for partial discharge measurement.
        m. Impulse tests. The neutral current method of fault detection shall be employed and oscillographic or digital records of all impulse tests shall be furnished with the test report.
        n. Core insulation resistance test.
        o. Sweep Frequency Response Analysis. For use in creating a baseline response analysis.
        p. Transformer noise frequency spectrum analysis (under no load and full load conditions).
        q. Insulation power factor test.
    3. The certified test report shall indicate all impedance values (positive, negative, and zero sequence); oil test reports, which include all tests indicated in ANSI C57.106.
    4. Copies of all factory power factor tests or equivalents shall

be furnished with the certified test reports. Certified test reports shall be prepared and submitted to the Company following completion of the testing and prior to transformer shipment.

6. STARTUP, TESTING, AND COMMISSIONING

7. PACKAGING, SHIPPING, AND STORAGE

A. Transformers shall be shipped under positive dry air pressure.

B. Seller shall install and ship impact recorders on rail cars transporting the transformers. The impact recorders shall be installed at the factory to provide a permanent record of the magnitude of axial, transverse, and vertical forces to which the transformer was subjected while in transit (via truck, rail, and/or shipping vessel).

C. The transformer shall be designed to withstand transportation-related mechanical loadings generated by impacts, swaying, yawing, fatigue and vibration. The minimum design limits for impact loading with respect to the transformer shall be: 5 g longitudinal, 3 g vertical and 1 g transverse directions. The transformer shall be designed to allow transportation via rail and truck, (and via sea vessel as applicable).

8. ACCEPTABLE SUPPLIERS

Complete technical requirements as required for the identified topic.

EXHIBIT A

GENERATOR STEP-UP (GSU) TRANSFORMER

SCOPE OF WORK AND TECHNICAL SPECIFICATIONS

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1. SCOPE OF WORK

1.1 SUMMARY

1.1.1 Seller shall provide _____ Generator Step-Up (GSU) transformer**(s)** for the _____ Plant located in _____.

1.2 SCOPE OF WORK

1.2.1 Seller shall design, test and deliver _____, **< 3 >**-phase, 60 Hz, oil-filled GSU transformer**(s)**. Transformers shall be equipped with a high voltage no-load tap changer. Transformer MVA ratings shall be as specified in Exhibit B Data Sheets. Maximum winding temperature (hot spot) rise shall not exceed **< 80 >** ºC and maximum liquid oil temperature rise shall not exceed **< 65 >** ºC when the generator is running at the maximum gross MW output, 24 hours, at the specified altitude in the specified location. The high voltage neutral shall be brought out and grounded through a bushing.

1.2.2 **Seller shall be responsible for the following**:

A. Design, testing and delivery of GSU transformers as specified herein

B. Delivery of transformer oil

C. Field assembly

D. Oil drying and vacuum oil filling

E. GSU field testing

F. GSU operation and maintenance training for site personnel.

1.2.3 **Company shall be responsible for the following**:

A. GSU foundation(s)

B. GSU unloading and setting

C. GSU electrical connections (primary, secondary and control voltages)

D. GSU grounding connections

1.2.4 Seller shall allow Company personnel access to its factory during transformer assembly and for witness testing. Seller shall provide transformer manufacturing schedule and updates to the schedule to the Company. Travel costs for Company personnel for site factory visits are the responsibility of the Company.

1.3 REFERENCES

1.3.1. American National Standards Institute (ANSI/IEEE)

A. C57.12.00 General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

B. C57.12.70 Terminal Markings and Connections for Distribution and Power Transformers

C. C57.12.90 Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers

D. C57.13 Requirements for Instrument Transformers

E. C57.19.00 General Requirements and Test Procedure for Outdoor Power apparatus Bushings

F. C57.93 Guide for Installation of Liquid Immersed Power Transformers

G. C57.115 Guide For Loading Mineral-Oil-Immersed Power Transformers, Rated in Excess of 100 MVA (65oC Winding Rise)

H. C57.116 Guide for Transformers Directly Connected to Generators

I. C62.1 Surge Arresters for Alternating-Current Power Circuits

J. C62.11 Standard for Metal-Oxide Surge Arresters for AC Power Circuits

K. C57.106 Guide for Acceptance and Maintenance of Insulating Oil in Equipment

1.3.2. National Electrical Manufacturers Association (NEMA)

A. LA 1 Surge Arresters

B. TR 1 Transformers, Regulators and Reactors

C. 107 Methods of Measurement of Radio Influence Voltage of High-voltage Apparatus

1.3.3. American Society for Testing and Materials (ASTM)

A. D117 Guide to test Methods and Specifications for Electrical Insulating Oils of Petroleum Origin

B. D3487 Specification for Mineral Insulating Oil Used in Electrical Apparatus

1.3.4. NFPA 70 Latest edition of the National Electrical Code.

1.3.5. ANSI C2 National Electrical Safety Code (NESC).

1.4 CODES AND STANDARDS

1.4.1 In addition to the codes and standards of ANSI, ASTM, IEEE, NEMA, and NFPA, as referenced herein, all GSU materials and devices shall be in accordance with the applicable requirements of the Federal "Occupational Safety and Health Administration" (OSHA) Standards.

1.4.2. In case of conflict between the requirements of the specified codes and standards, the following hierarchy shall take precedence: Mandatory governmental regulations, codes and standards, this Specification and referenced industry codes and standards.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1. Transformers shall be shipped under positive dry air pressure.

1.5.2. Seller shall install and ship impact recorders on rail cars transporting the transformers. The impact recorders shall be installed at the factory to provide a permanent record of the magnitude of axial, transverse, and vertical forces to

which the transformer was subjected while in transit (via truck, rail, and/or shipping vessel).

1.5.3. The transformer shall be designed to withstand transportation-related mechanical loadings generated by impacts, swaying, yawing, fatigue and vibration. The minimum design limits for impact loading with respect to the transformer shall be: 5 g longitudinal, 3 g vertical and 1 g transverse directions. The transformer shall be designed to allow transportation via rail and truck, (and via sea vessel as applicable).

1.6 MAINTENANCE MATERIALS

1.6.1 The Seller shall furnish **< two (2) >** of each special tool required to operate and maintain the transformer.

1.6.2. The Seller shall furnish **< one (1) >** additional complete set of gaskets for all items removed for shipment and all items, which are normally removed for inspection during installation or maintenance.

1.7 SUBMITTALS

1.7.1 The Seller shall furnish Manufacturer's approval drawings (**< Two (2) >** full-size hard copies and **< one (1) >** AutoCAD File each), consisting of the following minimum documents:

A. Manufacturer's approval drawing schedule (submitted with proposal)

B. Transformer installation instructions/details including unloading rigging information and equipment loadings

C. Transformer dimensioned outline drawings (English dimension units)

D. Transformer nameplate drawings

E. Current transformer saturation curves

F. Control panel schematics and wiring diagrams

G. Final test reports.

1.7.2 Seller shall furnish **< three (3) >** Operations & Maintenance (O&M) manuals. In addition to all required information required to operate and maintain furnished equipment O&M manuals shall contain Manufacturer's cut sheets and brochure data for all furnished ancillary equipment (control panel, annunciator, monitoring equipment, fans, etc.).

1.7.3 Seller shall furnish warranty information for all equipment supplied.

1.7.4 Seller shall submit completed "SELLER DATA" as outlined in Exhibit B Data Sheets. Seller Data shall be submitted with proposal.

2. TECHNICAL SPECIFICATIONS

2.1 COOLING CLASS AND TEMPERATURE RISE

The generator step-up (GSU) transformers shall be rated **< 65 >** ^{o}C rise to limit temperature to a maximum rise above temperature ranges indicated in Exhibit E Site Conditions. Winding and hot spot temperature rise shall be per ANSI Standards. Transformer cooling class shall be in accordance with Exhibit B Data Sheets.

2.2 SITE CONDITIONS

Site conditions shall be as specified in Exhibit E Site Conditions.

2.3 RATINGS

2.3.1. Generator Step-up Power Transformer

H. Transformer ratings shall be as specified in Exhibit B Data Sheets.

I. Nameplate information shall be per the ANSI-C57.12.00 requirements.

J. Low Voltage (X) Primary: 3-phase, 60 Hz, **< delta >** connected.

K. High Voltage (H) Secondary: **< Grounded-Wye >** connected.

L. Taps: **< Two (2) 2.5% >** full capacity taps above nominal rated high voltage, **< Two (2) 2.5% >** full capacity taps below nominal rated high voltage, arranged for de-energized operation.

M. Vector Relationship: High voltage **< leading >** low voltage by **< 30 >** degrees.

N. Winding BIL rating: as specified in Exhibit B Data Sheets.

O. Transformer impedance shall be measured per ANSI C57.12.90. Impedance tolerance shall be per ANSI standard. The zero sequence impedance shall be equal to or less than the positive sequence impedance.

P. Sound Levels shall be in accordance with NEMA TR1 Table O-2.

2.4 DESIGN FEATURES AND CONSTRUCTION

2.4.1 Short Circuit & Over-Voltage Capacity

A. The transformer shall be capable of withstanding, without damage, the mechanical and thermal stresses caused by short circuits on the external terminals of any winding or windings, with 105% rated voltage maintained across the terminals of any other winding connected to an energy source for two seconds.

B. The transformer will be directly connected to the generator in such a way that it may be subjected to load rejection conditions which result in an abnormally high voltage from the generator. Therefore, the transformer shall be designed to withstand, as a minimum, the resulting voltage stresses with 1.4 times rated voltage for 5 seconds, applied at the transformer terminals.

C. The transformer shall be capable of operating at 100% duty cycle at 10% above rated voltage at full load and 15% above rated voltage at no load.

D. The transformer shall be capable of being back-fed from the **< ___ >** kV switchyard to serve auxiliary loads while the generator is disconnected.

2.4.2 Losses

A. The transformer kW losses as a percentage of the base rating shall be evaluated based on no load losses, load losses at maximum nameplate rating, and cooling equipment power requirements at nameplate rating.

B. The loss evaluation factors shall be as follows: No Load (core losses): $2,000/kW; Load (copper losses): $2,000/kW; Cooling System (fan losses): $2,000/kW.

C. If Seller's actual losses at full load are higher than their guaranteed losses, the difference shall be deducted from the order price at a rate of $2,000 /kW.

2.4.3 High Voltage Bushings

A. High voltage bushings shall be cover mounted, oil-filled, porcelain-clad, with liquid level indicators, the voltage class and BIL shall be as specified in Exhibit B Data Sheets. Draw lead connections with silver plated threaded studs are preferred.

B. Transformer high voltage bushing terminals shall be designed and constructed for connection to an overhead line via NEMA four-hole flat pads.

C. Each high voltage bushing shall have bushing current transformers as specified in Exhibit B Data Sheets.

D. The transformer design shall not utilize reduced clearance capabilities specific only to one (1) bushing manufacturer. The transformer design shall allow for interchangeability of all approved manufacturer's bushings in accordance with ANSI C57.19.00.

2.4.4 Low Voltage Bushings

A. Low voltage phase bushings shall be oil-filled, porcelain-clad as specified in Exhibit B Data Sheets.

B. Low voltage bushings shall be designed for connection to **< iso-phase bus >**.

C. Low voltage bushings shall be rated for connection to the **< bus >** operating at 105°C.

D. Each low voltage bushing shall have current transformers as specified in Exhibit B Data Sheets.

E. Three (3) IEEE C62.11 station-class, metal oxide surge arrestors shall be provided (one for each high voltage phase). Surge arrestors shall be manufactured by General Electric, Cooper Industries, Ohio Brass, or ABB

2.4.5 Surge Arresters

A. Three (3) IEEE C62.11 station-class, metal oxide surge arrestors shall be provided (one for each high voltage phase). Surge arrestors shall be manufactured by General Electric, Cooper Industries, Ohio Brass, or ABB.

B. A copper ground loop connecting the three surge arresters to two (2) separate ground pads at separate corners of the tank shall be furnished. Arrester rating shall be as specified in Exhibit B Data Sheets.

C. Surge arrester line terminals shall be tin-plated.

2.4.6 Neutral Bushing

A. The high voltage neutral bushing shall be equipped with a current transformer as specified in Exhibit B Data Sheets.

B. The Seller shall furnish an appropriately sized, permanently installed copper ground bus. This bus shall be connected to a grounding pad located on the transformer cover adjacent to the neutral bushing, and shall be routed down the side of the transformer to a second grounding pad located 6 inches from the bottom of the transformer base. Each grounding pad shall have four (4) ½-inch tapped holes located on 1 ¾-inch centers. The Seller shall furnish a removable, semi-rigid or flexible connection between the cover mounted grounding pad and the neutral bushing.

2.4.7 Grounds

A. Tank Grounds: Two (2) stainless steel, NEMA four-hole ground plates on opposite corners, one (1) stainless steel, NEMA four-hole ground plate located on the top of the transformer near the H0/X0/Y0 bushing(s), and stainless steel, NEMA two-hole hole ground plates adjacent to each core ground bushing.

B. Core Ground: The core ground shall be brought through the tank wall using a bushing of appropriate ampacity. Ground connection shall be made to a NEMA drilled and tapped, copper faced, steel ground pad located near the bushing. The transformer core ground connection shall be accessible from a manhole without removing any oil from the transformer tank or climbing into the tank. Bushings shall have a protective cover with a permanent non-rusting metal nameplate with the words “CORE GROUND ACCESS” engraved with 1/2” letters into the nameplate.

C. Grounding Brackets: Two (2) grounding brackets for portable grounds shall be provided per high and low voltage side of the transformer for a total of four (4) grounding brackets. The brackets shall be made of copper or stainless steel and shall be brazed if copper or welded if stainless steel to the tank near each corner on both the high and low voltage sides. Appropriate procedures for brazing copper or welding stainless steel to the tank shall be used to ensure both good electrical conductivity and mechanical strength. The brackets shall not be painted. Grounding brackets shall be in accordance with Exhibit D, Personal Protective Grounding Bracket Detail.

D. High Voltage Grounding Brackets: Three high voltage porcelain insulators shall be provided with provisions for grounding the transformer. Steel supporting brackets shall be supplied that extend from the high voltage side of the transformer and support the (3) insulators and (3) surge arrestors. Insulators shall be located furthest from the high voltage bushing and adjacent to the surge arrestor. Insulators shall be supplied with a copper bracket extending from the insulator. Copper bracket and insulator shall be of suitable for use in attaching Company-supplied grounding balls and grounding cables (for connecting safety grounds between the high voltage line source, and ground).

2.4.8 Core and Coils

A. Cores and coils shall be braced to withstand short-circuit forces limited only by the transformer impedance without damage or displacement of the coil on the core under conditions described in this Specification, and to withstand normal moving and handling without the use of special shipping braces.

B. Transformer coils shall be copper. The coils shall be insulated from the core and from each other with sufficient insulation to withstand the standard impulse and low frequency tests for transformers of the designed voltage class. Insulation materials shall be asbestos-free.

C. Rectangular windings are not acceptable for main or tap windings.

D. Transformer windings shall be designed to be free-buckling and shall not rely on winding tubes for short circuit strength.

E. Core and coil assembly and all other internal components shall be dried by vapor-phase process to assure proper dryness of the insulation material.

F. The core legs shall have a solid support from the bottom to the top clamp to prevent sideways deformation and bulging of the outermost laminations. The core shall be adequately braced to the core clamping structure, so that it cannot move in any direction. The windings shall be tight to prevent sideways movements. The core and coil assembly and other internal components shall be supported by permanent bracing to the interior of the tank.

2.4.9 Oil Preservation System

A. The oil preservation system shall be a sealed conservator with flexible bladder to prevent contact with the atmosphere and allow expansion and contraction of the oil volume as the temperature changes. The conservator shall have a capacity between highest and lowest levels that are adequate for full range of oil temperature. All conservator alarm contacts shall be wired to the main control cabinet

B. The system shall include a Buchholz gas detector relay and a sampling valve located at ground level. Access opening shall be provided at the conservator for cleaning and inspection purposes. A working platform with access ladder shall be provided for inspection and maintenance of the conservator and associated Buchholz relay. The relay shall be located in the piping between the main tank and the conservator.

C. All tanks and enclosures subject to operating pressures of the oil preservation system shall be designed to withstand 125% of the maximum operating pressures. In addition, the transformer tank and equipment shall be designed with sufficient bracing and strength to permit full vacuum filling with insulating liquid.

2.4.10 Cooling Equipment

A. Integrally mounted equipment shall be furnished to provide the cooling capacity necessary to maintain the transformer rating. Temperature control shall be provided by an assembly of devices arranged and designed to automatically vary the transformer cooling equipment capacity in steps proportional to transformer load and temperature.

B. Cooling fan motors shall be 480V, 3-phase, 60 Hz. Motors shall be totally enclosed, non-ventilated, with sealed, pre-lubricated ball bearings with bearing wear indicator, and rated for all-weather outdoor operation. Non-metallic bearings for fan motors are not acceptable.

C. Controls

D. The transformer cooling equipment control shall be via Electronic Temperature Monitor (ETM). The ETM shall monitor winding hot spot temperature and top oil temperature. The ETM shall be mounted onto the outside of the transformer in a self-contained corrosion and weatherproof enclosure.

E. The transformer cooling equipment control system shall utilize control contacts furnished on the winding temperature indicator. Where multiple thermal relays are provided, thermal relay temperature control contacts shall be wired for parallel control of the cooling equipment

F. Controls shall be provided for manually alternating the cooling fan operation sequence. Manual control switches shall be provided in the control cabinet to allow testing and maintenance of the cooling fans.

G. Cooling equipment shall be interruptible by an 86 (Lockout relay) type device such as an 86T, 86U or by fire detection.

H. Suitable alarm actuating devices with form C contacts shall be provided to indicate failure of any or all motors and loss of power.

I. Transformer cooling equipment shall be designed and arranged to allow individual radiators to be removed from the transformer without removing the transformer from service, draining oil from any other transformer component, or loss of oil past valve with 5 psi positive pressure on main tank.

J. Manually operated shutoff valves shall be provided, as required, for cooling equipment removal. All shutoff valves shall be bolted-flange mounted, and shall have provisions for padlocking in the open or closed position.

K. Each removable radiator shall be furnished with vent and drain valves for evacuation and oil filling.

L. The design of the radiators shall accommodate significant amounts of dust/ash particles in the air, and shall operate without clogging. Integrally mounted equipment shall be furnished to provide the cooling capacity necessary to maintain the transformer rating.

M. Spare flanges shall be installed for the tank on the addition of future radiators.

2.4.11 Transformer Tank

A. All tanks, bases, radiators, covers, junction boxes when required, and any other attached compartments shall be fabricated from steel of sufficient strength to withstand normal service stresses and vacuum filling without distortion or damage to any part. The base shall be extra heavy (3/4-inch minimum thickness) and suitable for rolling or skidding in any direction.

B. All joints in transformer tanks, radiators, bases, etc., shall be made gas-tight and oil-tight by welding, except that the connections between oil coolers, pumps, and tanks shall be provided with gasketed, bolted flanges. All covers shall be welded in place.

C. Transformers shall be equipped with welded cover lifting lugs, jack bosses (located not less than 16 inches above the base and shall provide a minimum unobstructed jack clearance of 6 inches from tank wall or other obstruction), pulling eyes, skids, and jacking pads to accommodate rollers.

D. The tank finish color shall be **< ANSI Z55.1 No. 70, grey >**. Seller's surface preparation, painting procedures and materials used shall be submitted with bid proposal for Company review. Products containing lead are not acceptable.

E. All interiors and exteriors of tanks, enclosures, cabinets and other metal parts which are not galvanized, stainless steel or of corrosion resistant material and are exposed to oil and weather shall be thoroughly cleaned and painted as required

F. The interior color of the transformer tank and control cabinet(s) shall be white and shall be fully capable of withstanding transformer operating conditions without degradation such as chipping, cracking, or peeling.

G. The top of the transformer tank shall be covered with skid resistant paint, which is the same color as the exterior tank walls.

H. Tank side seams and the connection point of the tank sides to the tank bottom shall be welded both inside and outside.

I. A minimum of two (2) 24-inch diameter manholes shall be provided on top of the transformer tank. One (1) of the required manhole covers shall include a 1-inch threaded nipple and a flanged vacuum fitting for a connection of a 4-inch diameter vacuum hose. The 4-inch (nominal) vacuum fitting shall have eight (8) 3/4-inch diameter bolt holes, equally spaced on a 7 1/2-inch diameter bolt circle. The vacuum-fitting flange shall be mounted sufficiently high off of the manhole cover to allow for easy access for removing and replacing bolts and nuts.

J. All piping connections for Owner use shall be American standard threads or flanges.

K. Gaskets and gasketed joints shall be designed so that the gasket shall not be exposed to the weather or standing water, and shall be provided with mechanical stops to prevent crushing.

2.4.12 Wiring

A. All wire shall be stranded, tinned copper conductor with 600V flame-retardant, cross-linked synthetic polymer insulation, type XHHW or equal. The minimum wire size for control and alarm functions shall be stranded No. 14 AWG. The minimum wire size for motor circuits, power circuits, and CT circuits shall be No. 12 AWG.

B. Wiring shall not be spliced or tapped. All interconnections shall be made and identified with wire markers at equipment terminals or terminal blocks.

C. All control wiring, including CT circuits, shall be terminated with non insulating, seamless barrel ring tongue lugs (Burndy type YAV HYLUG is preferred)

D. All CT secondary leads shall be terminated to short-circuiting type terminal blocks located in the control cabinet. CT terminal blocks shall be 6 point, shorting type 600V, 30A class minimum, Marathon type 1506, GE type EB-27, or Penn union type 606.

E. All CT secondary leads shall be brought to terminal blocks mounted in a junction box outside the transformer tank. CT terminal blocks shall be 6 point, shorting type 600V, 30A class minimum, Marathon type 1506, GE type EB-27, or Penn union type 606.

F. Control terminal blocks shall be 12-point, 600V, 30A class minimum, Marathon type 1512, GE type EB-25, or Buchanan type 2B112.

G. DC power Blocks shall be 600V class GE type EB-1 or equivalent.

H. Terminals shall be labeled with white terminal identification marking strips. Terminal blocks shall be mounted on the sides or back walls of the transformer control cabinet, and shall be easily accessible with normal tools.

I. Rigid galvanized steel conduit shall be used for all power, control, and alarm external wiring. When the wiring terminates at an externally tank-mounted power, control, or alarm device, rigid conduit shall be provided to a suitable location near the device. Wiring may be routed through tank support channels as an alternate to rigid conduit.

J. Liquid-tight, flexible, metal conduit may be provided from a point near the device to the device itself.

K. Associated terminal blocks shall be grouped together to facilitate the use of multi-conductor cables for interconnecting equipment. Common voltage rated control and power terminal blocks shall be grouped together (i.e. 480VAC terminal blocks and wiring physically separated from 120VAC or 125VDC control terminal blocks and wiring; 120VAC control terminal blocks and wiring physically separated from 125VDC control terminal blocks and wiring). A minimum of 10% spare terminal blocks shall be provided, and shall be grouped and reserved for Company's use only.

L. The transformer control cabinet shall be designed such that all exposed 480VAC points of contact are contained in a separate compartment with a dead front metal door or panel. Physical separation of 480VAC from lower voltage (DCS contact indication, 120VAC, or 125VDC) control circuits shall be maintained.

M. Plastic self-locking tie wraps shall not be an acceptable material for lead support.

N. All conduit, cable, and fittings shall be weatherproof, and securely fastened to the transformer at regular intervals. Rubber covered cable is acceptable for fans and gauges, and external wiring runs of less than 4 feet, however, its use shall be limited.

O. No more than two (2) wires are permitted to terminate at a given terminal.

2.5 AUXILIARY EQUIPMENT & ACCESSORIES

2.5.1 Each transformer shall be equipped with a high voltage, de-energized tap changer with an external operating mechanism located on the side of the transformer tank. The tap changer handle shall have provisions for padlocking in any position, and shall provide visible indication of the tap position without unlocking.

2.5.2 A single weatherproof control cabinet shall be provided for all external conduit/cable connections, control components. The cabinet shall be accessible from ground level, and shall be sized large enough to house all forced air-cooling equipment control components.

A. The control cabinet shall be supplied with thermostatically controlled space heaters to prevent condensation. Space heaters shall be rated 240 VAC, but shall be sized for a normal operating voltage of 120 VAC. Space heater circuits shall be individually protected with molded case circuit breakers. Molded case circuit breakers shall be manufactured by General Electric, Square D, or Cutler-Hammer.

B. The cabinet shall include vertically hinged doors arranged to permit ready access to the cabinet from the ground level. A locking device shall be provided to hold the doors in the fully open position. Should design of cabinets be such that door width is in excess of 30 inches, double doors

shall be provided and the doors shall be hinged for center opening. Hinge material shall be stainless steel.

C. Doors shall have three-point latches for the closed position and shall include provisions for attaching padlocks. Bolts or screws to secure the door shall not be used.

D. The top of the control cabinet shall not be more than 7 feet above the bottom of the tank. The bottom of the control cabinet shall be located a minimum of 2.5 feet above the bottom of the tank.

E. A removable, gasketed plate, minimum size 12 inches by 16 inches, shall be provided in the bottom of the control cabinet to permit field drilling and installation of control system conduits. The Contractor shall not place the plate directly under any device within the control cabinet that would encumber the pulling of control conductors into the cabinet.

F. Each auxiliary equipment branch circuit shall be protected by an individual molded case circuit breaker properly coordinated with the Control Power Transformer (CPT) breakers. Molded case circuit breakers shall be manufactured by General Electric, Square D, or Cutler-Hammer.

G. The control cabinet shall be provided with a 120 VAC, duplex (3-wire) with ground fault interruption (GFI) receptacle and switched cabinet light, wired to a 20 amp, molded case circuit breaker. The circuit breaker line side shall be wired to control cabinet terminal blocks. Molded case circuit breakers shall be manufactured by General Electric, Square D, or Cutler-Hammer.

H. The control cabinet shall be equipped with a Seekirk Inc. Model B1002BNC-S33 annunciator (125 VDC, feed thru, LED, NC contacts (open to alarm)). Two (2) form C contacts rated for operation at 125 VDC shall be provided for a common output alarm. The normally closed contacts shall be wired in series and wired out to a terminal block in the control cabinet.

I. The control voltage for the annunciator, transformer protective relays and associated equipment shall be 125 VDC.

J. The control cabinet shall be equipped with a “Loss of DC Alarm Voltage” alarm relay, with alarm and trip contacts wired to a terminal block in the cabinet.

K. All control relays shall have enclosed, dust tight contacts.

L. All devices and terminal blocks mounted in the control cabinet shall be clearly labeled with a designation. This label shall be located on or near the device and be affixed in such a manner that they will not become detached during the life of the transformer (Dymo Tape or similar embossed plastic tapes are not acceptable).

M. A metal oxide arrestor (MOV) surge suppressor shall be mounted across the 125 VDC supply terminal within the control cabinet. The MOV shall be rated for a minimum of 10 kA, 200 joules capability with a maximum peak discharge voltage of 500V.

N. All control devices, controllers, and control systems and assemblies shall be in accordance with NEMA ICS 1 and 2 and shall meet the requirements of this Standard.

O. For each transformer, an automatic voltage seeking transfer switch shall be provided to supply power to the transformer auxiliary equipment. Two (2) sources of nominal 480V, 3-phase, 3-wire, 60 Hz power to feed this switch will be provided. The automatic transfer equipment shall be of sufficient capacity to transfer the total cooling equipment, control circuit, and space heater load from the normal source to the standby source upon failure of the normal source voltage. Voltage failure relays shall be installed in order to monitor normal and standby source voltages. Each relay shall provide a contact closure on loss of voltage. The contacts shall be wired to terminal blocks in the control cabinet. Control power for the transfer controls shall be 120 VAC.

P. Alarm Requirements. The following minimum alarm points shall be provided:

1. Top Oil Temperature – (26Q).
2. Winding Temperature – Monitor One Winding (49T)
3. Liquid Level Indicator – Main Tank/Conservator – Normal High (71Q-1(MT)/HA)
4. Liquid Level Indicator – Main Tank/Conservator – Normal Low (71Q-1(MT)/LA)
5. Liquid Level Indicator – Main Tank/Conservator – Emergency Low (71Q-3(MT)/LT)
6. Transformer Gas Detection – Buchholz Relay (71GD(MT))
7. Pressure Relief Device – Main Tank (63P-1(MT))
8. AC Supply – Loss of Main AC Supply (27-1)
9. Stage 1 Cooling – Loss of AC (27-2)
10. Stage 2 Cooling – Loss of AC (27-3)
11. Loss of Cooling Control Voltage – AC (27-4)
12. Loss of DC Control Voltage – DC (27-6)

Q. Tank cover pressure relief devices shall be supplied for each oil-filled compartment. Each device shall be equipped with form C alarm contacts, a manual reset, and mechanically operated flag, to indicate that the relief device has operated. Released oil shall be directed away from all control cabinets or where personnel may be standing. Alarm contacts shall be wired to terminal blocks in the control cabinet. Pressure relief device shall be Qualitrol 213 series.

R. Liquid level indicators (main tank and all other oil filled compartments) shall be provided with all alarm contacts wired to terminal blocks located in control cabinets:

1. The main tank shall either have a single, magnetic-type level indicator with two (2) low level and one (1) high level alarm contacts or two (2) separate, magnetic-type level indicators. All contacts shall be Form “C” contacts.
2. All other oil filled compartments shall have single indicators with Form “C” contacts at the lowest level considered safe for continued operation of the transformer and wired to terminal blocks in the main control cabinet.

3. All liquid level indicators shall be readable from ground level**.**

S. An Electronic Temperature Monitor (ETM) shall be provided.

1. The ETM shall monitor winding hot spot temperature and main tank top oil temperature.
2. A minimum of six (6) form C dry contact outputs [with auxiliary interposing relays as needed to accommodate a 125 VDC contact make/break rating for four (4) of the six (6) contacts (output contacts used for first and second stage temperature alarm levels on each of the top oil and hot spot winding temperatures), with the other contacts used for controlling the cooling system (responsive to the simulated winding hottest spot temperature)].
3. Form C alarm and trip contacts shall be wired out and terminated to terminal blocks in the transformer main control cabinet.
4. The ETM shall be mounted adjacent to or within the transformers main control cabinet, at an approximate height of 5 feet above the base of the transformer for easy viewing from ground level.
5. Source to the ETM shall be from a 125 VDC input power supply. On loss of DC, all stages of fans shall be triggered to energize.
6. A minimum of two (2) 0 to 1 mA DC analog (corresponding to 0 to 200°C) SCADA outputs for both top oil temperature and hot spot winding temperature.
7. Weather-tight NEMA 3R or better enclosure with outdoor-rated display and controls accessible without opening the enclosure's front door. A switch or operator accessible front panel menu for manual control of the system. Basic Temperature error (including probe) to be less than 1°C.
8. RS232/485 digital interface and MS Windows-based programming software for setup and monitoring from a PC.
9. Acceptable ETM manufacturers/models are as follows:

Manufacturer	**Model Number**
Weschler Instruments	Transformer Advantage CT - Electronic
Qualitrol	509-100 Series – Electronic

T. Transformers shall be equipped with the following valves and fittings:

1. A combination drain and lower filter valve shall be provided to drain the oil as completely as possible but to at least within 1 inch of the bottom of the main tank and for outlet to the filtering means. The drain valve shall be 2 inches with a built-in 3/8-inch sampling device.
2. Lower filter press valve with malleable iron pipe plug.
3. A 1 ½-inch upper filter press valve with malleable iron pipe plug.
4. Standard 4-inch bolted round pipe flange with gasketed cover plate for attaching the Company's vacuum valve and hose. The flange shall be located on the corner farthest from the upper filter press valve to insure that oil does not enter the Company's vacuum system.

5. A shut-off valve shall be provided on each end of the connection piping to the main tank.

U. Transformer shall be equipped with a gas detector relay with seal in coil, mounted in the control cabinet. Gas detector relay shall be a EMB Buchholz Type BF80-10, twin float relay DR80, Model 09-236 with form C contacts wired out to a seal-in relay panel (Qualitrol model 909-200-01 AC/DC Seal-In relay). Seal-in relay panel to be mounted in the control cabinet.

V. Transformer shall be equipped with a GE Hydran M-2 dissolved gas-in-oil intelligent monitor/transmitter.

W. Transformer shall be equipped with the following fall protection devices:

1. Brackets for mounting of 2-inch diameter pipes for use as safety rails shall be provided at the top of the transformer. Design and fabricate brackets to meet OSHA-required lateral loads at the top of the safety rail. Brackets shall be spaced a maximum of 4 feet apart, with one on each corner of the transformer. Brackets shall be in accordance with Exhibit C, Figure 1, Safety Rail Pocket Detail.

2. A weld-on base shall be provided near the center of the transformer top. It will be used for attaching a 4-foot Company-supplied tether pole to meet OSHA 29 CFR 1926.502(d). The base shall be designed to support a horizontal force of 10,800 lbs at the top of a 4' tether pole. The area above the base should be clear of obstructions as to facilitate attachment of the Company- supplied tether pole. Tether pole base shall be in accordance with Exhibit C, Figure 2, Tether Pole Base Plate Detail.

3. Unique Concepts Ltd. weld-on base, Part Number 10816, shall be installed by the Seller for attachment of a portable fall arrest system provided by the Company. Weld-on bases shall be installed on the transformer cover within three (3) inches of each manhole and shall be in accordance with Exhibit C, Figure 3, Portable Fall Arrest Weld-on Base Detail.

X. Nameplates: All nameplates shall be inked and engraved stainless steel. At least four (4) bolts or rivets shall attach nameplates. Mounting holes shall be provided with rubber grommets or equivalent to decrease vibration noise. Nameplate shall be located to be accessible and readable from grade level with no other equipment blocking or otherwise limiting view of the nameplate

1. A temperature relay nameplate shall be supplied and shall give the recommended temperatures at which the first set of cooling equipment shall be started, the second set of cooling equipment shall be started, and the temperature at which an alarm shall be actuated. All of these shall be calculated on the basis of operation at 65°C winding temperature rise. This information shall also be provided on the wiring diagram. The nameplate shall be mounted on or near to the temperature indicator(s)

2. De-energized tap changer nameplates shall be provided and shall include make and model information. These nameplates shall be mounted next to the main nameplate or the information may be incorporated into the main nameplate

2.6 INSULATING LIQUID

2.6.1 Insulating oil shall be Type II and shall meet ANSI C57.106 requirements. It shall be free of PCB's, chemically stable, free from acidity or other corrosive ingredients, and shall contain a suitable oxidation inhibitor. Maximum oxidation inhibitor content shall be 0.3% by weight and transformer nameplates shall indicate that the oil is inhibited. The oil shall contain less than 30 ppm water when tested in accordance with the procedures of ASTM D1533-88 (Karl Fischer method). The dielectric strength of the oil shall be at least 30 kV when tested in accordance with the procedures of ASTM D877-87, or 20 kV when tested in accordance with the procedures of ASTM D1816-84A using a 0.04-inch gap.

2.7 SOURCE QUALITY CONTROL

2.7.1 Transformers shall be tested in accordance with ANSI/IEEE C57.12.00 and ANSI/IEEE C57.12.90.

2.7.2 The following tests shall be performed and certified by the Seller for each transformer:

A. Resistance measurements on all windings. The test report shall indicate how windings were connected, either series or parallel.

B. Ratio tests on the rated voltage connection and on all tap connections.

C. Polarity and phase relation test on the rated voltage connection.

D. No load loss and exciting current at rated frequency and voltage and at maximum raise and lower tap position.

E. No load loss and exciting current at rated frequency at 90% rated voltage (0.9 p.u.).

F. No load loss and exciting current at rated frequency at 110% rated voltage (1.10 p.u.).

G. Auxiliary losses shall be verified by actual test measurements.

H. Impedance volts at rated current and at maximum raise and lower tap positions.

I. Load loss at rated current and at maximum raise and lower tap positions.

J. Temperature rise test made at the transformer self-cooled KVA rating at rated current.

K. Applied voltage test.

L. Induced voltage test for Class II power transformers with radio influence voltage (RIV) for partial discharge measurement.

M. Impulse tests. The neutral current method of fault detection shall be employed and oscillographic or digital records of all impulse tests shall be furnished with the test report.

N. Core insulation resistance test.

O. Sweep Frequency Response Analysis. For use in creating a baseline response analysis.

P. Transformer noise frequency spectrum analysis (under no load and full load conditions).

Q. Insulation power factor test.

2.7.3 The certified test report shall indicate all impedance values (positive, negative, and zero sequence); oil test reports, which include all tests indicated in ANSI C57.106.

2.7.4 Copies of all factory power factor tests or equivalents shall be furnished with the certified test reports. Certified test reports shall be prepared and submitted to the Company following completion of the testing and prior to transformer shipment.

END OF EXHIBIT

EXHIBIT B

GENERATOR STEP-UP TRANSFORMER DATA SHEETS

DATA SHEETS

GENERATOR STEP UP TRANSFORMER	UNITS	REQUIREMENTS	SELLER RESPONSE
Manufacturer		Seller	
City & Country of Manufacture		Seller	
Duty Cycle		Continuous	
ELECTRICAL PARAMETERS:			
Capacity	MVA		
Capacity with one section of the cooling inoperative	MVA	Seller	
Temperature Rise	ºC	**65**	
Type of Cooling			
Phase Displacement		**High Voltage leads Low Voltage by 30 º**	
Frequency	Hz	60	
Connection - High Voltage Winding		**Wye**	
Connection - Low Voltage Winding		**Delta**	
Voltage Rating - High Voltage Winding	kV		
Voltage Rating - Low Voltage Winding	kV		
No Load Tap Voltages (Full Capacity Taps) – High Voltage Winding	kV	**-____% to +____% @ ____ % Steps**	
No Load Tap Voltages (Full Capacity Taps) - Low Voltage Winding	kV	None	
BIL - High Voltage Winding	kV		
BIL - Low Voltage Winding	kV		
BIL - High Voltage Winding at Neutral Point	kV		
No Load Loss at - 100% of Rated Voltage	kW	Seller	
No Load Loss at - 105% of Rated Voltage	kW	Seller	
No Load Loss at – 110% of Rated Voltage	kW	Seller	
Load Loss at 100% of Rated Voltage, 100% ONAN Loading Of Transformer	kW	Seller	
Load Loss at 100% of Rated Voltage, 100% ONAF Loading Of Transformer	kW	Seller	

Total Cooling System Losses (@ max ONAF Loading).	kW	Seller	
Total Loss (No Load + Load) at 100% of Rated ONAN Loading Of transformer, 100% Voltage.	kW	Seller	
Total Loss (No Load + Load + Cooling) at 100% of Rated max ONAF Loading of transformer, 100% Voltage.	kW	Seller	
Impedance at Rated Capacity (at ONAN rating)	%		
Reactance at Rated Capacity	%	Seller	
Resistance at Rated Capacity	%	Seller	
X/R Ratio		Seller	
Maximum Overvoltage Excitation Capability at Full Load in % of Rated Voltage	%	ANSI	
Exciting Current in % of Full Load Current at Rated Voltage and Frequency	%	Seller	
Three Phase Capacitance to Ground H.V. Side Only	pF	Seller	
MATERIALS			
Color		**ANSI Z55.1 Color 70, Light Gray**	
Tank		Plate steel	
H.V. Windings		Copper	
L.V. Windings		Copper	
Fall Protection Brackets (for railing on top of transformer)		Yes	
Fall Protection Tether Pole Base		Yes	
Fall Arrest Brackets near each Manhole		Yes	
NOISE DATA			
Audible Sound Level @ 100% Load	dBA	NEMA TR1	
Audible Sound Level @ No Load	dBA	NEMA TR1	
APPROXIMATE WEIGHTS			
Core and coils	lb	Seller	
Tank and Fittings	lb	Seller	
Oil	lb	Seller	
Shipping Weight (without oil)	lb	Seller	

APPROXIMATE DIMENSIONS			
Overall height	in	Seller	
Width	in	Seller	
Depth	in	Seller	
Untanking	in	Seller	
Minimum Clearance of Jacking Lugs to base	in	16	
COOLING			
Quantity of Fans		Seller	
Rated Voltage	V	480	
OIL PRESERVATION SYSTEM			
Conservator Tank System		Yes	
High/Low Pressure Gauges & Alarm Contacts		Yes	
Minimum Positive Pressure	PSIG	0.5	
Maximum Positive Pressure	PSIG	5	
Maintenance-Free Dehydrating Breather (High Voltage Supply model 1030-012K)		Yes	
CONTROL CABINET			
Enclosure type	NEMA	4X	
Heater Voltage	VAC	120	
Heater Wattage	Watts	Seller	
Alarm Annunciator		Seekirk (per spec)	
INSTRUMENTATION / ALARMS			
Electronic Temperature Management (ETM) for cooling fan control, High temperature alarms, Hot Spot Winding Temperature (49T), and Top Oil Temperature (26Q)		Qualitrol ETM 509-100 Or Weschler Instruments Transformer Advantage CT – Electronic	
Pressure/Vacuum gage (63P) & bleeder device.		Yes	
Oil Level Indicator (71Q-HA) for Main tank and conservator tank.		Yes	
Oil Level Indicator (71Q-LA) for Main tank and conservator tank		Yes	
Oil Level Indicator (71Q-LT) for Main tank and conservator tank		Yes	
Transformer Gas Detection Relay (Buchholz) (71GD)		Yes	

Combustible Gas Monitor (GE Hydran M-2)		Yes	
Pressure Relief Device (63P-1) w/ trip contact and alarm contact		Yes	
Loss of Main AC Supply (27-1)		Yes	
Stage 1 Cooling – Loss of AC (27-2)		Yes	
Stage 2 Cooling – Loss of AC (27-3)		Yes	
Loss of cooling control voltage – AC (27-4)		Yes	
Loss of DC control voltage (27-5)		Yes	
TERMINAL BUSHINGS			
Manufacturer - High Voltage		ABB	
Manufacturer - Low Voltage		ABB	
Manufacturer - High Voltage Neutral		ABB	
Type/Style - High Voltage		Oil-Filled/Porcelain	
Type/Style - Low Voltage		Oil-Filled/Porcelain	
Type/Style - High Voltage Neutral		Oil-Filled/Porcelain	
Arrangement of Bushings – High Voltage (Sidewall or Cover).		Cover	
Arrangement of Bushings – Low Voltage (Sidewall or Cover).		Cover	
Arrangement of Bushings – High Voltage Neutral (Sidewall or Cover).		Cover	
Creepage Distance - High Voltage	In	Seller	
Creepage Distance - Low Voltage	In	Seller	
Creepage Distance - High Voltage Neutral	In	Seller	
Rated Voltage - High Voltage	kV		
Rated Voltage - Low Voltage	kV		
Rated Voltage - High Voltage Neutral	kV		
Rated Amps - High Voltage	Amps		
Rated Amps - Low Voltage	Amps		
Rated Amps - High Voltage Neutral	Amps		
BIL - High Voltage	kV		
BIL - Low Voltage	kV		
BIL - High Voltage Neutral	kV		
Terminal Bushings Shipped Loose		Yes	
Core Ground Bushing		Yes	

BUSHING CURRENT TRANSFORMERS			
High Voltage Bushing CT Quantity/Bushing			
High Voltage Bushing CT Ratio			
High Voltage Bushing CT Accuracy		**_____ @ C800,** **_____ @ 0.3-B1.8**	
High Voltage Bushing CT Burden		Seller	
Low Voltage Bushing CT Quantity/Bushing			
Low Voltage Bushing CT Ratio			
Low Voltage Bushing CT Accuracy		**_____ @ C800,** **_____ @ 0.3-B1.8**	
Low Voltage Bushing CT Burden		Seller	
High Voltage Neutral Bushing CT Quantity/Bushing		1	
High Voltage Neutral Bushing CT Ratio			
High Voltage Neutral Bushing CT Accuracy		C800	
High Voltage Neutral Bushing CT Burden		Seller	
HV SURGE ARRESTERS			
Manufacturer/Model No		ABB, Cooper, GE or Ohio Brass	
Type		Porcelain/MOV	
Rating	kV rms		
Maximum Continuous Voltage Capability, MCOV	kV rms		
GROUND PROVISIONS			
Tank Grounds – Two, NEMA 4-Hole		Yes	
Core Ground – with Bushing / Cover / Ground Pad		Yes	
HO Ground Bus / Pad		Yes	
Surge Arrestor Grounding Cable		Yes	
Grounding Brackets – Four brackets / side of Transformer		Yes	
(3) High Voltage Insulators with Grounding Brackets		Yes	
TERMINAL CONNECTIONS			
High Voltage		**Open Air**	
Low Voltage		**Iso-Phase**	

END OF EXHIBIT

SECTION 16950

INSTRUMENTATION AND CONTROL

PART 1: GENERAL

1.01 DESCRIPTION

A. Bidding requirements, conditions of the Agreement and pertinent portions of Sections in Division One of these Specifications apply to the Work of this Section as fully as though repeated herein.

B. The scope of the work includes the furnishing and installation of the electrical equipment building as required. The building shall be complete with door, door hardware, and exhaust fan. The contractor shall furnish and install the 480 and 240 volt panelboards, stepdown transformer, lights, outlets, exterior light and pole, SCADA panel and other appurtenances as required by the documents.

C. The work specified in this section includes furnishing, installing, startup, and testing of required equipment, including field instruments, the SCADA panel and components, wiring, piping, conduits, hardware, accessory equipment, and training.

1.02 SCHEDULING

A. The Contractor shall schedule execution of the installation and startup of the process instrumentation system to meet requirements of the overall Project.

1.03 SUBMITTALS

A. The Contractor shall submit complete shop drawings, instruction manuals, and record drawings in compliance with the General Conditions. As a minimum the information shall include:

1. System schematic diagrams (3 line drawings), ladder format
2. Sub-system schematic diagrams
3. Component schematic diagrams and specification sheets
4. Component instruction manuals
5. Dimension drawings and piping and wiring diagrams
6. Enclosure layout, structural and equipment layout drawings

B. The submittal shall conform with the requirements of the contract documents.

C. After installation and before the final acceptance of the equipment, final bound books containing the record drawings in addition to complete information in connection with the assembly, operation, adjustments, maintenance and repair of all equipment, together with a detailed parts list with drawings and photographs shall be furnished to the Company.

D. Where the contract documents indicate a nomenclature for terminal strips then the shop drawings and manufactured equipment shall also utilize the same nomenclature. Where none is assigned on the contract documents the Contractor shall assign a nomenclature. The nomenclature shall be approved by the Company with shop drawings.

1.04 GUARANTEE

A. The Contractor shall guarantee the operation of the system and that materials and workmanship of the equipment be free from defects for a period as defined in the General Conditions of the

project manual providing the equipment has been operated and maintained in accordance with the manufacturer's recommendations.

1.05 TESTING AGENCY CERTIFICATION

A. All panels furnished under this Section shall be constructed in accordance with Underwriter's Laboratories (UL) Standard 508 - AIndustrial Control Equipment@.

B. Each panel shall be shop-inspected by UL, or constructed in a UL-recognized facility. Each completed panel shall bear a serialized UL label indicating acceptance under Standard 508.

1.06 FUNCTIONAL DESCRIPTIONS

A. General

1. Functional descriptions define how each portion of the instrumentation and control system is to operate. The descriptions, in conjunction with the drawings and the minimum technical requirements for products as described in Part 2 of this Section define the minimum requirements for the installation.

B. Functional Descriptions.

1. The Contractor shall furnish and install the channel level and temperature transmitter. The level transmitter shall transmit a 4 - 20 mAdc signal to the SCADA panel. The channel temperature transmitter shall transmit a 4 - 20 mAdc signal to the SCADA panel. The Contractor shall furnish and install the terminal strips in the SCADA panel. Furnish and install the isolation transformer and associated outlets. The isolation transformer can be mounted on top of the SCADA panel. Outlets shall be furnished and installed next to the isolation transformer and in the SCADA panel. Connections to the Company PLC will be by Company personnel. Company personnel will calibrate the channel level and temperature transmitter. Furnish and install the cable holding clamp. The wiring shall be routed from the transmitter to the signal junction box. The signals shall be consolidated into a single conduit and routed to the SCADA panel.

2. The Contractor shall furnish and install the three trash rack level transmitters. The level transmitters shall transmit 4 - 20 mAdc signals to the SCADA panel. The HART signal shall be superimposed on the analog signal. The Contractor shall install terminal strips in the SCADA panel. Connections to the Company PLC will be by Company personnel. Company personnel will calibrate the trash rack level transmitters. Furnish and install the cable holding clamps. The wiring shall be routed from the transmitter to the Endress & Hauser signal terminal boxes. The signals shall be consolidated into a single conduit in the signal junction box and routed to the SCADA panel.

3. The Contractor shall furnish and install the river level and temperature transmitters. The level and temperature transmitters shall transmit a 4 - 20 mAdc signal to the SCADA panel. The HART signal shall be superimposed on the analog signal loops. Furnish and install the cable holding clamp and the Endress & Hauser transmitter terminal box. The Contractor shall install terminal strips in the SCADA panel. Connections to the Company PLC will be by Company personnel. Company personnel will calibrate the river level and temperature transmitters. The wiring shall be routed from the transmitters to the signal junction box. The signals shall be consolidated into a single conduit in the signal junction box and routed to the SCADA panel.

4. The Contractor shall provide power and signal wiring from the three gate actuators to the distribution panelboard for power, and to the SCADA panel for control, torque switches and signals. The power wiring shall be in separate conduits and the control wiring shall be in

separate conduits to the control junction box. The wiring shall be consolidated into one conduit in the control junction box and the control circuits routed to the SCADA panel. The signal wiring from the actuators for position, and for the torque switches shall be routed to the signal junction box, consolidated with other signal wiring and extended to the SCADA junction box.

5. The Contractor shall furnish and install the stainless steel control junction box to be located adjacent to the signal junction box. The Contractor shall furnish and install the SCADA junction box, quad-outlet and the UPS. The Contractor shall furnish and install the 24 VDC power supply that shall source the transmitters as required.

PART 2: PRODUCTS

2.01 ENCLOSURES

A. NEMA 4X. Stainless steel enclosure.

B. Steel subpanel for components

C. 14 gauge stainless steel with 16 gauge stainless steel door minimum

D. Stainless steel hinges and hardware

E. Doors flanged with stiffeners for rigidity

F. Latches.

2.02 SYSTEM WIRING

A. Instrumentation and control wiring shall be terminated on barrier type terminal strips using ring or spade connectors. All terminal strips shall have each point, as well as the terminal strip, identified. The labels shall be engraved plastic labels bonded to the enclosure with a two part epoxy adhesive.

B. Ring or spade connectors shall be of the "crimp" type.

2.03 SUBMERSIBLE LEVEL TRANSDUCER

A. Submersible level transducer housings shall be stainless steel. Assembly shall be UL labeled, or labeled by a third party organization approved by the local inspection authority. The transducer shall be Endress & Hauser FMX21 with HART communication protocol. The transducer for the channel monitoring shall include level (pressure) and temperature. Provide a Pt100 RTD with a transmitter located in a Endress & Hauser junction box above the probe for the channel level transmitter.

B. Span shall be from 0 to 12 feet of water. Output shall be a 4 - 20 mAdc signal proportional to the measured depth of the liquid. Provide a HART signal superimposed on the 4 – 20 mAdc signal line. Power supply shall be 23 to 40 volts, DC, with reverse polarity protection.

C. The following specifications shall apply: overrange to 580 psi; thermal change ∀0.5% of span; loop resistance, 500 ohms; accuracy, ∀0.25% of span; stability, ∀0.1% of upper range for 12 months. Power supply effect, ∀0.005% per volt. Surge protection shall be standard.

D. The transducer shall have a cap to protect the diaphragm.

E. Cable to the Endress and Hauser terminal box above the transducer shall be furnished. This shall be up to 50 feet (field confirm). The cable shall be submersible and approved for the application.

2.04 PANELBOARDS

A. Panelboards that are referred to as "power panels" refer to a system voltage of 120/240. Panelboards that are referred to as "distribution panelboards" refer to a system voltage of 277/480. Panelboards shall be surface mounted. Panelboards shall be mounted on 2 inch plywood. Unless shown otherwise the bussing shall be suitable for 200 amps, minimum. The number of circuits shall be not less than indicated on the schedules shown on the drawings. Unless shown otherwise, panelboards shall be NEMA 1. All panelboards on the project shall be by the same manufacturer, shall bear the U.L. label and listed as "suitable for use as service equipment" where applicable.

B. Cabinet rough-in boxes shall be code gauge steel, zinc galvanized, on both inside and outside surfaces, with an inturned flange on all sides of the front. The front covers shall be sheet steel, with a rust inhibitor primer and a baked enamel finish for surface mounted panels. The front covers shall be fitted with a door with a continuous butt type hinge concealed and welded to the back of the door. The other three sides shall have door stops. Doors over 48 inches high shall have auxiliary fasteners at the top and bottom. The doors shall have locks with two keys per lock. When the front cover and door assembly is removed, access to the wiring gutters shall be provided. The sub-plate shall be fastened to the panelboard with screws. The entire panelboard shall be of dead-front construction. The trim shall be adjustable.

C. Unless otherwise shown, main and branch circuit breakers rated at 240 volts shall have an interrupting rating of not less than 10,000 amps, r.m.s., sym. Unless otherwise shown, main and branch circuit breakers rated at 480 volts shall have an interrupting rating of not less than 22,000 amps. r.m.s., sym. Where panelboards and breakers are UL labeled for the application, series rated main and branch breakers may be used. Circuit breakers shall indicate open, closed, or trip conditions by handle position. Circuit breakers shall be quick-make, quick-break with thermal-magnetic trips having long-time and instantaneous tripping characteristics. Multi-pole breakers shall have one handle with internal trip bar with the circuit breaker cases fastened together. Panelboards are to be of bolt-on circuit breaker construction.

D. Install closure plates in each space not occupied by a breaker where the knockout has been removed. Accurately list the circuit numbers on the panelboard schedule utilizing a typewriter. Use actual room numbers.

2.05 DISTRIBUTION TRANSFORMER

A. Distribution transformer shall be a dry type suitable for indoor service. Transformers shall have a basic impulse level of not less than 10 kV. Transformers shall have not less than two 2-1/2% full capacity above normal primary voltage and two 2-1/2% full capacity below normal primary voltage taps. The transformers shall have a kVA rating as required. The primary voltage shall be 480 volts with a secondary voltage of 120/240 volts, single phase, three wire. The transformers shall have the insulations suitable for NEMA Class H, 150°C.

B. Transformers shall meet NEMA Standard TP-1, Energy Efficient Transformer Requirements.

C. Transformers shall be constructed in accordance with NEMA and ANSI standards. The transformers shall be finished with one coat of rust inhibiting primer and two finish coats of paint.

2.06 UPS

A. APS ES-450G, 450 VA, 120 VAC back-up UPS.

B. Input voltage range: 88 - 139 volts. Output 120 VAC when on UPS.

2.07 ELECTRICAL EQUIPMENT BUILDING

A. Plasti-Fab guardian, 8' by 8' shelter. Exterior surface, smooth gel coat. Interior surface white with webbing. 30% minimum glass content. Exterior color shall be tan.

B. Walls and roof to be sandwich construction with 1/8" (minimum) FRP skins, ½" thick (min) CDX plywood and 1" thick foam core. Insulated structure.

C. Insulated per energy code. Building shall include data plate indicating conformance with Minnesota State Building Code requirements.

D. Exterior door shall include not fewer than three hinges, door lockset assembly with key lock. Exterior door shall include ventilation opening with bug screen. Opening shall include insulated damper assembly for closing the opening in the winter.

E. Stainless steel hardware. 10" exhaust fan with motorized damper.mounted in wall opposite door.

2.08 ISOLATION TRANSFORMER

A. Isolation and transient protection. 1000 watts continuous capability. Reduce 6kV, IEEE587 Cat A&B ring wave test surge to 0.5 volts common mode.

B. 680 joules suppression rating.

C. Tripp-lite model IS1000 or equal.

PART 3: EXECUTION

3.01 FABRICATION

A. Fabricate per requirements of documents

B. Refer to project manual requirements concerning installation, inspection, etc.

C. All components and subassemblies shall be mounted to the sub-chassis or chassis, and sub-chassis shall be attached to the chassis with bolts or screws. Adhesives are not acceptable.

D. Front panel labels shall be attached with screws.

E. Internal components and labels shall be attached with screws.

3.02 INSTALLATION

A. Supplier shall define to Contractor dimensions, space requirements, access requirements for instrumentation devices.

3.03 MAINTENANCE EQUIPMENT

A. All special tools required for servicing equipment furnished under this division shall be delivered, properly identified as to use, to the Company prior to acceptance of the work. Adapters, electrical, pneumatic or otherwise necessary for servicing and maintaining the system shall also be delivered to the Company in the same manner.

3.04 CALIBRATION, ADJUSTING AND TESTING

A. All instruments will be calibrated by Company personnel.

3.05 START-UP SERVICE

A. When the equipment is ready, an instrumentation technician shall complete troubleshooting and start-up, at the Company's discretion, to place the instrumentation into satisfactory operation. The engineer or technician will make the necessary inspection of the completed installation, make the necessary final field adjustments, and instruct the operating personnel in the proper care and use of the equipment.

END OF SECTION 16950

SECTION 16500
LIGHTING

PART 1: GENERAL

1.01 DESCRIPTION

A. Bidding requirements, conditions of the Agreement and pertinent portions of Sections in Division One of these Specifications apply to the Work of this Section as fully as though repeated herein.

B. The Contractor shall furnish and install all lighting fixtures as required by the contract documents and in accordance with the fixture schedule. No lighting fixtures shall be substituted without prior written approval. Proposed substitutions shall be accompanied with complete engineering data including foot candle distribution curves.

1.02 SUBMITTALS

A. The Contractor shall submit complete shop drawings, instruction manuals, and record drawings to the Company for review and approval. The quantity and general format shall be as defined in the General Conditions.

B. After installation and before the final acceptance of the equipment, bound books containing the record drawings in addition to complete information in connection with the assembly, operation, adjustments, maintenance and repair of all equipment, together with a detailed parts list with drawings and photographs shall be furnished to the Company.

C. Submit lamp list for all lamp types provided under this project for inclusion in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 FIXTURES

A. All fixtures shall bear the seal of the Underwriter's Laboratories (UL). The seal shall be for the type of area the fixture is to be located in.

B. On all HID fixtures that utilize ballasts, the entire assembly shall have a power factor of not less than 0.90 at its designated voltage. All ballasts shall be of the type where the starting current does not exceed the operating current. Ballasts on fixtures that are located outside the building envelope shall be suitable for starting and operating at -20°F.

C. All fixtures shall be complete with lamps, starters, diffusers, guards, clips, retainers, etc. in accordance with the drawings, specifications and ordinances governing the installation of the fixtures.

D. Outdoor fixtures shall be complete with a pole as required. The pole shall be suitable to support the fixture in winds to 70 miles per hour.

E. Provide anchor bolts for the fixtures.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall verify, prior to ordering the fixtures, that the fixture bears the UL label and meets the requirements for the location where the fixtures are to be installed.

B. The Contractor shall install fixtures in accordance with the manufacturer's recommendations and shall be mounted carefully and rigidly.

C. The fixtures shall be connected into the power distribution system per the requirements of the National Electrical Code, the manufacturer's requirements, or the contract documents, whichever is more stringent.

END OF SECTION 16500

MASTER SPECIFICTION
FOR
METAL ENCLOSED SWTICHGEAR (MV)

Revision _0_
Date 20131202

Responsible Technical Specialist _____

Author: John J Howard Jr	Revision No.:	Specification Approval:

METAL ENCLOSED SWTICHGEAR (MV)

GENERAL

A. Description

1. Switchgear equipment shall be arc-resistant metal-clad and mounted in one-high or two-high designed vertical sections fabricated of steel and assembled to provide rigid self-supporting, completely enclosed structures.
2. Contractor shall furnish and install all switchgear gas ducting from the switchgear to building exterior.
3. The breakers/contactors shall be removable from the front. All live parts shall be completely enclosed. Grounded removable steel barriers shall be provided between adjacent sections and solid removable metal barriers shall isolate the major primary sections of each circuit. The medium voltage switchgear, breakers and contactors shall be designed and furnished with remote racking.
4. Each breaker cubicle shall have individual back panels to allow rear access to associated cables etc. and shall be able to be removed without exposure to adjacent breaker live parts.
5. The switchgear shall be capable of extension from either end at a future date without modification to existing structural members.
6. Switchgear shall be installed on concrete floors.
7. If louvers are furnished as part of the switchgear enclosure they shall be provided with air filters.
8. The depth of cable entries shall allow for entrance, bending, and termination of power cables, including stress cones, and shall have a minimum of 24 inches of clearance between the terminal pads and the cable entrance point to the cubicle. Cable supports shall be provided every 24 inches to properly support and brace cables for lugs not located near the cable entrance.
9. Switchgear sections shall allow top and bottom entry of power cables and control and instrumentation cables.
10. The MV motor contactor assemblies shall be equipped with at least a 10 inch rear cubicle extension to provide for additional space for MV cable entry and termination.
11. Medium voltage breakers shall have separate DC sources for closing and tripping circuits.
12. Medium Voltage switchgear shall be located in HVAC-controlled rooms.
13. Minimum switchgear bus rating shall be 4,000A.

Specifier – Add discussion of options and criteria that must be addressed

B. Bus Duct Layout
   1. Refer to site layout and powerhouse layout drawings for location and orientation of powerhouse and auxiliary power transformer equipment.
   2. The following estimated bus duct lengths, number of supports, and fittings may be used for bidding purposes (per bus duct run).
      a. Outdoor bus duct length/run
      b. Indoor bus duct length/run
      c. Fittings (quantity)
      d. Outdoor supports(quantity)/run
   3. Include separate additional add/deduct pricing in proposal for elbows and a cost per foot of bus for final price adjustments.

C. Reference Information
   See Attachment 4

D. Technical Proposal Documentation
   See Attachment 1

E. Approved Manufacturers
   See Attachment 8

SUMMARY: Specifier to include 2 to 3 sentences of requirements of the specification.

APPLICABLE CODES AND STANDARDS

A. State and local codes, laws, ordinances, rules and regulations
B. ANSI - American National Standards Institute
C. ASTM - American Society for Testing and Materials
D. ICEA - Insulated Cable Engineers Association
E. IEEE - Institute of Electrical and Electronic Engineers
F. NEMA - National Electrical Manufacturer's Association
G. NFPA - National Fire Protection Association
H. OSHA - Occupational, Health and Safety Administration
I. UL Underwriter's Laboratories

In case of conflict or disagreement between codes and standards, the more stringent conditions shall govern.

TECHNICAL REQUIREMENTS

PERFORMANCE REQUIREMENTS & GUARANTEES
See Appendix 3

DESIGN & CONSTRUCTION FEATURES
A. ENVIRONMENTAL

1. The following ambient and site conditions shall be used in the designed of all furnished equipment.

   See Appendix 4

2. Considerations shall be given to the exposure to solar heat in the areas of outdoor installation.

B. INFRARED INSPECTION VIEWING PANES

1. Infrared (IR) inspection viewing panes shall be installed to permit thermography inspection of all line and load connections. IR inspection viewing panes shall be oriented to allow viewing from ground level.
2. IR inspection viewing pane NEMA rating shall be equal to, or greater than, that of the enclosure in which it is being installed.
3. IR inspection viewing panes shall be NFPA 70E compliant.
4. IR inspection viewing panes shall be 3” minimum diameter and shall consist of reinforced polymeric optic material.

C. SPACE HEATERS

1. Compartment Space Heaters – Each vertical section shall be provided with thermostatically controlled space heaters. Heaters shall be rated for 240 VAC and energized and sized for application at 120 VAC.
2. Motor Space Heaters – Motor heaters shall be powered from their respective switchgear. An individual circuit breaker and ammeter shall be furnished and flush mounted on the door for protection of the motor space heater circuit.

D. POWER BUS BARS

1. Switchgear bussing shall consist of electrical grade high-conductivity copper bars, silver plated at all contact surfaces, and shall be designed to continuously carry rated design current.
2. The bus shall be braced with rigid, tracking-resistant, fire-resistant, and moisture-resistant insulating supports capable of withstanding the mechanical forces imposed by short-circuit currents equal to the momentary current rating of the largest circuit breaker in the assembly.
3. All power bus bars shall have fluidized bed epoxy, flame resistant, non-hygroscopic insulation with a continuous current rating. Bus joints shall have insulated boots that can be easily removed and reinstalled to allow inspection of the joints. The bus bar insulation shall be flame resistant and shall be flame resistant in accordance with ANSI standards.
4. For motor controller lineups installed as an extension to a medium voltage switchgear lineup, the power bus connections between the switchgear and motor controllers shall be solid bus bars.

5. Phase sequencing for power connections and main bus shall have proper identifications which shall be left-to-right, top-to-bottom, front-to-back (phase A-B-C) when facing the front of the switchgear.

E. GROUND BUS

1. A non-insulated, predrilled copper bar ground bus shall extend the entire length of each switchgear lineup and to each cubicle. The minimum size of the copper ground bar shall be 1/4 inch by 2 inches.

F. POWER CIRCUIT BREAKERS

1. The switchgear shall be furnished with draw-out medium voltage power circuit breakers. The power circuit breakers shall be vacuum type.
2. Each breaker shall have three (3) positions: operate, test, and disconnected. Breaker position shall be indicated on the breaker.
3. The power circuit breaker operating mechanism shall be fully mechanically and electrically trip-free in any position. The main contacts of the power circuit breakers shall not touch or arc across into a faulted circuit when a breaker close signal is received while a trip signal is being applied.
4. Each breaker shall be furnished with a manual trip push button, which mechanically trips the breaker. The manual trip push button and its associated breaker trip linkage shall have no common components with the electrical trip mechanism, except the final breaker release device.
5. Each circuit breaker shall be capable of being padlocked in the disconnected position.

G. MOTOR CONTROLLER ASSEMBLIES

1. Motor controller assemblies shall be draw-out two-high construction where possible. Each motor controller cubicle shall have individual rear panels to allow rear access to associated cables etc. and shall be able to be removed without exposure to adjacent compartment live parts.
2. All motor controllers shall be NEMA Class E2.
3. The contactors in the motor controller assemblies shall be vacuum type.
4. Each motor controller assembly shall be furnished with primary current-limiting fuses on each phase of the incoming side of each contactor for short-circuit protection, and with controls and relays specified on the drawings provided by the Company for overload and single-phase protection. Primary fuses shall be the largest size available that still protects the contactor.
5. Primary fuses shall be an integral part of the motor controller assembly and shall not require special tools for installation or

removal. Primary fuses shall be selected according to the motor locked rotor current and to provide coordinate with the motor protection relay such that the contactor is allowed to clear low and medium level faults without blowing any of the fuses and without exceeding the contactor interrupter ratings. The primary fuses shall be allowed to interrupt high-level fault currents that exceed the current interrupter rating. Primary fuses shall have visible blown fuse indicators.

6. Each contactor shall have a control power transformer (CPT). The CPT shall be protected on the high side by current limiting fuses and on the secondary by fuses or breaker.
7. Each draw-out motor controller unit shall have line and load stab fingers to allow complete removal of the draw-out unit without disconnecting any field or factory-installed power cabling.
8. Each starter or contactor shall have an externally operated, manual, three-pole, isolating switch with quick-make/quick-break contacts. The switch should be mechanically interlocked to prevent opening under load or closing with the high voltage door open. Each unit shall be capable of being padlocked in the disconnected or open position.
9. The racking mechanism for each controller shall be designed such that it is impossible to rack the contactor in or out of the bus without first opening the contactor. Likewise, the mechanism must prevent opening of the compartment door unless the contactor is in the open position.
10. Contactors shall be provided with remote racking.
11. The contactor in each motor controller assembly shall be magnetically-held and non-latching for motors and latching for transformer feeders.
12. Each controller shall be provided with a built-in test circuit connection to test operation of the contactor. This circuit shall be interlocked to only function when the contactor is disconnected from the bus.

H. SHUTTERS

1. Grounded automatic metal safety shutters shall be provided which isolate the primary connections in the power circuit breaker or voltage transformer compartment when the power circuit breaker or voltage transformer is withdrawn from the connected position.
2. The shutters shall automatically operate when the power circuit breaker/contactor or voltage transformer is racked in or out.

I. AUXILIARY SWITCHES

1. Breaker/Contactor Draw-out Auxiliary Position Switches

(52/a/b/M)

a. Each power circuit breaker/contactor shall be furnished with breaker/contactor-mounted auxiliary position switches mounted on the breaker/contactor frame.

b. The breaker/contactor-mounted auxiliary position switches provide breaker/contactor opened or closed indication only when the breaker/contactor is in the fully “in-service” and “test” position.

c. A minimum of two (2) normally-open (“a”) and two (2) normally-closed (“b”) contacts shall be furnished for Company’s future use in addition to those required by the Contractor’s design.

2. Breaker/Contactor Stationary Position Switches (52S/a/b/MX)

a. Each breaker/contactor shall be furnished with stationary auxiliary position switches mounted in the breaker/contactor cell compartment.

b. The breaker/contactor stationary auxiliary position switches provide breaker/contactor opened or closed indication only when the breaker/contactor is in the fully “in-service” position. When the breaker/contactor is not in the “in-service” position (e.g. in the “test” position or “disconnected” positions) the breaker/contactor stationary auxiliary position switches shall indicate the breaker/contactor is open at all times.

c. A minimum of two (2) normally-open (“a”) and two (2) normally-closed (“b”) contacts shall be furnished for Company’s future use in addition to those required by the Contractor’s design.

3. Breaker/Contactor Truck Position Switches (52H/MH)

a. Each breaker/contactor shall be furnished with truck position switches mounted in the breaker/contactor cell compartment. Each switch shall be field convertible to be either normally open or normally-closed.

b. The breaker/contactor truck position switches shall provide breaker/contactor “in-service”/“not inservice” indication. The switches shall indicate that the breaker/contactor is “in-service” only when the breaker/contactor is fully racked in to the “in-service” position.

c. A minimum of two (2) normally-open (“a”) and two (2) normally-closed (“b”) contacts shall be furnished for Company’s future use in addition to those required by

the Contractor's design.

J. CONTROL AND INSTRUMENT WIRING

1. Wiring installed by the Contractor shall be stranded Type SIS, VW-1, extra flexible, insulated to 600 V with XLPE or EPR insulation. The wiring shall have the following minimum sizes:

Service	Minimum Wire Size
Current Transformer Circuits	10 AWG
All Other Wiring	14 AWG or Larger if Required for Load and Voltage Drop Considerations

2. The switchgear and motor controllers shall be controlled and monitored by the DCS and the DCS requirements herein.
3. All low voltage control and instrument wiring shall be installed and tested at the factory.
4. All interior wiring shall be installed in wiring gutters or conduit and secured with nylon ties. All wiring shall be protected from contact with sharp edges with grommets. Flexible wire guards shall be furnished for wiring at hinge points.
5. The Manufacturer shall install heat-shrinkable wire markers labeling at each end of each wire.

K. TERMINAL BLOCKS

1. All terminal blocks shall be one-piece UL94-VO material terminal blocks with strap-screw connectors and a minimum rating of 600 V, 30 amperes.
2. All current transformer circuits shall be wired to shorting-type terminal blocks.
3. All terminal blocks and terminals on terminal blocks shall have plainly legible machine lettering.
4. No more than two (2) wires shall be terminated at any one (1) terminal point.
5. One (1) side of each terminal block used for external connections shall be reserved solely for external connections.

L. TERMINATIONS

1. Terminal blocks shall be provided 20% spare terminals.
2. When compatible with Manufacturer's standard supply, all circuits shall be terminated with ring-type connectors.
3. All spare contacts shall be wired to terminal blocks.

M. CONTROL POWER

1. A common 125 VDC bus shall be wired throughout each switchgear lineup to provide power for breaker control, charging motor, protective relaying, and other auxiliary components. The common 125 VDC bus shall have one (1) supply point in each switchgear lineup. A single, visible break disconnecting device shall be provided to disconnect both the closing and tripping circuits.

2. Each breaker's close and trip circuit shall be fused separately in each cubicle. Any control or protective devices that are common to more than one (1) breaker shall be fused on separately fused circuits. Minimum trip circuit fuse rating shall be 30 A.
3. The contactors shall be powered from the control power transformers.

N. PROTECTIVE RELAYING, CONTROLS, AND INDICATION

1. At a minimum, the Manufacturer shall furnish and install protective relaying, controls, and indication as shown on Appendix I – Relaying One-Line Diagrams. The schemes and equipment furnished by the Manufacturer shall be based on the drawings provided by the Company.
2. Test switches shall be provided for all metering, CTs, PTs and shall be provided as shown on Appendix I – Relaying One-Line Diagrams. Test switches shall be ABB FT-1 or States Type FMS. Test switches shall have black handles for current and potential poles, red handles for trip poles. Test switches shall have clear switch covers.
3. The power for the closing circuit for each breaker shall be sub-fused from the power supply for the tripping circuit for hat breaker.
4. Control switches shall be furnished and installed for each breaker. The switches shall be wired such that the power circuit breakers cannot be closed with the power circuit breakers racked in to the "inservice" position.
5. Lock-out relays (LOR) shall be Electroswitch Series 24, lighted target nameplate with (2) LEDs.
6. Indicating lights shall be provided and installed. Indicating lights shall be long-life LED type with push-to-test feature. Red lights shall indicate breaker in "closed" position, green lights shall indicate breaker "open" position.
7. Coil monitoring relays shall be furnished and installed. These relays shall be flush mounted on the front door so that the red indicating light is visible from the front.
8. Interposing relays shall be provided for interfacing with the DCS controls.
9. Optical arc flash detection relays shall be furnished and installed for all medium voltage switchgear. Optical relays shall coordinate with protective devices specified herein and are intended to reduce the arc flash hazard to plant personnel.

O. METERING

1. At a minimum, the Contractor shall furnish and install metering as shown on Appendix I – Relaying One-Line Diagrams.

2. Switchgear metering shall have factory installed meter parameter settings.

P. CURRENT TRANSFORMERS

1. Current transformer installation shall be designed to permit maintenance or replacement of the current transformers without damage to the connections. Current transformers shall be mechanically braced to withstand the same momentary current as the circuit breakers/contactors with which they are used.
2. Current transformer mechanical and thermal limits shall be coordinated with the momentary and short time ratings of the circuit breakers with which they are used.
3. All spare breakers/contactors and equipped spaces shall be furnished with multi-ratio current transformers. Unless otherwise specified or shown on the as shown on Appendix I – Relaying One-Line Diagrams, the polarity marking shall be toward the power circuit breaker.
4. Excitation curves shall be furnished by Contractor for all the current transformers.

Q. VOLTAGE TRANSFORMERS

1. Voltage transformers shall be mounted on draw-out type removable units designed to isolate and ground the potential circuits when the unit is in the fully withdrawn position.
2. Each voltage transformer shall be provided with current limiting primary fuses. Secondary fusing shall also be provided and shall be fast-acting type and selected to fully coordinate with the primary fuses for a fault on the secondary control circuits.

R. NAME PLATES

1. Engraved nameplates shall be furnished on the outside of each switchgear lineup and individual switchgear section. Engraved nameplates shall also be furnished for devices mounted inside compartments.
2. Switchgear nameplates shall be 1/16 inch laminated phenolic resin with white background and black core. Name plates shall indicate the following minimum information:
   a. Equipment name
   b. Equipment tag number
   c. Service Information: Voltage, current rating
3. Nameplates shall be mounted using stainless pan-head self-tapping screws.

S. SPARE PARTS AND TOOLS

1. The switchgear shall be furnished, at a minimum, with the following spare parts, maintenance and operating equipment for each lineup location:
   a. One (1) portable lift truck to move the draw-out

breaker units into and out of the compartments.

b. One (1) ground and test device per switchgear class.
c. Manual lever or crank for moving the breaker elements into and out of the operating position.
d. Manual spring charging handle for circuit breaker.
e. Remote racking device(s) for breakers and contactors.
f. Equipment necessary for testing the circuit breaker outside the cubicle and in the test position.
g. Special tools required for operation or maintenance.
h. Per Line-Up – test module/test device/test equipment, software, and software licenses for testing and setting relays or protective devices.
i. Provide 50% spare set of fuses for each size and type of fuse furnished and 10% spare set of indicating lights and lenses.

SOUND CONTROL REQUIREMENTS

Specifier Note: Additional information required

ELECTRICAL REQUIREMENTS

Specifier Note: Additional information required

INSTRUMENTATION & CONTROL REQUIREMENTS

Specifier Note: Additional information required

MATERIALS & WELDING

Specifier Note: Additional information required

CLEANING, PAINTING & COATING

Specifier Note: Additional information required

PACKAGING & SHIPPING

See Appendix 7

STORAGE & HANDLING PROCEDURES

See Appendix 7

SPARE PARTS

Commissioning spares to be included/supplied with the equipment.

QUALITY ASSURANCE

See Appendix 5

TESTING

See Appendix 5

SELLER'S DATA SUBMISSION SCHEDULE

See Appendix 2

APPENDICES

APPENDICES TO SPECIFICATION

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.
****

1. DELIVERABLES

2. PROPOSAL DATA REQUIREMENTS
3. PERFORMANCE GUARANTEES

4. SITE CONDITIONS AND REFERENCE MATERIALS

1.0 Summary

1.1. This Schedule outlines the Site conditions used for the design of all equipment covered under this contract.

2.0 Location

2.1. Xcel Energy's xxxxxx Station site is located xxxxxxxxx.

2.2. The property consists of approximately xxx acres.

2.3. Existing plant site consists of xxxxxx generating units.

3.0 Ambient Design Criteria

3.1. Meteorology

3.1.1. Local meteorological data with long periods of record for xxxxxx is available. Xxxxx data is used for design wet-bulb temperature, dry-bulb temperature, wind, and other design criteria. Contractor is responsible for verifying Meteorological data by obtaining the most recent information available.

3.1.1.1. Temperature and Humidity

- Maximum Summer Extreme Temperature xx°F
- Minimum Winter Extreme Temperature xx°F
- Summer Design Dry Bulb Temperature xx°F
- Summer Design Wet Bulb Temperature xx°F
- Winter Design Dry Bulb Temperature xx°F
- Average Annual Dry Bulb Temperature xx°F
- Average Annual Wet Bulb Temperature xx°F

3.1.1.2. Indoor Temperatures

- Indoor temperatures can be expected to range from xx°F to xx°F.

3.1.1.3. Precipitation and Snow

- Annual precipitation in the site vicinity is expected to average about xx inches. Annual snowfall in the plant vicinity averages about xx inches.
- The snow load for xxxxxx is xx lb/ft2.

3.2. Barometric Pressure

3.2.1. The standard barometric pressure adjusted to the site elevation of xxxxx feet is xx psia..

5. QA/QC (Including Inspection Test Plans)
6. STARTUP, TESTING, AND COMMISSIONING
7. PACKAGING, SHIPPING, AND STORAGE
8. ACCEPTABLE SUPPLIERS

Complete technical requirements as required for the identified topic.

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A Equipment and Materials

A.1 Summary

These specifications are for the purchase of wire and cable for Xcel Energy's Energy Supply construction projects.

A.2 Product Selection

A.2.1 General Product Requirements

Provide products that comply with this Specification, that are undamaged, and unless otherwise specified or indicated, new at the time of installation.

Conform to applicable specifications, codes, standards, and regulatory agencies.

A.2.2 Manufactured and Fabricated Products

Fabricate and assemble in accordance with industry acceptable engineering and shop practices.

Materials shall be suitable for service conditions intended.

Provide labels where required by regulatory agencies or to state identification and essential operating data.

Do not use products for any purpose other than for which designed.

A.2.3 Labels and Identification System

Supplier shall use the Company's existing identification system for electrical wiring and cables.

All wiring within cabinets, panels and termination boxes shall have circuit/wiring numbering as shown on the drawings provided by the Company.

B Products

B.1 Medium Voltage Cable

This Section covers 5 kV, 8 kV, 15 kV, 25 kV and 35 kV single conductor shielded power cable rated for use in wet or dry locations. The cable will be placed in cable tray, conduit, and/or underground duct. All materials furnished herein shall be designed to meet or exceed all applicable standards of ICEA, AEIC, NEMA, and ASTM.

B.1.1 Temperature Rating:

B.1.1.1 The cable shall be rated at the following minimum values:

B.1.1.1.1 90° C for normal operation.

B.1.1.1.2 130° C for emergency overload.

B.1.1.1.3 250° C for short circuit conditions.

B.1.2 Conductor:

B.1.2.1 The conductor shall be soft, annealed, coated or uncoated copper.

B.1.2.2 The electrical and tensile properties shall comply with the latest ASTM specifications: B-3, B-33 and B-189.

B.1.2.3 Cables shall be stranded per ICEA S-19-81, Section 2.3, Class B. The lay of concentric stranded conductors shall be in accordance with ASTM B-8.

B.1.3 Construction:

B.1.3.1 Single conductor with metallic tape insulation shielding.

B.1.4 Insulation:

B.1.4.1 Insulation level shall be 133%.

B.1.4.2 The insulation shall be a thermosetting dielectric based on an ethylene-propylene rubber (EPR) elastomer.

B.1.4.3 All electrical and physical characteristics of the insulation shall meet or exceed values given in ICEA S-68-516 for ethylene-propylene insulation.

B.1.4.4 The insulation shall fit tightly to the conductor, yet be “free-stripping”.

B.1.4.5 The average wall thickness at any cross section of the insulation shall be in accordance with ICEA S-68-516 Table 3-2 for voltages 5 kV, 8 kV, 15 kV, 25 kV and 35 kV at 133% insulation level. Maximum wall thickness deviation from these values shall be from –10% to +15% from the nominal values.

B.1.5 Conductor Shield:

B.1.5.1 The conductor shield shall be an extruded, semi-conducting material. The conducting material shall be extruded, compatible with the insulation and the conductor, and firmly bonded to the inner surface of the insulation.

B.1.5.2 The shield shall have a volume resistivity less than 100,000 ohm-centimeters at 90° C.

B.1.6 Insulation Shield:

B.1.6.1 The insulation shield shall be an extruded or taped non-metallic, semi-conducting layer.

B.1.7 Metallic Shield:

B.1.7.1 Metallic shield shall be 5 mil tinned copper tape helically applied with a minimum of 12.5% overlap.

B.1.8 Insulation Jacket:

B.1.8.1 The insulated shielded conductor, covered with a jacketing material which is either a chloro-sulfonated polyethylene (Hypalon) compound, or polychloroprene (Neoprene) compound, or a chlorinated polyethylene (CPE) compound. The jacket shall be oil-resistant, moisture resistant, and self-extinguishing flame resistant. Sunlight resistant and flame retardant Polyvinyl Chloride (PVC) jacket shall be allowed for 15 kV to 35 kV cables.

B.1.8.2 All cable jackets shall have printed in a clearly visible fashion, every 18”-24”, information indicating gauge size or MCM, voltage rating, sequential footage, and manufacturer. All cables shall also bear on the jacket surface a unique traceability number.

B.1.9 Final Assembly Testing:

B.1.9.1 Tests shall be performed in accordance with ICEA S-68-516, Section 6. Testing shall be performed in the order of listing.

B.1.9.2 High Voltage AC Test: Each length of cable shall be subjected to and withstand a high voltage 60-cycle test of 5

minutes. The test voltage and procedure shall be performed in accordance with Part 6 of ICEA S-68-516.

B.1.9.3 Insulation Resistance Test: An insulation resistance test shall be made on each sample in accordance with ICEA S-68-516, Part 6.28, corrected to 15.6° C (60° F) per ICEA S-68-516, Table 6-10. The measured value shall not be less than the applicable calculated value for the specific cable.

B.1.9.4 High Voltage DC Test: Each sample shall be subjected to, and shall withstand, a high voltage DC test for 15 minutes at a potential stated in Part 6.27 of ICEA S-68-516.

B.1.9.5 Partial Discharge Test: A partial discharge test shall be carried out in accordance with AEIC CS-6, Parts F and G.

B.1.9.6 Flame Resistance Test: Samples shall be subjected to and shall pass the flame test as set forth in Section 2.5 of IEEE 383-1974.

B.1.10 Manufacturers:

Recommended manufacturers for shielded power cables are:

B.1.10.1 Cable Continental Cables Co.

B.1.10.2 The Okonite Company

B.1.10.3 Pireli Cable Corporation

B.1.10.4 Kerite Cable Corporation

B.2 600 Volt Power Cable

This section covers multi-conductor and single-conductor power cable rated for use at 600 volts in wet or dry locations. The cable will be placed in cable tray, conduit, and/or underground duct. Cables shall be either single, three conductor, or four conductor as specified. The finished cable shall be bunched and filled to be round in cross-section. All fillers and binder tape (if required) shall be non-hygroscopic and flame retardant. All materials furnished herein shall be designated to meet or exceed all applicable standards of ICEA, AEIC, NEMA, and ASTM.

B.2.1 Temperature Rating:

B.2.1.1 The cable shall be rated at the following minimum vales:

B.2.1.1.1 90° C for normal operation

B.2.1.1.2 130° C for emergency overload

B.2.1.1.3 250° C for short circuit conditions

B.2.2 Conductor

B.2.2.1 The conductor shall be soft, annealed, coated or uncoated copper.

B.2.2.2 The electrical and tensile properties shall comply with the latest ASTM Specifications: B-3, B-33 and B189.

B.2.2.3 Cables shall be stranded per ICEA S-19-81, Section 2.3, Class B. The lay of concentric stranded conductors shall be in accordance with ASTM B-8.

B.2.3 Insulation

B.2.3.1 The insulation shall be a cross-linked thermosetting polyethylene (XHHW) compound.

B.2.3.2 All electrical and physical characteristics of the insulation shall be tested in accordance with ICEA S-66-524 for cross-linked polyethylene insulation.

B.2.3.3 The insulation shall fit tightly to the conductor, yet be “free-stripping”.

B.2.3.4 The average wall thickness at any cross section of the insulation shall be in accordance with IECA S-66-524. Maximum wall thickness deviation from these values shall be from –10% to +15% from the nominal values.

B.2.3.5 Guaranteed values for the physical and electrical requirements for all insulation shall be in accordance with values given in ICEA S-66-524 for the specific insulation.

B.2.4 Jacket:

B.2.4.1 The insulated conductor shall be covered with a jacketing material, which is either a chlorosulfonated polyethylene (Hypalon) compound or a polychloroprene (Neoprene) compound, or a chlorinated polyethylene (CPE) compound.

B.2.4.2 The jacket shall be oil-resistant, moisture resistant, self-extinguishing flame resistant, and shall be in accordance with ICEA S-19-81.

B.2.4.3 The jacket wall thickness shall be in accordance with NEMA WC-3 (ICEA S-19-81), Table 4-15 and shall exhibit a maximum wall thickness deviation between 90% and 125% of the nominal value.

B.2.4.4 All cable jackets shall have printed in a clearly visible fashion, every 18" – 24", information indicating gauge size or MCM, voltage rating, sequential footage, and manufacturer. All cables shall also bear on the jacket surface a unique traceability number.

B.2.4.5 Guaranteed values for the physical and electrical properties of the jacket shall be in accordance with NEMA WC 3 (ICEA S-19-81).

B.2.5 Final Assembly Testing:

B.2.5.1 Testing shall be performed in accordance with ICEA 8-66-524. Each cable shall meet or exceed the values given in the applicable ICEA publication. Test shall be performed in the order of listing.

B.2.5.2 High Voltage AC Test: Each length of cable shall be subjected to and withstand a high voltage 60-cycle test of 5 minutes. The test voltage and procedure shall be performed in accordance with ICEA S-66-524.

B.2.5.3 Insulation Resistance Test: An insulation resistance test shall be performed on each sample and shall be in accordance with ICEA S-66-524.

B.2.5.4 Flame Resistance Test: Samples shall be subjected to and shall pass the flame test as set forth in Section 2.5 of IEEE 383-1974.

B.3 Multi-Conductor Control Cable

This section covers multi-conductor control cable designed for service at 600 volts with a continuous operating temperature of 90° C. The cable will be used in cable tray, conduit, and/or underground duct. All materials furnished herein shall be designed to meet or exceed all applicable standards of ICEA, AEIC, NEMA, and ASTM.

B.3.1 Ratings:

B.3.1.1 The cable shall be designed for service at 600 volts with a continuous operating temperature of 90° C.

B.3.2 Conductor:

B.3.2.1 The conductor shall be of soft, annealed, coated or uncoated copper.

B.3.2.2 The electrical, tensile, and coating properties shall comply with the latest ASTM specifications, B-3, B-8, B-33, and B189.

B.3.2.3 The control cables shall be stranded per ICEA S-19-81, Section 2.3, Class B.

B.3.3 Insulation:

B.3.3.1 The insulation shall be a cross-linked thermosetting polyethylene (XHHW) compound or ethylene-propylene rubber (EPR) elastomer.

B.3.3.2 All electrical and physical characteristics of the insulation shall be tested in accordance with ICEA S-66-524 for cross-linked polyethylene insulation wire and in accordance with ICEA S-68-516 for ethylene-propylene rubber (EPR) insulation.

B.3.3.3 The insulation shall fit tightly to the conductor, yet be “free-stripping”.

B.3.3.4 The average wall thickness at any cross section of the insulation shall be in accordance with ICEA S-66-524. Maximum wall thickness deviation from these values shall be from –10% to +15% from the nominal value.

B.3.3.5 Guaranteed values for the physical and electrical requirements for all insulations shall be in accordance with values given in ICEA S-66-524 for the specific insulation.

B.3.4 Circuit Identification

B.3.4.1 Conductors shall be identified by Color Coding in accordance with ICEA S-66-524, Appendix K, Method I, Table K-2.

B.3.5 Conductor Assembly

B.3.5.1 The required number of conductors shall be cabled concentrically with the outer layer having a left-hand lay.

B.3.5.2 When necessary to make a multiple conductor cable assembly round, non-hygroscopic flame resistant fillers shall be used. The overall conductor assembly shall be covered with a non-hygroscopic flame barrier tape.

B.3.6 Outer Jacket

B.3.6.1 The assembled, bound cable shall be covered with a jacketing material, which is either a chlorosulfonated polyethylene (Hypalon) compound or a polychloroprene (Neoprene) compound, a chlorinated polyethylene (CPE) compound.

B.3.6.2 The jacket shall be oil-resistant, moisture resistant, and self-extinguishing flame resistant meeting the specifications of ICEA S-19-81.

B.3.6.3 The jacket wall thickness shall be 45 mils and shall exhibit a minimum wall thickness deviation between 90% and 125% of the nominal value.

B.3.6.4 All cable jackets shall have printed in clearly visible fashion, every 18" - 24", information indicating gauge size, number or conductors, voltage ratings, sequential footage, and manufacturer. All cables shall also bear on the jacket surface a unique traceability number.

B.3.6.5 Guaranteed values for the physical and electrical requirements of all specified jacket materials shall meet or exceed the values given in the appropriate ICEA publication for the specific jacket.

B.3.7 Final Assembly Testing:

B.3.7.1 All cables shall pass the IEEE-383 - 70,000 BTU gas ribbon burner vertical tray flame test.

B.3.7.2 All insulated singles shall be subjected to a 5-minute wet AC voltage withstand test after a 6 hour immersion in water prior to cabling.

B.3.7.3 All completed cables are subjected to a conductor resistance test, a 5-minute dry AC voltage withstand test, and an I.R. test.

B.3.7.4 Test voltages shall be 4000 volts.

B.4 Instrument Cable

This section covers shielded, twisted pairs and triads. The cable is designed for service at 600V with a continuous operating temperature of 90°C. The cable will be used in cable tray, conduit, and/or underground duct. All materials furnished herein shall be designed to meet or exceed all applicable standards of ICEA, AEIC, NEMA, and ASTM.

B.4.1 Conductor:

B.4.1.1 The stranded conductor shall be of soft annealed, coated or uncoated copper.

B.4.1.2 The electrical, tensile, and coating properties shall comply with the latest ASTM specifications B-3, B-33, and B-189.

B.4.1.3 Resistance shall be in accordance with ICEA S-61-402, Section 2.6.

B.4.2 Insulation:

B.4.2.1 The insulation shall be either a thermosetting dielectric based on an ethylene propylene elastomer (EPR), or a cross-linked thermosetting polyethylene (XLPE) compound.

B.4.2.2 All electrical and physical characteristics of the insulation shall be tested in accordance with ICEA S-68-516 for ethylene-propylene insulation and ICEA S-66-524 for cross-linked polyethylene insulation, and shall meet or exceed the values given for the specific insulating material.

B.4.2.3 The insulation shall fit tightly to the conductor, yet be "free-stripping."

B.4.2.4 The average wall thickness at any cross section of the insulation shall be in accordance with the applicable ICEA standard and values shall exhibit a maximum wall thickness deviation of -10% and +25% from the nominal thickness.

B.4.3 Circuit Identification:

B.4.3.1 Each pair of conductors shall be made up of a black pigmented conductor and a white pigmented conductor.

B.4.3.2 For multi-pair assemblies, the pair number shall be stamped on both conductors of that pair.

B.4.3.3 For triad construction, each triad shall be made up of a black pigmented conductor, a white pigmented conductor, and a red pigmented conductor.

B.4.3.4 For multi-triad assemblies, the triad number shall be stamped on all three conductors.

B.4.4 Conductor Assembly

B.4.4.1 Each pair or triad shall have an individual drain wire, with a minimum size of #20 AWG.

B.4.4.2 This assembly shall then be twisted with a maximum twisting lay of 2.5" for pairs and 3.5" for triads.

B.4.4.3 Each pair or triad shall then be shielded by helically wrapping with a 2 mil polyester/aluminum tape with the metal side down. Isolation tape shall be wrapped over the shielded pair assembly.

B.4.4.4 Assembled pairs or triads, and multi-pairs or multi-triads shall then be cabled concentrically.

B.4.4.5 When necessary to make a multi-pair cable or multi-triad cable assembly round, moisture-resisting fillers shall be used.

B.4.4.6 In addition, an optional drain wire and 2 mil polyester/aluminum tape may be applied over the multi-pair or multi-triad cable.

B.4.4.7 A non-hygroscopic flame-barrier tape shall be applied over all conductor assemblies.

B.4.5 Outer Jacket:

B.4.5.1 The assembled, bound cable shall be covered with a jacketing material, which is either a chlorosulfonated polyethylene (Hypalon) compound or a chlorinated polyethylene (CPE) compound.

B.4.5.2 The jacket shall be oil-resistant, moisture resistant, self-extinguishing flame resistant, and shall meet the specifications of ICEA S-19-81.

B.4.5.3 The jacket wall thickness shall be 35 mils.

B.4.5.4 All cable jackets shall have printed in a clearly visible fashion every 18" - 24" information indicating gauge size, number of pairs or triads, voltage rating, sequential footage, and manufacturer.

B.4.6 Final Assembly Testing:

The following tests shall be made either on the individual conductors or on the completed cable as indicated:

B.4.6.1 Continuous Flaw Test: The insulated single conductors shall withstand for their entire length a potential of 3.0 kV AC as applied by conventional spark test equipment.

B.4.6.2 High Voltage AC Test: An alternating current voltage of 1.0 kV AC shall be applied to each conductor in the completed cable for one minute without breakdown.

B.4.6.3 Insulation Resistance: Following the high voltage AC test, the insulation resistance shall be measured at room temperature between adjacent conductors. The insulation resistance shall not be less than shown on ICEA S-19-81.

B.4.6.4 Flame Resistance: All cables shall pass the IEEE-383 70,000 BTU gas ribbon burner vertical tray flame test.

B.5 Thermocouple Extension Cable

This section covers shielded, twisted pairs thermocouple type KX or EX extension cable. The cable is designed for service at 600V with a continuous operating temperature of not more than 105°C. The cable will be used in cable tray, conduit, and/or underground duct. All materials furnished herein shall be designed to meet or exceed all applicable standards of ICEA, AEIC, NEMA, and ASTM.

B.5.1 Conductor

B.5.1.1 The conductor shall be manufactured from solid thermocouple extension grade alloys in accordance with ANSI MC 96.1. All thermocouple cable shall be type KX or EX.

B.5.2 Insulation:

B.5.2.1 The insulation shall be either a thermosetting dielectric based on an ethylene propylene elastomer (EPR) or a cross-linked thermosetting polyethylene (XLPE) compound.

B.5.2.2 All electrical and physical characteristics of the insulation shall be tested in accordance with ICEA S-68-516 for ethylene-propylene insulation and ICEA S-66-524 for cross-linked polyethylene insulation and shall meet or exceed the values given in these standards.

B.5.2.3 The insulation shall fit tightly to the conductor, yet be "free-stripping."

B.5.2.4 The average wall thickness at any cross section of the insulation shall be in accordance with applicable the ICEA standard publication for the specified insulation and the values, and shall exhibit a maximum wall thickness deviation of -10% and +25% from the nominal thickness.

B.5.3 Circuit Identification:

B.5.3.1 Type EX: Each pair conductor shall be made up of purple for (+) conductor and red for (-) conductor, and purple jacket.

B.5.3.2 Type KX: Each pair conductor shall be made up of yellow for (+) conductor and red for (-) conductor and yellow jacket.

B.5.3.3 For multi-pair assemblies, the pair number shall be stamped on both conductors of that pair.

B.5.4 Conductor Assembly

B.5.4.1 Each pair shall have an individual drain wire, with a minimum size of #20 AWG.

B.5.4.2 This assembly shall then be twisted with a maximum twisting lay of 2.5" for pairs.

B.5.4.3 Each pair shall then be shielded by helically wrapping with a 2-mil polyester/aluminum tape with the metal side down. Isolation tape shall be wrapped over the shielded pair assembly.

B.5.4.4 Assembled pairs and multi-pairs shall then be cabled concentrically. When necessary to make a multi-pair cable assembly round, moisture resistant fillers shall be used.

B.5.4.5 An optional drain wire and 2 mil polyester/aluminum tape may be applied over the multi-pair cable.

B.5.4.6 A non-hygroscopic flame-barrier tape shall be applied over all conductor assemblies.

B.5.5 Outer Jacket

B.5.5.1 The assembled, bound cable shall be covered with a jacketing material, which is either a chlorosulfonated polyethylene (Hypalon) compound or a chlorinated polyethylene (CPE) compound.

B.5.5.2 The jacket shall be oil-resistant, moisture resistant, self-extinguishing flame resistant, and shall be in accordance with applicable ICEA S-19-81.

B.5.5.3 The jacket wall thickness shall be 35 mils with maximum deviation of ± 10% from the nominal thickness.

B.5.5.4 All cable jackets shall have printed in a clearly visible fashion every 18" - 24" information indicating gauge size, number of pairs or triads, voltage rating, sequential footage, and manufacturer.

B.5.6 Final Assembly Testing

The following tests shall be made either on the individual conductors or on the completed cable as indicated:

B.5.6.1 Continuous Flaw Test: The insulated single conductors shall withstand for their entire length a potential of 3.0 kV ac as applied by conventional spark test equipment.

B.5.6.2 High Voltage AC Test: An alternating current voltage of 1.0 kV AC shall be applied to each conductor in the completed cable for one minute without breakdown.

B.5.6.3 Insulation Resistance: Following the high voltage AC test, the insulation resistance shall be measured at room temperature between adjacent conductors. The insulation resistance shall meet or exceed the values given in ICEA S-68-516.

B.5.6.4 Flame Resistance: All cables shall pass the IEEE-383 70,000 BTU gas ribbon burner vertical tray flame test.

B.6 Fire Detector Cable

This section covers fire detector cable at 600 volts with a continuous operating temperature of 90° degree C. The cable will be used in conduit. All material furnished herein shall be designed to meet or exceed all applicable standard of ICEA, AEIC, NEMA, and ASTM.

B.6.1 Ratings:

B.6.1.1 The cable shall be designed for service at 600 volts with a continuous operating temperature of 90° C.

B.6.2 Conductor:

B.6.2.1 The conductor shall be 16 AWG of soft, annealed, coated or uncoated copper.

B.6.2.2 The electrical, tensile, and coating properties shall comply with the latest ASTM specifications, B-3, B-8, B-33, and B-189.

B.6.2.3 The control cables shall be stranded per ICEA S-19-81, Section 2.3, Class B.

B.6.3 Insulation

B.6.3.1 The insulation shall be TFE, FEP, PAF, or PTF insulation for high temperature areas, or TFFN insulation for areas not classified as high temperature and listed for the purpose.

B.6.3.2 All electrical and physical characteristics of the insulation shall be tested in accordance with applicable ICEA standard for the proposed insulation.

B.6.3.3 The insulation shall fit tightly to the conductor, yet be "free-stripping."

B.6.3.4 Insulation thickness shall be in accordance with applicable ICEA standard for the specific insulation.

B.6.3.5 Guaranteed values for the physical and electrical requirements of the specific insulation material shall meet or exceed the values given in the appropriate ICEA standard for the proposed insulation.

B.6.4 Conductor Assembly:

B.6.4.1 The required number of conductors shall be cabled concentrically with the outer layer having a left-hand lay.

B.6.4.2 When necessary to make a multiple conductor cable assembly round, non-hygroscopic flame resistant fillers shall be used. The overall conductor assembly shall be covered with a non-hygroscopic flame barrier tape.

B.6.4.3 Exception: For point addressable fire alarm systems the communications wiring shall be arranged in a twisted pair configuration with an overall shield and in accordance with NFPA 70.

B.6.5 Outer Jacket:

B.6.5.1 The assembled, bound cable shall be covered with a jacketing material, which is either a chlorosulfonated polyethylene (Hypalon) compound or a chlorinated polyethylene (CPE) compound, or a Teflon compound.

B.6.5.2 The jacket shall be oil-resistant, moisture resistant, self-extinguishing flame resistant, and shall be in accordance with applicable ICEA S-19-81.

B.6.5.3 The jacket wall thickness shall be 35 mils.

B.6.5.4 All cable jackets shall have printed in a clearly visible fashion every 18" - 24" information indicating gauge size, number of pairs or triads, voltage rating, sequential footage, and manufacturer.

B.6.6 Final Assembly Testing:

Final assembly testing: The following tests shall be made either on the individual conductors or on the completed cable as indicated:

B.6.6.1 Continuous Flaw Test: The insulated single conductors shall withstand for their entire length a potential of 3.0 kV AC as applied by conventional spark test equipment.

B.6.6.2 High Voltage AC Test: An alternating current voltage of 1.0 kV AC shall be applied to each conductor in the completed cable for one minute without breakdown.

B.6.6.3 Insulation Resistance: Following the high voltage AC test, the insulation resistance shall be measured at room temperature between adjacent conductors. The insulation resistance shall meet or exceed the values given in applicable ICEA publications.

B.6.6.4 Flame Resistance: All cables shall pass the IEEE-383 70,000 BTU gas ribbon burner vertical tray flame test.

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1. Example 600V Power Cable

X-Olene®

Type XHHW-2

600V Power and Control

Copper Conductor/90°C Wet or Dry

A Bare, Solid or Stranded Copper Conductor

B X-Olene Insulation

Insulation

X-Olene is Okonite's trade name for its chemically cross-linked polyethylene insulating compound with outstanding electrical and physical properties. Its excellent chemical physical resistance permits X-Olene's use in areas exposed to alcohol, ketones and dilute acids and bases, without additional coverings.

Applications

X-Olene Type XHHW-2 600 Volt Cables are recommended for general low voltage power and control applications. Where the National Electrical Code applies, Type XHHW-2 may be used up to 90°C in wet or dry locations. These cables may be installed in wet or dry locations, indoors or outdoors, in raceways, underground ducts, or lashed to a messenger for aerial installation.

Specifications

Conductor: Bare, solid or stranded copper per ASTM B-3 or B-8.

Insulation: Meets or exceeds all requirements of ICEA S-95-658, NEMA WC-70,

and UL Standards.

Listed by Underwriters Laboratories, Inc. as Type XHHW-2.

Product Features

- Small diameter, permits use of smaller conduit or more wires per conduit.
- Excellent heat resistance.
- Rated 90°C in wet or dry locations.
- Mechanically rugged.
- Stable electrical properties.
- Low moisture absorption.
- Highly resistant to weather and most chemicals.
- UL Listed.

1-Catalog Number	**07-Approx.O.D. - mm**
2-Conductor Size - AWG or kcmil	**08-Approx. Net Weight lbs./1000'**
3-Number of Strands	**09-Approx. Ship Weight lbs./1000'**
4-Insulation Thickness - mils	**10-90°C Wet(1) NEC Ampacity**
5-Insulation Thickness - mm	**11-75°C Wet(1) NEC Ampacity**
6-Approx.O.D. - Inches	**12-ICEA Ampacity(2)**

1	2	3	4	5	6	7	8	9	10	11	12
112-31-3061	14	1	30	.76	.13	3.30	17	21	15	15	24
112-31-3071	14	7	30	.76	.14	3.56	18	22	15	15	24
112-31-3101	12	1	30	.76	.15	3.81	25	29	20	20	30
112-31-3111	12	7	30	.76	.15	3.81	26	30	20	20	30
112-31-3141	10	1	30	.76	.17	4.32	38	42	30	30	42
112-31-3151	10	7	30	.76	.18	4.57	40	44	30	30	42
112-31-3221	8	1	45	1.14	.24	6.10	64	72	55	50	55
112-31-3231	8	7	45	1.14	.24	6.10	67	75	55	50	55
112-31-3271	6	7	45	1.14	.28	7.11	100	108	75	65	75
112-31-3311	4	7	45	1.14	.32	8.13	150	158	95	85	97
112-31-3371	2	7	45	1.14	.38	9.65	231	245	130	115	130
112-31-3401	1	19	55	1.40	.44	11.2	294	328	150	130	156
112-31-3421	1/0	19	55	1.40	.48	12.2	365	382	170	150	179
112-31-3441	2/0	19	55	.53	.53	13.5	454	484	195	175	204
112-31-3461	3/0	19	55	.58	.58	14.7	566	586	225	200	242
112-31-3481	4/0	19	55	.64	.63	16.0	706	749	260	230	278
112-31-3511	250	37	65	.71	.70	17.8	839	882	290	255	317
112-31-3541	350	37	65	.81	.81	20.6	1158	1233	350	310	384
112-31-3581	500	37	65	.94	.98	24.9	1632	1710	430	380	477
112-31-3641	750	61	80	1.15	1.14	29.0	2447	2555	535	475	598
112-31-3701	1000	61	80	1.30	1.36	34.5	3233	3378	615	545	689

Minimum Manufacturing Quantity: 10,000 ft.

To order a color other than black, change the last digit of the catalog number as follows:	
White	2
Red	3
Green	4
Orange	5
Blue	6
Yellow	7
Example: To order #14/SOL - Red, the catalog number would be 112-31-3063.	

Ampacities

(1) Ampacities are based on Table 310-16 of the National Electrical Code for these 90°C rated conductors at an ambient temperature of 30°C. The 75°C wet column is provided for additional information.

The ampacities shown apply to open runs of cable, installation in any approved raceway, direct burial in the earth, or as aerial cable on a messenger. Derating for more than three current carrying conductors within a raceway is in accordance with Note 8 to NEC Tables 310-16 through 310-19.

(2) Based on three (3) conductors in a single enclosed or exposed conduit. Capacities based on 40°C air ambient using ICEA methods. For 30°C ambient multiply values by 1.10; for 50°C multiply by .90. For other ambients or installation conditions refer to Okonite's Engineering Data Book EHB-90.

The ampacities shown also apply to cables installed in cable tray in accordance with NEC Section 318-11.

2. Example 15 kV Power Cable

Okoguard®-Okoseal® Type MV-105

15kV Shielded Power Cable

One Okopact® (Compact Stranded) Copper Conductor/105°C Rating
100% and 133% Insulation Level

For Cable Tray Use-Sunlight Resistant

A Uncoated, Okopact (Compact Stranded) Copper Conductor

B Strand Screen-Extruded Semiconducting EPR

C Insulation-Okoguard EPR

D Insulation Screen-Extruded Semiconducting EPR

E Shield-Copper Tape

F Jacket-Okoseal

Insulation

Okoguard is Okonite's registered trade name for its exclusive ethylene-propylene rubber (EPR) based, thermosetting compound, whose optimum balance of electrical and physical properties is unequalled in other solid dielectrics. Okoguard insulation, with the distinctive red color and a totally integrated EPR system, provides the optimum balance of electrical and physical properties for long, problem free service.

The triple tandem extrusion of the screens with the insulation provides optimum electrical characteristics.

Jacket

The Okoseal (PVC) jacket supplied with this cable is mechanically rugged and has excellent resistance to flame, oil, acids and most chemicals.

Applications

Okoguard shielded Okoseal Type MV-105 power cables are recommended for use as feeder circuits, in electric utility generating stations, for distribution circuits, and for feeders or branch circuits in industrial and commercial installations.

Type MV cables may be installed in wet or dry locations, indoors or outdoors (exposed to sunlight), in any raceway or underground duct, directly buried if installed in a system with a grounding conductor in close proximity that conforms with NEC Section 310.7, or messenger supported in industrial establishments and electric utilities. Sizes 1/0 AWG and larger may also be installed in cable tray.

Specifications

Conductor: Annealed uncoated copper compact stranded per ASTM B-496.

Strand Screen: Extruded EPR semiconducting strand screen. Meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74 & S-97-682, AEIC CS8, CSA C68.3 and UL 1072.

Insulation: Meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74 & S-97-682, AEIC CS8, CSA C68.3 and UL 1072.

Insulation Screen: Extruded EPR semiconducting insulation screen applied directly over the insulation. Meets or exceeds electrical and physical requirements of ICEA S-93-639/NEMA WC74 & S-97-682, AEIC CS8, CSA C68.3 and UL 1072.

Shield: 5 mil bare copper tape helically applied with 25% nominal overlap.

Jacket: Meets or exceeds electrical and physical requirements of ICEA S-93-

639/NEMA WC74 & S-97-682, CSA C68.3 and UL 1072 for polyvinyl chloride jackets.

UL Listed as Type MV-105, sunlight resistant and for use in cable tray in accordance with UL 1072.

CSA listed meeting the requirements of C68.3 and rated FT4 sizes 4/0 and larger are rated -40°C.

Product Features

Triple tandem extruded, all EPR system. Okoguard cables meet or exceed all recognized industry standards (UL, CSA, AEIC, NEMA/ICEA, IEEE). 105°C continuous operating temperature. 140°C emergency rating. 250°C short circuit rating. Passes the Vertical Tray Flame Test requirements of UL 1072 and IEEE 383. Excellent corona resistance. Screens are clean stripping. Exceptional resistance to "treeing". Moisture resistant. Resistant to most oils, acids, and alkalies. Sunlight resistant. For Cable Tray Use. Improved Temperature Rating.

1-Catalog Number
2-Conductor Size - AWG or kcmil
3-Conductor Size - mm2
4-Approx. Dia. over Insulation(in.)
5-Approx. Dia. over Screen(in.)
6-Jacket Thickness - mils
7-Jacket Thickness - mm
8-Approx. O.D. - Inches
09-Approx. O.D. - mm
10-Approx. Net Weight lbs./1000'
11-Approx. Ship Weight lbs./1000'
12-Ampacities Conduit in Air(1)
13-Ampacities Underground Duct(2)
14-Ampacities Cable Tray(3)
15-Conduit Size-Inches*(4)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Okoguard Insulation:175 mils(4.45mm), 100% Insulation Level														
115-23-3064	1/0	53.5	0.73	0.79	80	2.03	0.98	24.8	760	850	215	215	220	3
115-23-3066	2/0	67.4	0.77	0.83	80	2.03	1.02	25.8	875	970	255	245	250	3
115-23-3067	3/0	85.0	0.82	0.88	80	2.03	1.07	27.1	1010	1075	290	275	290	3
115-23-3069	4/0	107.0	0.87	0.93	80	2.03	1.12	28.4	1175	1270	330	315	335	3
115-23-3074	250	127.0	0.91	0.97	80	2.03	1.16	29.5	1375	1435	365	345	370	3 1/2
115-23-3076	350	177.0	1.01	1.07	80	2.03	1.26	32.0	1695	1830	440	415	460	3 1/2
115-23-3090	500	253.0	1.13	1.21	80	2.03	1.40	35.5	2250	2445	535	500	575	4
115-23-3091	750	380.0	1.31	1.39	80	2.03	1.58	40.1	3145	3405	655	610	745	5
115-23-3092	1000	507.0	1.47	1.55	110	2.79	1.80	45.6	4120	4385	755	690	890	5
Okoguard Insulation:220 mils(5.59mm), 133% Insulation Level														
115-23-3230	1/0	53.5	0.82	0.88	80	2.03	1.07	27.2	855	945	215	215	220	3
▲115-23-3232	2/0	67.4	0.86	0.92	80	2.03	1.11	28.2	965	1060	255	245	250	3

115-23-3234	3/0	85.0	0.91	0.97	80	2.03	1.16	29.4	1110	1155	290	275	290	3 1/2
▲115-23-3236	4/0	107.0	0.96	1.02	80	2.03	1.21	30.7	1280	1390	330	315	335	3 1/2
115-23-3238	250	127.0	1.01	1.07	80	2.03	1.25	31.8	1430	1565	365	345	370	3 1/2
▲115-23-3240	350	177.0	1.11	1.18	80	2.03	1.37	34.7	1815	1950	440	415	460	4
▲115-23-3242	500	253.0	1.22	1.30	80	2.03	1.49	37.8	2375	2570	535	500	575	5
▲115-23-3243	750	380.0	1.40	1.48	80	2.03	1.66	42.2	3252	3517	655	610	745	5
115-23-3244	1000	507.0	1.56	1.66	110	2.79	1.91	48.5	4315	4730	755	690	890	6

▲**Authorized Stock Item.** Available from our Customer Service Centers.

Minimum Manufacturing Quantity for non-stock items is 5000'.

Ampacities

(1) Ampacities are in accordance with Table 310-73 of the NEC for three single Type MV-105 conductors, or single conductors twisted together (triplexed) and installed in an isolated conduit in air at an ambient temperature of 40°C and a conductor temperature of 105°C.

(2) Ampacities are in accordance with Table 310-77 of the NEC for three single conductors or triplexed cable in one underground raceway, three feet deep with a conductor temperature of 105°C, 100% Load Factor, an ambient earth temperature of 20°C, and thermal resistance (RHO) of 90.

Refer to the NEC, IEEE/ICEA S-135 Power Cable Ampacities, or the Okonite Engineering Data Bulletin EHB for installation in duct banks, multiple point ground shields, other ambient temperatures, circuit configurations or installation requirements.

(3) Ampacities based on single Type MV-105 conductors, or single conductors twisted together (triplexed, quadruplexed, etc.) size 1/0 AWG and larger, installed in uncovered cable tray in accordance with Section 318-13 of the NEC at an ambient temperature of 40°C and a conductor temperate rating of 105°C. In accordance with NEC Section 318-13(b) (copper conductors), the values are 75% of the values given in table 310-69. Where the cable tray is covered for more than six feet with solid unventilated covers, the ampacities shall not exceed 93% of the values shown above.

(4) Recommended size of rigid or nonmetallic conduit for three conductors based on 40% maximum fill.

*The jam ratio, conduit I.D. to cable O.D. should be checked to avoid possible jamming.

MASTER SPECIFICATION
FOR
PIPING DESIGN STANDARD

Revision _0_
Date 12-4-2013

Responsible Technical Specialist _____

Author:	Revision No.:	Specification Approval:

PIPING DESIGN STANDARD

GENERAL

A. Description

1. The Piping Design Standard provides guidelines for the selection of materials and components for the design of piping systems.
2. The Piping Design Standard will be used by project engineering and design personnel to specify, lay out and procure piping and valves for Energy Supply projects.
3. The standard will allow uniformity in the design of piping systems. This standard is applicable to mechanical (non-nuclear) piping systems.

Specifier – Add discussion of options and criteria that must be addressed

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B. Bus Duct Layout

C. Reference Information

See Attachment 4

D. Technical Proposal Documentation

See Attachment 1

E. Approved Manufacturers

See Attachment 8

SUMMARY: Specifier to include 2 to 3 sentences of requirements of the specification.

APPLICABLE CODES AND STANDARDS

A. State and local codes, laws, ordinances, rules and regulations

B. **ASME BPVC** – American Society of Mechanical Engineers Boiler and Pressure Vessel Code.

C. **ASME Section IX** Welding and Brazing Qualifications

D. **ASME** B16.5 Steel Pipe Flanges and Flanged Fittings.

E. **ASME** B16.11 Socket Weld Couplings.

F. **ASME** B16.25 Butt Welding Ends.

G. **NBIC** – National Board Inspection Code.

H. **PFI** – Pipe Fabrication Institute.

I. ANSI - American National Standards Institute

J. ASTM - American Society for Testing and Materials

K. ICEA - Insulated Cable Engineers Association

L. IEEE - Institute of Electrical and Electronic Engineers

M. NEMA - National Electrical Manufacturer's Association

N. NFPA - National Fire Protection Association
O. OSHA - Occupational, Health and Safety Administration
P. UL Underwriter's Laboratories

In case of conflict or disagreement between codes and standards, the more stringent conditions shall govern.

TECHNICAL REQUIREMENTS

PERFORMANCE REQUIREMENTS & GUARANTEES

See Appendix 3

DESIGN & CONSTRUCTION FEATURES

A. ENVIRONMENTAL

1. The following ambient and site conditions shall be used in the designed of all furnished equipment.
   See Appendix 4
2. Considerations shall be given to the exposure to solar heat in the areas of outdoor installation.

B. GENERAL STANDARDS

1. When two lines of different design pressure ratings are connected, the higher rating shall prevail up to and including the first shutoff valve on the line of the lower rating.
2. The design shall protect against freezing of fluids by the use of steam tracing, steam jacketing, and electric heating, insulating or draining.
3. The design all provides for accessibility to and ease of dismantling of piping, instrument connections, and equipment.
4. Welded joints joining two different P-numbered materials, as defined in ASME Section XI, shall be identified on the drawings. For example, carbon steel piping (P-1 material) joining a chrome-moly nozzle connection (P-5A material) shall be indicated on the drawing at the weld joint "P-1 to P-5A" materials.
5. When welded joint of two different P-numbered materials exist, the Project Engineer shall be notified and action taken to eliminate this condition as follows:
   a. Weld transition pieces on equipment in the Vendor's shop.
   b. Change connection to flanged connection if design pressure and system requirements are not violated.
   c. Change connection to "Conoseal" type joint.
   d. Approve the joint for welding with Engineer's approval only.

6. Where required, low points of piping shall be provided with valved drains.
7. Where required, high points of piping shall be provided with valved vents.
8. All piping shall be designed with adequate flexibility to permit expansions of the piping without imposing excessive forces and moments on the connected equipment. Cold springing of piping is normally not preferred.
9. Main and auxiliary steam safety valve escape lines discharging directly to the atmosphere shall be provided with drain openings at the valve outlet, piped to a safe point of discharge. The flexibility of the system shall be checked to ensure its adequacy.
10. All connections on equipment drawings shall be checked to make sure that the nozzle material, thickness, and welding end machining details are shown. If possible, the schedule number of the connecting pipe shall also be shown. Weld ends shall match Standard weld ends. Exceptions shall be resolved or noted on the drawings.
11. Field welds or flanged joints required for assembly shall be indicated on drawings.
12. Fabricated pieces of irregular shape shall be designed with due consideration to shipping clearances and, in general, should not exceed 40 feet in length, 12 feet in width and 8 feet in height.
13. Piping around equipment shall be arranged and supported to permit ready access for maintenance and inspections of the equipment.
14. ASME B31.1 piping 2-1/2 inches and larger shall be dimensioned.
15. Cast iron valves shall not be used in ASME B31.1 systems requiring seismic analysis other than the fire protection system. The fire protection system valves require Underwriters' Laboratories approval and will be treated as separate entities.

C. CLEARANCES

1. Minimum clear width of passageways shall be 3 feet unless specifically approved by the Engineer.
2. Lines on sleepers on the ground shall be spaced for convenient external cleaning, painting, and inspection. Sleepers shall be a minimum of 12 inches high above paving or finished grade.
3. Minimum headroom clearance under all piping, covering, and appurtenances shall be as follows:
   a. 7ft-0 in. within structures
   b. 10ft-0 in. with yard areas

c. 14ft-0 in. over secondary unit roads
d. 22ft-0 in. over railroads and main plant roads

4. Piping runs shall not be located on building floors where they will obstruct passage or access.

D. WELD ACCESSIBILTY

1. Field welds shall be located so that the piping assembly can be installed without any interference from structures or equipment, and the field welds shall be accessible for initial installation and repair. Piping assemblies that will be installed through penetration sleeves shall have a field weld located on one side of the penetration sleeve.
2. Three basic requirements for working accessibility to a welded joint area:
   a. Head Room – The ability of the welder to get his head protective hood into the working area so that he can move freely around the weld and see directly into the weld area of the joint at all times.
   b. Arm Room – Freedom for the welder to move his arms so he can direct the arc into the weld and move it smoothly around the full circumference of the pipe without blockage from other pope or components.
   c. Visibility – Full vision into the joint and sufficient distance from the eyes to the weld for correct eye focus. This distance is variable, depending upon the individual. A distance of 6 inches from the face of the welder's hood eye shield is a practical minimum for short periods of work. For sustained work, the greatest possible focal distance should be provided to prevent tiring and double vision. The welder's line of sight should be at an angle to the perpendicular of the pipe less than the angle of bevel. For example, a joint beveled to 37-1/2 degrees requires line of sight not exceeding 30 degrees from perpendicular.

E. PIPING REQUIREMENTS

1. PIPE SIZES
   a. The following nominal pipe sizes shall not be used except where required to connect to equipment. Where these sizes are encountered, as soon as practical increase to a preferred size:
      1. 3/8 in.
      2. 3-1/2 in.
      3. *1-1/4 in.
      4. *5 in

      *May be used for building service piping
2. PIPING FURNISHED BY EQUIPMENT MANUFACTURER
   a. The fluid system diagrams and design drawings shall

clearly indicate the point at which the continuation of a line is furnished by an equipment manufacturer or supplier. That portion of a line furnished by an equipment manufacturer or supplier shall be shown on the design drawings "out of function" to an extent sufficient to clearly indicate its identity on the manufacturer's drawing.

3. INTERSECTIONS
   a. Welding adapters and branch welded connections shall be reinforced to meet the requirements of ASME B31.1.
   b. Branch connections shall be as follows:
      1. Branch runs shall be made with full size tees or reducing tees when the ratio of the branch run nominal pipe size to the main run nominal pipe size is equal to or greater than ½.
      2. Branch runs should be made with weldolets or sockolets when the ratio of the branch run nominal pipe size to the main run nominal pipe size is less than ½.
   c. Branch Connections shall be weldolets starting at the first reduction from the main piping run nominal size. For 2" and under branch connection sockolets shall be used in on radioactive systems.
   d. Thermowells shall be as shown on drawings ENA-0-009-41-12-012 and ENA-0-009-41-12-013 for 600 Class and below systems. Thermowells shall be as shown on drawing ENA-0-009-41-12-014, and ENA-0-009-41-12-015 for radioactive and 900 and 1500 Class systems.
   e. Pressure taps for all systems shall be ¾ inch nipolets.
4. FLANGES
   a. In cases where ASME 150 Class series steel flange will be bolted to a Class 125 standard cast-iron flange, the steel flange shall be flat face. All steel flanges, except as above, shall be raised face per ASME B16.5 and MSS-SP44.
   b. Slip-on flanges shall be used only with permission of Engineer.
   c. Lap joint flanges shall be used on carbon steel or stainless steel pipe, unless specified.
   d. Carbon steel reducing slip-on threaded flanges shall be used only with permission of Engineer and their use shall be marked on drawings.
   e. Reducing welding neck flanges shall normally not be used.

f. Overall piping dimensions shall be indicated to the extreme raised face of flange.

g. Special flanges which do not conform to the line class shall have the size, rating, facing, and drilling noted on the drawings.

h. In all cases where a flanged connection is made between a steel and copper or brass pipe, the mating surfaces shall be electrically insulated from each other. The flanged joints shall be furnished with plastic washers under the bolt heads and plastic ferrules. Electrical non-conducting gaskets shall be used.

5. FITTINGS

a. Welding elbows as listed are long radius elbows. All other types are special and, if used, shall be so marked on the drawings.

b. Welding fittings shall be used in preference to flanged fittings.

c. All safety related, radioactive, and 2 inch and smaller piping shall use pipe bends to the maximum extent possible to eliminate welds.

d. Reducing elbows may be used where their use results in improved arrangements with approval of the Engineer.

e. Minimum schedule of piping used for nipples between pipelines or equipment, and first shutoff valves, shall be seamless Schedule 80, except as otherwise noted in the pipe classes.

f. Close threaded nipples shall not be used. Use full nipples.

6. VALVES

a. All valves (except wafer type butterfly or insert type swing check valves) adjacent to exchangers, vessels or expansion joints, shall have a 6” minimum spool piece between the valve and the nozzles.

b. Globe valves shall be installed with pressure under the seat, except for globe valves in lines under vacuum, in which case the valves shall have vacuum under the seat. Flow direction arrows shall be shown on drawings.

c. All operating valves shall be accessible for operation and maintenance when possible.

d. All safety valves, control valves, check valves, and rupture discs, which may receive servicing shall be located so that they shall be readily accessible from

permanent platforms or ground level unless otherwise approved by the Engineer.

e. Safety valve discharge effects shall be considered during pipe stress analysis, i.e., for stresses both in nipple and connection on vessel. Valve allowable forces and moments shall be compared to calculated forces and moments for acceptability.

f. Infrequently used isolation valves shall be accessible but may be located more than 7 feet above the operating level.

g. Operating valves shall be oriented waist high when possible. Overhead valve hand wheels shall be oriented so that the centerlines of the valve hand wheels are 5 feet above the operating level. This orientation may be increased to 7 feet maximum provided that the valve can be opened or closed in this position. When this condition cannot be met, valves shall be provided with chain wheels, double end wrenches, or extension stems and hand wheel. Were such accessories are required, the length of chain, or length of extension stem from the center line of valve to hand wheel, shall be noted on the drawings.

h. Where valves are to be locked in an open or closed position, they shall be provided with a suitable locking device, and it shall be noted on the fluid system diagrams.

i. Wrench or lever operated plug, ball or butterfly valves shall be located to provide adequate clearance for turning wrenches and for lubricating. Special consideration shall be given to wrench clearance around control valve assemblies.

j. Operating valves located underground or in trenches or below platforms shall be provided with extension stems or otherwise arranged so that the hand wheels will be above the surface of the ground or grating, and in such a position as to be readily reached and operated.

k. All valves shall be tagged with a valve number. The valve number shall be stamped on a stainless steel tag 2” x 2” x 1/32” with figures no smaller than 3/16 inch high. The tag shall be wired to each valve using Number 20 gauge or thicker) stainless steel wire.

l. All loose parts associated with a valve shall also be tagged in the manner described above with the number of the associated valve.

m. Valves which are part of a Vendor supplied system or purchased by a Vendor will also contain the Vendor valve number stamped below the COM valve number.

7. PIPING AT PUMPS

a. Pump suction lines shall be as direct as possible. For centrifugal pumps, an elbow in the horizontal plane should be placed directly at the pump suction. If an elbow for the pump suction is required in the horizontal plane, a straight run of pipe of not less than 4 to 6 diameters shall be used between the elbow and the pump suction.

b. Piping to end suction pumps shall be arranged to permit removal of the pump impeller without removing the suction valve.

c. All valves and piping at pumps shall be arranged to permit removal of the pumps, impellers or pistons without hindering the operation of other equipment.

d. When a reducer is required between the pump suction nozzle and the line, an eccentric reducer shall be used if the pump has a horizontal suction. The reducer shall be located, horizontal side up, so that air pockets do not exist.

e. With the exception of deep well and pit type pumps, centrifugal pump suctions shall be provided with shutoff valves.

f. When a check valve is installed in the centrifugal pump discharge, it shall be installed upstream of the pump discharge shutoff valve.

g. Pump suctions shall be provided with temporary basket type strainers and spool pieces between the shutoff valve and the pumps. Strainers shall be installed before plant startup and removed after preliminary operation, unless otherwise specified. The Engineers shall specify location and type of strainers to be used.

8. BEND REQUIREMENTS

a. To determine minimum radii for pipe bends, see table 1 below.

Table 1: Minimum Bending Radii, Inches

Nominal Size	Schedule of Pipe 10	20	30	40	60	80	100	120	140	160 and Heavier
¾				4		4				4
1				5		5				5
1-1/2				7-1/2		7-1/2				7-1/2
2				10		10				10
2-1/2				12-1/2		12-1/2				12-1/2
3				15		15				15
4				20		20				20
6				30		30				30
8		48	48	40	40	40	40	40	40	40
10		60	60	50	50	50	50	50	50	50
12		84	72	60	60	60	60	60	60	60
14		98	84	84	70	70	70	70	70	70
16	128	112	96	80	80	80	80	80	80	80
18	144	126	108	90	90	90	90	90	90	90
20	160	140	120	120	100	100	100	100	100	100
24	192	168	144	144	120	120	120	120	120	120

Wall thickness, tm =	.250 In.	.375 In.	.500 In.	.750 In.	1.00 In.
26	234	2085	182	130	130
28	280	224	196	168	140
30	300	240	210	180	150
32	320	288	256	192	160
34	374	306	272	204	170
36	432	324	288	216	180

F. WELD END PREPARATION

1. GENERAL

a. The governing codes are ASME B31.1 for power piping. Piping and Components (vessels, pumps and valves) shall have weld ends prepared in accordance with ASME B16.25, “Buttwelding Ends” or ASME B16.11, “Forged Fittings, Socket Welded and Threaded” as appropriate. These details shall be noted on the component drawings. Exceptions shall be noted so fabricator can prepare pipe ends.

2. BUTT WELDS

a. Butt welds shall be used on all piping 2 ½ inches nominal pipe size and above.

b. Open butt or welds shall be used on all piping including stainless steel piping, and dissimilar metal welds as appropriate for the pipe diameter to be welded. Weld end preparation shall be in accordance with ASME B16.25, “Buttwelding Ends”.

c. Tapered machined or split backing rings shall not be used. Consumable inserts shall only be used when specifically approved by the Company.

3. SOCKET WELDS

a. Socket welds will be used on all piping 2 inches NPS and smaller not covered under Item 4.1.1. Socket weld configuration and joint geometry shall be in accordance with ASME B16.11, “Forged Fittings, Socket Welded and Threaded”.

G. PIPE MATERIAL IDENTIFIER

1. <u>Code Descriptions:</u>

A	125#
B	150#
C	300#
D	300#
E	600#
F	900#
G	1500#
H	2500#
J	4500#
M	No Class, Other Material
P	NO Class, Plastic
T	No Class, Tubing

2. <u>Code Descriptions:</u>

AA	ASTM A53, TYPE E (ERW), GRADE B, SEAMED C.S./A106 SMALL BORE
AB	ASTM A53, TYPE E (ERW), GRADE A, SEAMED C.S.
BA	ASTM A106/A53 GRADE B SEAMLESS C.S.
BB	ASTM A106 GRADE C SEAMLESS C.S.
BC	A333 GRADE 6 SEAMLESS C.S.
BD	ASTM A139 HELICAL SEAM WELDED, GRADE B C.S.
BE	ASTM A106/A53 GRADE B, EFW, EPOXY COATED
CA	ASTM A335 GRADE P11 SEAMLESS CR-MO

DA ASTM A335 GRADE P22 SEAMLESS CR-MO - B31.1 CODE
EA ASTM A335 GRADE P91 SEAMLESS CR-MO - B31.1 CODE
FA ASTM A312 GRADE TP304H (SML, SEAMLESS) S.S.
FB ASTM A312 GRADE TP304L (SML, SEAMLESS) S.S.
FC ASTM A312 GRADE TP304L (WLD, SEAMED) S.S.
GA ASTM A312 GRADE TP316H (SML, SEAMLESS) S.S.
GB ASTM A 213 GRADE TP316H SEAMLESS S.S. - TUBING
GC ASTM A312 GRADE TP316L (WLD, SEAMED) S.S.
GD ASTM A213 GRADE TP316L SEAMLESS S.S. - TUBING
HA ASTM B88 TYPE K COPPER – TUBING
HB ASTM B88 TYPE L COPPER TUBING
JA ASTM B75 COPPER TUBING
KA ASTM A74 CAST IRON SOIL PIPE
KB AWWA C151 DUCTILE IRON PIPE, PUSH JOINTS
KC AWWA C151 DUCTILE IRON PIPE, MECHANICAL JOINTS
LA ASTM A351 GRADE CN-7M (ALLOY 20)
MA ASTM A269 VIC-PRESS 304L, GR T
NA ASTM D1785 PVC PIPE TYPE 1, GRADE 1
QA ASTM D2665 PVC DWV PIPING
RC ASTM D4710 POLYETHYLENE PIPE, SDR 11
RF ASTM D3350 POLYETHYLENE PIPE, FM CL200
UF ASTM D1784 TYPE IV GRADE 1 CPVC PIPE
VA AWWA C900, DR14, CLASS 200 PVC PIPE
WA AWWA C301 CONCRETE PRESSURE PIPE

SOUND CONTROL REQUIREMENTS

Specifier Note: Additional information required

ELECTRICAL REQUIREMENTS

Specifier Note: Additional information required

INSTRUMENTATION & CONTROL REQUIREMENTS

Specifier Note: Additional information required

MATERIALS & WELDING

Specifier Note: Additional information required

CLEANING, PAINTING & COATING

Specifier Note: Additional information required

PACKAGING & SHIPPING

See Appendix 7

STORAGE & HANDLING PROCEDURES

See Appendix 7

SPARE PARTS

Commissioning spares to be included/supplied with the equipment.

QUALITY ASSURANCE

See Appendix 5

TESTING

See Appendix 5

SELLER'S DATA SUBMISSION SCHEDULE

See Appendix 2

APPENDICES

APPENDICES TO SPECIFICATION

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.
****

1. DELIVERABLES

2. PROPOSAL DATA REQUIREMENTS
3. PERFORMANCE GUARANTEES
4. SITE CONDITIONS AND REFERENCE MATERIALS
5. QA/QC (Including Inspection Test Plans)
6. STARTUP, TESTING, AND COMMISSIONING
7. PACKAGING, SHIPPING, AND STORAGE
8. ACCEPTABLE SUPPLIERS

Complete technical requirements as required for the identified topic.

1. DELIVERABLES

a) Produce test report to include:

- **i.** Summary of the test procedures, equipment, results and observations in a written report.
- **ii.** Detailed breakdown of the results per location

b) Timeline for testing will begin after <DATE> upon execution of the Agreement.

2. PROPOSAL DATA REQUIREMENTS

<END USER – populate this section with specific instructions>

This information should be included in the SOW (Exhibit B) and is specific to the project.

3. PERFORMANCE GUARANTEES

Warrantee and Guarantee

a) Acceptance

For The purposes of payment under the contract, and for determining the warranty period, Acceptance shall be deemed to occur after completion of test and when the Contractor has resolved any/all issues on a corrective list developed by the Owner. Payment to the contractor shall be forthcoming once all list items are resolved.

4. SITE CONDITIONS AND REFERENCE MATERIAL

This is specific to each site. Include any applicable site layout drawings if available. Include in SOW any obstructions or other construction going on near the test sites. These obstructions could affect the contractors bid.

The Project must outline and identify the specific areas or boundaries of the testing in writing and through the markup of drawings. Include this in the SOW for the contractor

5. QA/QC (Including Inspection Test Plans)

Quality Control

Include Attachment 2.0, "Quality Management Program" and Attachment 2.1 "General Welding Requirements" with the RFQ and Contract.

The Contractor shall be responsible for implementation of a Quality Control program to ensure the installation meets the requirements of this Specification and industry standards. The independent monitoring activities performed by Xcel Energy shall not relieve the Contractor of this responsibility. The Contractor shall document and notify Xcel Energy of any non-conformance or deficient component condition. Any non-conformance of the code specification or drawings shall be documented by the Contractor and provided immediately in writing to Xcel Energy's representative. Non-conformances may also be initiated by Xcel Energy. The Contractor should present a disposition report with their recommendation/proposal on corrective action to Xcel Energy.

i. Click the box on the front page of the Exhibit B under Quality Management that states "The Quality Management QA/QC does/does not apply to this project."

6. STARTUP, TESTING, AND COMMISSIONING

Does not apply to this type of service.

7. PACKAGING, SHIPPING, AND STORAGE

8. ACCEPTABLE SUPPLIERS

MASTER SPECIFICTION
FOR
PIPING SPECIALTIES

Revision Date - 8-25-15

Responsible Technical Specialist: Curtis Crowe

100. GENERAL

101. SUMMARY

101.1 This Specification prescribes the minimum requirements for piping specialties and shall include steam traps, air vents for steam and liquid systems, compressed air drain traps, temporary and permanent strainers (including self-cleaning strainers) and restriction orifices for use in electric power generating stations.

101.2 This Section supplements the specialty data sheets, piping specialty list, piping line list, piping design tables and valve design tables on which the specialty requirements will be specified in one or more of the attachments.

102. GENERAL DESIGN REQUIREMENTS

102.1 Design Requirements:

a. The specialties shall be designed for the service conditions specified.

b. Specialties shall be designed to function to the appropriate ASME, NFPA and AWWA Standards as specified herein

c. All specialties and operators shall be suitable for indoor or outdoor installation, based on prevailing ambient conditions at their installed location.

d. The pressure-temperature ratings shall be those specified in the applicable ASME standard for the type of end connections used.

e. For specialties which must be installed with flow in a particular direction or with a particular orientation, the flow direction and/or orientation shall be clearly and indelibly marked.

f. Designed Systems:

f1. The specialty requirements will be specified in one or more of the following attachments to the Specification: Specialty Data Sheets, Piping Specialty List, Piping Line List, Piping Design Tables and Valve Design Tables.

f2. Company references the governing code classification and jurisdiction using Pipe Classes. The Pipe Classes are as follows:

f2.1 Class D: ASME B31.1 for Non-boiler External Piping

f2.2 Class E: ASME Section 1 for Boiler External Piping

f2.3 Class N: Others such as National Fire Protection Association (NFPA)

f2.4 Class W: AWWA

103. GENERAL QUALITY CONTROL AND QUALITY ASSURANCE PROVISIONS

103.1 Piping specialties shall conform to the requirements of the governing Code(s); in other respects, piping specialties shall conform to the requirements of this Section and shall satisfy all conditions and requirements specified.

103.2 In the event of variance between the general requirements delineated in this Section and the particular requirements set forth in the Specification, the Specification shall take precedence.

103.3 For systems designed by the Contractor, the requirements of this Section and the Specification shall be used to determine the appropriate specialty.

103.4 For systems designed by Company, the specialty type, size, materials, accessories and operating conditions will be specified.

103.5 ASME Code vessels, pipe, valves and other ASME components furnished by the Contractor shall be marked and stamped in accordance with the applicable requirements of the ASME Code designated in this Section.

103.6 Certification and Data Reports for all piping components furnished by Contractor shall be submitted in accordance with the requirements of the applicable section of the above codes and (where applicable) standards.

103.7 Each ASME Code vessel furnished by the Contractor shall be assigned a National Board Number which shall be indicated on the Manufacture's Data Report.

103.8 All welding shall be performed by operators and procedures that are qualified in accordance with the ASME Boiler and Pressure Vessel Code, Section IX, Welding Qualifications.

104. DEFINITIONS

104.1 Piping and Instrumentation Diagrams (P&IDs) – This document provides the diagrammatical representation of the piping system. P&IDs include the piping line numbers, valve numbers, specialty numbers, equipment numbers, pipe class breaks, PDTs and design conditions.

104.2 Piping Design Tables (PDT) – This document provides the dimensional and material requirements for the designated pipelines. The PDTs also reference the applicable valve design table. The PDTs are organized by ASME pressure class ratings (i.e., PDT 0300 corresponds to ASME pressure class rating of 300 lb. In this case, valves and flanges are required to be ASME 300 lb. rating).

104.3 Piping Line List – This document contains a numeric listing of all pipe lines designated on the P&IDs and design drawings. The list contains the Pipe Line Number, Furnish and Installation Specifications, P&ID number, Piping Design Table, pressure, temperature, insulation type and thickness and remarks.

104.4 Piping Specialty List – This document contains a numeric listing of all specialties designated on the P&IDs and design drawings. The Specialty List contains the Pipe Line Number, Piping Specialty Number, Furnish and Installation Specifications, P&ID number, Specialty Data Sheet Number and Remarks.

104.5 Valve Design Tables (VDT) – This document provides the dimensional, material and procurement requirements for the project designated valves.

104.6 Valve List – This document contains a numeric listing of all valves designated on the P&IDs and design drawings. The list contains the Valve Number, Furnish and Installation Specifications, P&ID number, Pipe Line Number, PDT, VDT, Pressure, Temperature and Remarks.

104.7 Valve Data Sheet – This document summarizes the valve list information and provides the requirements for operators and accessories to be furnished with the valve.

105. RELATED WORK SPECIFIED IN OTHER SECTIONS

a. Schedule B, Submittals and Document Review

b. Schedule A, Section xxxx – Design and Operating Data

c. Schedule A, Section xxxx – Nameplates and Tags

d. Schedule A, Section xxxx – Piping Systems

e. Schedule A, Section xxxx – Valves

2.0 APPLICABLE CODES AND STANDARDS

105.1 Standards, specifications, manuals, codes and other publications of nationally recognized organizations and associations are referenced herein. Methods, equipment and materials specified herein shall comply with the specified and applicable portions of the referenced documents indicated in Schedule A, in addition to federal, state or local codes having jurisdiction. References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the applicable additions, addenda, amendments, supplements, thereto, in effect as of the date indicated in Schedule A.

105.2 ASME – American Society of Mechanical Engineers:

a. B 31.1 – Power Piping Code

b. Boiler and Pressure Vessel Code, Section I – Power Boilers (Boiler External Piping)

c. Boiler and Pressure Vessel Code, Section VIII – Division I Pressure Vessels

d. Boiler and Pressure Vessel Code, Section XI –Welding and Brazing Qualifications

105.3 ASTM – ASTM International:

a. A XXX –material specifications as required

b. A 106 – Specification for Seamless Carbon Steel Pipe for High Temperature Service

c. A 167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

d. A 240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

e. A 515 – Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

f. A 672 – Standard Specification for Electric-Fusion-Welded Steel Pipe for High-Pressure Service at Moderate Temperatures

105.4 AWWA – American Water Works Association

105.5 EJMA – Expansion Joint Manufacturer's Association

105.6 ISO – International Organization for Standardization

105.7 MSS – Manufacturers Standardization from Society of the Valves and Fitting Industry Inc.:

a. SP – 25 – Standard Marking System for Valves, Fittings, Flanges, and Unions

105.8 NFPA – National Fire Protection Association

3.0 TECHNICAL REQUIREMENTS

201. <u>COMPONENTS</u>

201.1 Steam Traps:

a. All traps shall be made with cast steel or forged steel bodies, covers, etc., except traps with cast iron bodies may be furnished in systems where the design, as set forth in the applicable Piping Design Tables, permits the use of cast iron and bronze valves or except as specified.

b. All traps shall have metal working parts of materials suitable for the temperatures and pressures encountered. All seats and discs shall be removable.

c. All actuating levers and arms for the traps shall be of cast or forged steel. No pressed steel construction for these parts shall be used.

d. All traps shall be provided with properly valved bypasses and blowdown valves.

e. The following types of steam traps shall be acceptable:

e1. Inverted Bucket

e2. Bucket

e3. Thermodynamic (Including Impulse)

e4. Thermostatic

e5. Float and Thermostatic (F&T)

f. Steam traps shall be self-purging to avoid air binding.

g. Trap Strainer combinations are acceptable.

h. Steam Traps on exposed lines located in a cold climate where a vacuum occurs during shut down shall be provided with an integral vacuum breaker to avoid condensate freezing in the line.

i. Steam traps shall be maintainable / repairable without being removed from the pipeline. If the traps are not maintainable / repairable, they shall be provided with flanged connections.

201.2 Strainers:

a. Strainers shall be designed so as to be completely drainable. Temporary cone strainers installed at the suction of a pump are exempt from this requirement.

b. Strainer mesh or baskets shall be accessible for removal and cleaning without removing the strainer from the pipeline. Temporary cone strainers are exempt from this requirement.

c. All except Y-type strainer inlet and outlet connections shall be drilled and tapped to accept Contractor's pressure instrumentation.

d. Strainer mesh or baskets shall be capable of taking the full line operating pressure across a fully blocked strainer without damage, and shall be suitably reinforced as required to accommodate this feature.

e. Each manual strainer with a heavy cover plate and large basket(s) shall be provided with a lifting device mounted on the strainer body to facilitate removal of cover and basket(s) by a single person performing manual cleaning.

f. All straining elements shall be constructed of ASTM A240 Type 316 stainless steel. Alternate material shall be used if stainless steel is not compatible with the fluid.

g. Strainer area shall be sized so that the fouled pressure drop (before cleaning) does not exceed limits required for proper system operation. Strainers shall also be sized so as not to exceed the velocity limits for flow through the mesh.

h. Plate or flat type strainers inserted between flange faces shall not be acceptable since the area open to flow is less than the pump suction pipe inside area. Conical strainers which may be inserted in a flanged spool piece in the pump suction close to the pump suction flange are

acceptable for temporary use at startup. Tee type strainers with sufficient flow area may also be used.

i. The strainers shall be designed for the specified design pressure and temperature and shall be suitable for continuous operation at the specified flow rates. End connections shall be flanged, socket weld or buttwelded as specified.

j. Bodies on basket strainers shall have bolted top covers, unless otherwise specified. Strainer bodies shall have tapped and plugged drain connections.

k. Strainers which are specified as "Quick Opening" shall be provided with hinged strainer covers assemblies capable of holding the cover when maintenance is performed on the strainer.

l. Automatic self-cleaning strainers shall be equipped with a motorized rotating backwash arm, flanged end connections, with the body and cover designed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code. Inspection openings shall be provided to permit visual inspection or changing of straining media without removing drum.

m. Minimum pressure rating for all strainers shall be ASME 150# class.

n. Backwashing system shall be capable of providing continuous or intermittent backwashing operations while maintaining the specified output flow through the strainer. A motor operated or pneumatic cylinder operated backwash valve shall be provided. Pneumatic valves shall be supplied with a solenoid air valve and an air pressure filter-regulator set mounted in the actuator.

o. No initial pipeline flushing should be permitted through the pump. Initial pump operation after line flushing shall be with temporary strainers in place and the strainers shall remain in place until full pump flow at full temperature has been reached and inspection has established that no debris is being collected.

p. A “Y” type strainer shall be installed upstream of each trap, unless the traps are provided with integral strainers.

q. Instrumentation and Controls:

q1. Contractor shall supply the self-cleaning strainer backwash controls, complete with adjustable timer, control transformer, indicating lights, manual start-stop control and all external power and control wiring. Each self-cleaning strainer shall have a local control panel.

q2. Self-cleaning strainer differential pressure switch shall be pre-installed, adjustable, and shall override the primary timed backwash control on high differential pressure. Differential pressure switches shall conform to the requirements of the Specification.

q3. Pressure measuring taps shall be provided on the body of each manual strainer (except “Y” type) and in the piping adjacent to temporary strainers upstream and downstream of each strainer element to enable determination of fouling by observing the increase in pressure drop across the strainer. The self-cleaning strainer shall be provided with pressure gauges and connections on the strainer for indication of inlet and outlet pressure.

201.3 Restriction Orifices:

a. Orifice plates shall be circular concentric paddle type with square edge inlet. Orifice plate and paddle shall be either formed from a single solid plate or properly welded together. Minimum plate thickness shall be ¼ inches.

b. Orifice plates shall be constructed of ASTM A240 Type 316 stainless steel. Orifice plates for piping 2½ inches diameter and larger shall be suitable for mounting between raised face orifice flanges of the ASME pressure class required for the design pressure and temperature specified. Orifice plates for piping 2 inches diameter and smaller shall be suitable for mounting in orifice unions.

c. Orifice plate thickness and bore diameter shall be as specified. Each orifice plate for mounting between flanges shall be provided with a handle on which the orifice diameter and pipe diameter are stamped on the upstream side of the handle. This information shall be located where it can be read without removing the orifice plate from the pipeline.

d. Where plug resistant type orifices are specified, the orifices shall be of the stainless steel body socket weld type. The orifice plug shall be removable from the orifice body without disturbing the piping connections to the body.

e. Where multiple stage type orifices are specified, the orifices shall be supplied as one assembly, constructed of stainless steel.

201.4 Flexible Hoses:

a. Flexible hoses indicated for water service shall be stainless steel braided metal hoses or acceptable equal.

b. All hoses 2 inches and smaller shall have screwed end connections and all hoses 2½ inches and larger shall have ASME Class 150 flanged end connections and shall be designed for the pressure and temperature specified in the Pipeline List.

c. Flexible metal hose shall be of corrugated construction of stainless steel and shall have braided coverings. Fittings shall be attached to the hose with brazed joints.

201.5 Pipe Expansion Joints (Metal):

a. Design Requirements:

a1. Each expansion joint element shall be of the packless bellows type, hydraulically rolled or die-formed from a stainless steel cylinder. The stainless steel cylinder shall preferably be seamless, but in any case shall have no more than a single longitudinal weld in sizes under 16 inches in diameter and no more than two longitudinal welds in sizes 16 inches in diameter and larger. The longitudinal weld bead(s) shall have essentially the same thickness as the parent metal. No welds shall be used to form the corrugations. All restraining bolts and nuts shall be stainless steel.

a2. Each joint shall be designed to meet the internal design pressure and temperature conditions.

a3. For expansion joints within the condenser neck, the external design pressures and temperatures shall be –15 / +5 psig saturated.

a4. A ±¼ inch axial movement from neutral over that specified and a 1/8 inch lateral movement from the center line over that specified shall be included in the design of expansion joints to accommodate tolerances that will occur during installation. Rotational, lateral and axial movements will be imposed on the joints after they are welded in place. Contractor shall add an additional safety factor of 35% to the specified axial, rotational and lateral deflections over and above those added for installation tolerances.

a5. The lateral and rotational movements shall be applied on each side of the joint center line.

a6. The axial, lateral and rotational movements shall be accommodated simultaneously.

a7. Bellows design and construction shall be such that no single corrugation is permitted to deflect more than 90% of its design amount.

a8. Fabricated length (neutral position) tolerance shall be ± 1/16 inch.

a9. Each joint shall be stable against buckling or squirming when subjected to the operating conditions specified or during the specified hydrostatic test.

a10. Each joint shall be designed for at least 7000 operational cycles.

a11. Universal expansion joint assemblies shall be designed and constructed such that the full weight of the center spool piece and any connected piping shall be carried by the tie rods and not by the joint bellows.

a12. Limit stops and temporary positioning devices, when required, shall be designed so as not to interfere with the installation or removal of the joint from the piping system.

a13. All expansion joints shall have four (4) equidistant permanent tram-points around each welding neck. Points shall be clearly marked and so located as to prevent obliteration during installation. Distance between tram-points indicating neutral position shall be included in submitted shop drawings.

a14. Expansion joints weighing more than 500 lb. shall be provided with lifting lugs.

a15. The connections of bellows attached by welding to spool pieces shall be designed so as to minimize bending or thermal stresses in the attachment weld.

b. Internal Sleeves:

b1. Internal sleeves shall be provided in all expansion joints. The sleeves shall be installed prior to shipment of joints.

b2. The sleeves shall be designed and installed to preclude interference with the convolutions when the joint is in its maximum deflected position during operation, to preclude binding against the welding neck and to restrict entry of foreign material into the bellows area. The maximum deflected position during operation shall include the deflections arising from the tolerances specified.

b3. The sleeves shall not restrict steam flow and increase steam velocity. To avoid inducing vibration at either "normal operating conditions" or "the maximum flow conditions" the flow velocity inside the expansion joint lines shall not exceed:

b3.1 Wet Steam – 7,500 ft/min

b3.2 Superheated Steam – 20,000 ft/min

b4. Sleeve thickness shall be no less than 1/16 inch and otherwise shall be in accordance with EJMA design recommendations for internal sleeves.

c. Covers:

c1. The flexible portion of all expansion joints shall be provided with a permanent, stainless steel cover over the full circumference to protect it from damage by falling objects, prevent foreign objects from lodging between convolutions and protect convolutions from erosion. These covers should be removable to permit bellows inspection and shall in no way limit the free movement of the flexible portion of the joint. Clearances between the cover and the convolutions shall be based upon the specified deflections plus deflections due to the tolerances specified herein. The thickness of the covers shall be no less than 10-gauge. Covers shall be designed to preclude trapping of liquids after final cleaning. Covers shall be installed prior to shipment and shall be securely attached to the joints in order to prevent the covers from loosening due to vibration or steam impingement.

d. Materials:

d1. Materials for the expansion joints and components shall be in accordance with the following as appropriate for the application:

d1.1 Internal sleeves shall be Type 304 stainless steel per ASTM A167 or ASTM A240.

d1.2 Covers over flexible portion of expansion joints shall be Type 304 stainless steel per ASTM A167 or ASTM A240.

d1.3 The spool pieces and welding stubs shall be made of seamless carbon steel conforming to ASTM A106, Grade B, Schedule extra strong for sizes up to and including 24 inch. All sizes

above 24 inch shall be per ASTM A672 for welded plate pipe Grade B-60 (plate materials per ASTM A515, Gr. 60) Class 22, 1/2 inch plate thickness.

d1.4 Expansion joint bellows element shall be Types 304 or 316 stainless steel per ASTM A167 or ASTM A240.

201.6 Pipe Expansion Joints (Rubber):

a. General Design and Construction:

a1. Straight spool type expansion joints shall be concentric and at right angles to the flanged ends.

a2. Contractor shall design and furnish expansion joints suitable for the movements specified.

a3. Expansion joints shall be reinforced as applicable to suit the particular location and service for which they are intended.

a4. Expansion joints shall be designed for the design and hydrotest pressures specified. Additionally, the expansion joints shall retain full function and not collapse under vacuum conditions.

a5. When specified, the expansion joint shall be furnished with tie rods to restrain pressure thrust forces. The tie rods shall not limit the ability of the expansion joint to satisfy the design movements and shall be adjustable by Company during piping system operation. The tie rods shall be equally distributed around the circumference of the expansion joint and shall be sized to restrain the resultant pipeline pressure thrust forces at the specified maximum design pressure. Tie rods shall be furnished complete with all flanges, gaskets, nuts, bolts, and mounting hardware.

a6. Expansion joints located outdoors will be exposed to sunlight and thus subject to ultraviolet light. Materials of construction for expansion joints located outside shall resist softening and deterioration resulting from prolonged exposure to ultraviolet light.

a7. Contractor shall furnish all required materials and accessories including tie rods, rubber bushings, gussets, nuts and spherical washers. Tie rods shall be designed to resist the total forces (including pressure thrust) on the expansion joint.

a8. Expansion joints for low temperature water service shall be elastomer or rubber expansion joints reinforced in each case to suit the particular location and service for which they are to be used. Elastomer expansion joints shall not be used in piping where the working temperature exceeds 150°F.

a9. Expansion joints shall be suitable for the working pressures or vacuum, temperatures, and pipe movements in the line where they are to be installed and shall be of design, type, and manufacture acceptable to the Contractor.

b. Materials:

b1. All materials used in construction of the expansion joints and appurtenances shall be the best suited for the application.

b2. All materials used in the expansion joints, unless otherwise specified, shall be manufacturer's standard suitable for services and operating conditions as specified.

201.7 Miscellaneous Specialties:

a. For specialties not discussed in this Section, the Contractor shall meet the design requirements of the Specification, Specialty List and Specialty Data Sheets, as applicable.

202. MATERIAL REQUIREMENTS

202.1 All pressure retaining materials shall be in accordance with and identified by ASTM material specifications. Non-pressure retaining materials, such as: gaskets, packing, etc. may be to

Contractor's standard if they meet the specified service conditions. Compatibility of materials with the fluid handled is the responsibility of the Contractor.

202.2 Gasket and packing materials, where supplied, shall not contain a leachable chloride content more than 100 ppm if the packing or gasket material is in contact with stainless steel.

202.3 Rubber or synthetic materials shall not be used in the backwash section of self-cleaning strainers.

202.4 Each steam trap shall have stainless steel trim.

202.5 Straining elements in manual strainers and orifice plates (including paddles) shall be stainless steel. Alternate material shall be used if stainless steel is not compatible with fluid.

202.6 Bolting material shall be the same generic material as the specified body material or of a more corrosive resistant material.

202.7 All austenitic stainless steel materials shall be in a solution-annealed condition, which shall consist of heating to 1900°F or higher and holding for an appropriate time. Subsequent cooling shall be from the annealing temperature to below 800°F so as to prevent carbide precipitation in the grain boundaries.

202.8 Austenitic stainless steel shall not be used if subjected to a post-weld heat treatment in the range of 800°F to 1800°F regardless of subsequent cooling rate.

203. SOURCE QUALITY CONTROL

203.1 Inspection and Testing:

a. Perform all examination and testing and furnish documentation required by the governing code(s).

b. All materials used in pressure boundary parts shall be tested and repaired in accordance with the applicable ASTM material specifications.

c. Contractor shall indicate full extent of nondestructive testing in data sheets.

d. In addition to any required inspections, all fabrication and material may be subject to inspection by a representative of Company:

d1. All welds shall be visually inspected. Visual inspection shall consist of observations by Company's inspector for assurance of proper joint preparation and fit-up, proper materials procedures, qualifications and workmanship in process, proper appearance, surface condition and workmanship of the finished weld and supplementary inspection techniques as required to evaluate unusual conditions.

e. Shop Tests:

e1. Equipment shall be given tests to assure that workmanship and materials are free from defects and to establish that the design, construction and performance meet the requirements of this Section.

e2. All equipment shall be hydrostatically tested to the test pressures of the applicable ASME Standard and/or pressure rating class.

e3. Pipe Expansion Joints (Metal) Tests:

e3.1 Each expansion joint assembly shall be hydrostatically tested at a minimum of 1½ times the specified working pressure prior to shipment from the manufacturer's plant.

e3.2 Expansion joints that fail during the shop hydrostatic tests due to faulty, improper or inadequate design, materials or fabrication shall be replaced at the expense of the Contractor. Any discernible leakage of the expansion joint or evidence of weld defect shall constitute failure.

Unless proposed repair procedure submitted by Contractor is approved in writing by Company, the joint shall be replaced at the expense of the Contractor.

e3.3 A qualification test shall be performed on at least one sample of the smallest size expansion joint offered of each design in the presence of a representative of the Contractor. A design shall mean that the corrugations of the expansion joint shall be identical in material, contour of corrugations, process of manufacture, details of construction, operating pressure and movement per corrugation regardless of diameter. A higher pressure design may be used for a lower pressure provided it has successfully passed the qualification test at the higher pressure. Each sample shall consist of an assembled expansion joint of at least three complete corrugations of the flexible portion together with welding nipples or flanges. The qualification test shall consist of proof test for allowable movements at design pressure and temperature.

204. FABRICATION REQUIREMENTS

204.1 Pipe Expansion Joints (Rubber):

a. Each expansion joint assembly shall be completely shop fabricated. The expansion joints shall be shipped to the field with the retaining rings and control units shipped unassembled. Assembly is to be performed in the field.

b. All work shall be performed in accordance with the best modern practice for the manufacture of high-grade expansion joints and appurtenances. All machined parts shall have accurately machined mounting and bearing surfaces so that they can be assembled without fitting, chipping, or re-machining. All parts shall conform accurately to the design dimensions and shall be free of all defects in workmanship or material that will impair their service.

204.2 Welding:

a. All welding shall be done in accordance with Contractor's welding requirements, which shall comply with the applicable codes and standards. No plugging, impregnation, brazing or welding repair shall be permitted on cast iron or ductile iron.

b. All welding on stainless steel and between stainless and carbon steel shall be by the gas tungsten arc welding method (GTAW).

c. Butt-welds should be used where possible.

d. All butt-weld end preps shall conform to the details of this Section.

204.3 Identification:

a. Unless otherwise specified, each specialty indicated on the P&IDs and/or the isometric drawings bears an identification figure (specialty number).

b. All specialties furnished by Contractor shall have a securely attached metal tag marked to identify each item and its particular service. Tags shall be furnished in accordance with Schedule A, Section xxxx, unless otherwise specified.

c. Pipe Expansion Joints (Metal) Nameplates:

c1. Contractor shall attach, by securely welding, a 12-gauge metal nameplate of ASTM A167, Type 304 material to each joint cover, bearing the following information (Information shall be die-stamped using ¼ in. high letters):

c1.1 Manufacturer

c1.2 Equipment specialty number

c1.3 Type and size of expansion joint

c1.4 Design pressure and temperature

c1.5 Design movements (axial and lateral)

c1.6 Direction of flow arrow

c1.7 Heat number of bellows material

c1.8 Heat number of nozzle materials

204.4 Cleaning Pipe Expansion Joints (Metal):

a. All expansion joints assemblies shall be thoroughly cleaned on the interior and exterior of rust, scale, oil, grease and foreign matter. All surfaces (including welds) shall be free of all weld splatter and visible oxide. An aluminum oxide abrasive disc or stainless steel wire brush may be used to improve the surface finish. Vapor, glass bead or sandblasting may also be used; however, they shall be confined to the weld areas. Non-halogenated solvents shall be used to clean stainless steel components.

b. Exposed machined surfaces shall be coated with an easily removable rust preventative. All carbon steel interior and exterior parts shall be coated with an easily removable non-corrosive rust preventive film.

204.5 Shipping:

a. Materials shall be provided with protection against damage, corrosion and internal contamination in accordance with the following:

a1. All materials and equipment shall be packaged, packed or prepared for shipment in a manner which shall ensure arrival at destination in satisfactory condition.

a2. All openings shall be securely plugged, capped or otherwise blanked off, sealed with tape and suitably protected against damage and entry of foreign materials and moisture.

a3. Weld ends on all piping specialty items shall be capped and sealed with suitable, firmly attached protectors. Butt-weld ends on ferrous materials shall be coated with Special Chemicals Corporation Deoxaluminite, or acceptable equal, prior to capping, back to a ring whose length is the same as the weld preparation plus 2 inches minimum.

a4. Protectors for beveled ends shall have a plywood or hardboard liner disc held securely against the beveled end. Protectors for other weld ends may be metal caps without liner discs. Protectors shall not be welded to the weld end.

a5. All flange facings, bolt holes and other machined surfaces of ferrous materials (except butt joint end preparation) shall be coated with a suitable removable antitrust compound. No coatings shall be applied to nonferrous materials.

a6. All flanged connections and loose flanges shall be provided with suitable full face flange protectors bolted in place and sealed.

a7. All protectors for openings and all braces, brackets, spacers, ties, bindings and other shipping, packaging and packing materials and appurtenances used for protection in shipping, storing and handling of nonferrous piping and materials shall be of such design, type and/or arrangement as to prohibit contact between ferrous and nonferrous materials.

a8. Threaded connections shall be provided with plugs.

205. <u>FINISH REQUIREMENTS</u>

205.1 Unless otherwise specified, piping specialty items shall be cleaned and painted as follows:

a. Coatings shall meet the requirements in Schedule A, Section xxxx.

b. No paint having an asphaltum base shall be used.

c. Machined surfaces shall not be painted. Flange facings, bolt holes and other external machined surfaces of ferrous metal materials shall be coated with a suitable antirust compound.

d. Stainless steel and rubber parts shall not be painted.

MASTER SPECIFICATION
FOR

Safety Valves

REVISION HISTORY

Date	Revision	Change Description
8/30/2015	1.0	New

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PART 1 - GENERAL

1.1 SUMMARY

1.1.1 This document contains the minimum requirements for the design, sizing and selection of automatic pressure actuated safety valves, safety relief valves, and relief valves. The requirements should be supplemented by the Supplier's own requirements. The valves shall be delivered complete. Delivery dates are addressed in Exhibit 4.

1.1.2 The safety valves shall be supplied as per the Appendix 9 Safety Valve data sheets.

1.1.3 The Supplier shall comply with all the requirements of this specification. Approval of any drawings and/or test shall in no way relieve the Supplier from these responsibilities.

1.1.4 The valves shall be certified and stamped in accordance with ASME requirements.

1.1.5 All of the equipment and materials specified herein is intended to be standard equipment for use in controlling the flow of air or fluids.

1.1.6 Valves, appurtenances, and miscellaneous items shall be as specified so as to form complete, workable units.

1.1.7 No substitutes or alterations are authorized without written approval in the form of a change notice to the order.

1.1.8 The Supplier shall make a request for a change giving reasons and identifying the present and proposed method. Written consent in the form of a change notice is required. The change shall be duly noted and documents that are affected shall be changed as required.

1.1.9 Valves furnished under these requirements are classified as safety valves or safety relief valves. These valve types are functionally defined as follows.

1.1.9.1 Safety Valve - An automatic, re-closing, pressure-relieving device suitable for steam, gas or vapor service. Valve action is characterized by rapid full opening or "pop" action at valve set pressure.

1.1.9.2 Relief Valve – An automatic, re-closing, pressure relieving devices used for liquid service only. Valve action is characterized by opening in proportion to the increase in upstream static pressure over the valve set pressure.

1.1.9.3 Safety Relief Valve - An automatic, re-closing, pressure-relieving device suitable for use as either a safety or relief valve

1.2 SCOPE OF WORK

1.2.1 Equipment and service furnished by the Supplier shall include:

1.2.1.1 Design, fabrication, testing, certification and delivery of all valves, meeting the requirements of this specification and the safety valve data sheets.

1.2.1.2 Test rod and screw cap or other gagging mechanism shall be provided with each safety, safety relief and relief valves for hydrostatic testing. The hydrostatic test pressure will be at 1.5 times the design pressure of the system to which the safety valve is installed.

1.2.1.3 Any special tools required for assembly, disassembly and maintenance.

1.2.1.4 Valve drawings and calculations, including outline dimensions, weights, section drawings, part lists and materials.

1.2.1.5 Installation, operation, and manintenance manuals, including instructions for any sub-suppliers.

1.2.1.6 Perform shop testing and inspection.

1.2.1.7 Perform cleaning and shop painting of all valves, operators, and accessories.

1.2.1.8 Package and mark all valves, operators, and accessories for shipment.

1.2.1.9 Deliver all valves, operators, and accessories to jobsite.

1.2.1.10 Recommended spare parts list.

1.2.1.11 Valves shall be have permanent tags affixed to the valve and stamped with the information as required by the ASME Boiler and Pressure Vessel Code Sections I and VIII.

1.2.2 Equipment and services furnished by the Buyer shall include:

1.2.2.1 Receiving, unloading, storage and installation of all equipment supplied by Supplier

1.2.2.2 Electrical wiring for power and signals for position indicating lights, solenoids, and/or control stations

1.2.2.3 All external piping, tubing, valves, and fittings, except as specified to be furnished by the Supplier.

1.2.3 Supplier shall provide a recommended operational spare part list for two (2) years of operation as well as a pricing list for the items prior to delivery.

1.3 CODES AND STANDARDS

1.3.1 Publications of the following nationally recognized organizations are applicable to the engineering, design, manufacture, and testing of the equipment included in this Specification. All references to publications are to the latest issue of each together with all latest addenda, amendments, or additions thereto as of the date of Agreement. References will be made in accordance with the abbreviations listed below:

ASME B1.20.1	Pipe Threads, General Purpose (inch)
ASME B16.5	Steel Pipe Flanges and Flanged Fittings
ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves
ASME B16.20	Ring-Joint Gaskets and Grooves for Steel Pipe Flanges
ASME B16.34	Valves – Flanged, Threaded, and Welding End
ASME B31.1	Power Piping
ASME B31.3	Chemical Plant and Petroleum Refinery Piping
ASME VIII	Rules for Construction of Pressure Vessels – Division 1
ASME I	Rules for Construction of Power Boilers
ISA Guide	Control Valves, Practical Guides for Measurement and Control
ISA S20.50	Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves
ISA S75.01	Flow Equations for Sizing Control Valves
ISA S75.05	Control Valve Terminology
ISA S75.11	Inherent Flow Characteristic and Rangeability of Control Valves
ISA SP75.17	Control Valve Aerodynamic Noise Prediction
ISA RP75.23	Considerations for Evaluating Control Valve CavitationHI Hydraulic Institute
IEEE	Institute of Electrical and Electronics Engineers
MSS	Manufacturers Standardization Society
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
SSPC	The Society for Protective Coatings
UL	Underwriters Laboratories

1.3.2 All valves shall be in accordance with the applicable requirements herewith and shall comply with all federal, state, and local codes that govern.

1.3.3 In case of conflict between the requirements of the various parts of these documents, the requirements of the different parts shall govern in the following sequence: Mandatory Governmental Body regulations, codes and standards, this Specification and the referenced industry codes and standards.

1.3.4 Supplier shall provide proper Code certification that all work complies with all requirements of the Code including design, materials, construction, and workmanship.

1.4 DELIVERY, STORAGE AND HANDLING

1.4.1 The valves shall be delivered FOB destination to the Company's XXX Plant, located in XXX.

1.4.2 The Supplier shall adequately prepare all of the equipment to withstand any possible damage or loss due to rough handling or exposure to weather during transit or extended outdoor storage for up to 6 months. Where required by the nature of the equipment, the Supplier shall furnish and install necessary covers to protect the equipment from rain, hail, wind, dust, etc. Flanges and openings shall be adequately sealed and protected during shipment to prevent corrosion, entrance of foreign matter and possible damage from rough handling during transit and storage. Flanged connections shall be provided with suitable flange protectors bolted on before shipment. Screwed outlets shall be provided with plugs. Instructions for storage shall be included with the Installation, Operating & Maintenance manuals.

1.4.3 All exposed-machined ferrous metal surfaces shall be coated with a suitable antirust compound before shipment.

1.4.4 Preservative coatings used on components shall be suitable for the conditions normally expected during shipping, storage and throughout the erection period. Toxic and hazardous-type preservatives will not be allowed. Information pertaining to preservatives shall be submitted two months prior to delivery.

1.4.5 The Supplier shall be responsible for its Subcontractor(s) adhering to the above shipping preparations on all equipment and items shipped to the Company by the Subcontractor.

1.5 MAINTENANCE MATERIALS

1.5.1 The Supplier shall furnish two (2) items each of any special tools required to operate and maintain the valves and accessories. A list of these tools shall be provided with the Agreement. If no special tools are required the Supplier shall indicate so.

END OF SECTION

PART 2 - PRODUCTS

2.1 GENERAL DESIGN AND CONSTRUCTION

2.1.1 Safety valves, relief valves and safety relief valves shall be sized and constructed in accordance with the ASME Boiler and Pressure Vessel Code Sections I and VIII as applicable. All valves shall be of the bottom inlet, side outlet type.

2.1.2 Safety valves, relief valves, and safety relief valves shall also meet or exceed the requirements of the following Codes: ASME B31.1, API 526, API 527, and ASME PTC 25 as applicable. Valve certification shall conform to ASME Section VIII, UG-131 or ASME Section I PG- 69 depending on jurisdiction as noted in valve data sheet. Valve testing shall be in accordance with ASME PTC 25.

2.1.3 The Data sheets in Appendix 9 indicate the operating conditions that the individual valves will encounter. All safety valve, relief valve, and safety relief valves shall be suitable for service under the conditions as specified in Appendix 9.

2.1.4 The Supplier shall be totally responsible for the proper sizing, selection, and application of all safety valves, relief valves, and safety relief valves.

2.1.5 The valve shall be rated to meet the design pressure and design temperature of the application according to an internationally recognized standard. For flanged valves, the valve body rating shall never be lower than the flange rating. All safety valves shall have flanged outlets. All flange faces shall be of the raised face type.

2.1.6 Valve class ratings indicated on the Data sheets are anticipated as ASME B16.34 pressure class ratings only. In all cases, it shall be the responsibility of the Supplier to properly and economically select valves with pressure-temperature ratings that meet or exceed the design pressure and temperature specified.

2.1.8 The valve construction including materials for each safety valve, relief valve, and safety relief valve shall be in accordance with the requirements specified herein, and in the Data sheets in Appendix B. Finish shall be the Manufacturers standard unless otherwise specified in the Data sheets in Appendix B. As required by the process conditions in Appendix 9, the Supplier shall select relief valves that include valve body drain ports.

2.1.9 Safety and relief valves shall be installed vertically and vented to a safe location. Safety relief valves shall have carbon steel bodies with stainless steel seats and disks, packed lifting levers and spring enclosures.

2.1.10 Valves shall be designed to operate without chattering.

2.1.11 Tungsten alloy springs shall be used for valve applications above 450°F.

2.1.12 All safety valves, relief valves, and safety relief valves shall be suitable for outdoor service unless specified otherwise in the Data sheets. All Safety valves, relief valves, and Safety relief valves with inlet sizes 2" and smaller shall have closed bonnets. All other safety valves, relief valves, and safety relief valves shall have either a closed bonnet or a weather hood.

2.1.13 Set point and blowdown shall be field adjustable after installation. Screwed caps shall be provided to cover the set point adjustment mechanism. Means shall be provided for sealing all external adjustments. Seals shall be installed by the manufacturer in such a manner as to prevent changing the adjustment without breaking the seal.

2.2 OPERATING PARAMETERS

2.2.1 Safety Valve Sizing

2.2.1.1 The flow capacity of each valve shall be as shown on the Data sheets when operating at the fluid conditions, including back pressure, set pressure, and over pressure as specified.

2.2.1.2 Each safety valve, relief valve, and safety relief valve shall be sized by the Supplier performing their own independent calculations to meet the specified conditions.

2.2.1.3 The sizing differential pressure shall be considered as the maximum differential pressure that is effective in producing flow, or the actual differential pressure, whichever is smaller.

2.2.1.4 Unless otherwise specified on the Data sheets, the estimated backpressure shown on the Data sheets is based on the valve outlet discharging into a short radius elbow with 1 foot of straight pipe open to a vent stack releasing to the atmosphere. The elbow and pipe shall be the same diameter as the valve outlet.

2.2.1.5 The Supplier shall calculate a backpressure for each proposed safety valve, relief valve, and safety relief valve based on this discharge configuration.

2.2.2 Valves shall have port and body flow areas adequate to pass the required capacity. Pressure accumulation shall not be greater than 10 percent of the valve set pressure or 3 psi, whichever is greater. Capacity ratings shall be certified in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code. The valve outlet backpressure shall be not greater than 10 percent of the valve set pressure.

2.2.3 Valve capacity shall be based on the applicable service fluid.

2.2.4 Valves for steam, air, and hot water service over 140 degree F applications shall be provided with lifting devices. The lifting devices shall permit the valve disk to be positively lifted from its seat when the valve is subjected to a pressure of at least 75

percent of the valve set pressure. Lifting devices shall be packed to prevent leakage of the fluid when the disk lifts.

2.2.5 Body designs shall be such that crevices and retention pockets are minimized. If the body design for valves larger than 1-1/2 inch inlet is such that liquid can collect on the discharge side of the disk, a socket weld drain connection or a plain end pipe nipple of not less than 1/2 inch nominal pipe size shall be provided at the lowest point liquid can collect.

2.3 ELECTRICAL REQUIREMENTS

2.3.1 Section not required

2.4 INSTRUMENTATION AND CONTROL REQUIREMENTS GENERAL

2.4.1 Section not required

2.5 PAINTING AND COATING

2.5.5 All external ferrous steel surfaces shall be painted per manufacturer's standard coating.

2.6 FIELD SERVICES (OPTION)

2.6.1 Section not required

2.7 SPECIAL TOOLS

2.7.1 Supplier shall provide two (2) complete sets of special equipment and tools, required for repair, inspection, adjustment, complete dismantling and assembling of the equipment. Tools shall be new and of first-class quality. Tools shall be shipped to the project in a suitable, separate container clearly marked with the name of the equipment for which they are intended.

2.7.2 Supplier shall indicate if special equipment and tools are required for repair, inspection, adjustment, complete dismantling and assembling of the equipment in the Agreement.

2.8 SPARE PARTS

2.8.1 Supplier shall provide a quotation for recommended spare parts covering the first two (2) years of operation as identified below. Spare parts quotations shall:

a. Be submitted to Company prior to delivery.

b. Have been identified with Specification number, equipment name, unit

number, and station name.

c. Have been inclusive for and applicable to all equipment components, auxiliaries, accessories, materials, and lubricants being furnished under the Agreement.

d. Have included for each recommended spare part, the unit prices, quantity, description, part number references, etc., to completely identify the item and the equipment component for which it is recommended.

e. Have been based upon furnishing and delivering the parts at the Project Site.

f. Include a list of recommended test equipment and special tools. Test equipment list and special tools list shall indicate the cost of each component.

g. All requirements regarding quality control and documentation that apply to the original parts of the specified equipment shall apply equally to the spare parts of the specified equipment.

2.8.2 Startup and Commissioning Spare Parts:

2.8.2.1 Supplier will submit a listing of startup and commissioning spare parts. The startup and commissioning spare parts list may be unit priced or lump-sum priced but will be included in the firm price offer and indicated separately from the condensate pumps price.

2.9 TRAINING (OPTION)

2.9.1 Section not required

2.10 SOURCE QUALITY CONTROL

2.10.1 Valves and appurtenances shall be products of well-established manufacturers who are fully experienced, reputable, and qualified in the manufacture of the particular equipment to be furnished. The manufacturer shall have a minimum of five years experience in the manufacture of control valves as specified herein. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these specifications as applicable.

2.10.2 It is the Supplier's responsibility to obtain copies of all documents referenced in this specification. Unless specific exception is requested formally by the Supplier, and formally granted by Purchaser, these referenced documents shall be binding.

2.10.3 Purchaser reserves the right to inspect the product and audit material and processes at any of the Supplier’s facilities that are performing work in support of this specification. Products and services supplied under this specification are subject to Purchaser's final inspection, acceptance, and release.

2.10.4 The following standard tests shall be performed on each Safety valve:

- Valve hydrostatic pressure test

2.10.5 Supplier shall furnish Certification of Compliance with ASTM specifications referenced for manufacture. Data on certificates of material compliance shall include the name of supplier, name and address of prime material manufacturer, material specification and grade, class, or type designation. In addition, Supplier shall provide a statement certifying compliance with material specifications, including the Supplier's Quality Assurance Manager signature and date.

2.10.6 Supplier shall also provide a complete MTR (Mill Test Report) showing results of all chemistry and physical tests for impact tested steels, alloy steel or stainless steels.

2.10.7 Supplier shall provide a Positive Material Identification or "PMI" report for the fabrication of all control valves to confirm valve body material. Carbon steel valves will not require a "PMI" report.

2.11 PERFORMANCE ACCEPTANCE TESTS

2.11.1 Supplier shall furnish a test procedure for testing the equipment. The test procedure shall clearly spell out the instrumentation, test connections, cycle isolation requirements, and any other equipment for the tests and where they must be located in the system to obtain the necessary test data.

2.11.2 All instrumentation required for Supplier's test procedure that is mounted on Supplier's equipment or interconnecting piping shall be provided by Supplier. This instrumentation may be permanent or temporary instrumentation. If temporary instrumentation will be utilized Supplier shall provide this instrumentation on a loan basis. Instrumentation required by Supplier's test procedure that requires installation on Company's equipment or piping shall be identified to Company prior to pump shipment to allow provisions for its installation. Supplier shall provide data sheets regarding the accuracy of such instrumentation. Instrumentation that requires backfitting into Company's equipment or piping will be backcharged to Supplier.

END OF SECTION

Appendices

Appendix 1

Deliverables

1. <u>GENERAL INFORMATION.</u>

1.1 Issuance

1.1.1 All Submittals shall be issued to Company, and other Company authorized parties by electronic transfer using a Company approved electronic media storage and retrieval system. Supplier's system shall be compatible with Company's software capability.

1.2 Definitions

1.2.1 Compliance Submittals include engineering calculation books, design drawings, and construction documents that are prepared by Supplier, or any sub-supplier and submitted by Supplier to Company as a basis for approval or Agreement compliance and materials proposed for incorporation in the Work or needed to describe installation, operation, maintenance, or technical properties.

1.2.2 Miscellaneous Submittals are Technical reports, Administrative Submittals, certificates, guarantees, Shop Drawings, product data, and samples.

1.2.2.1 Technical reports include laboratory reports, tests, technical procedures, technical records, and Supplier's design analysis.

1.2.2.2 Administrative Submittals are those nontechnical Submittals required by the Agreement. These Submittals include maintenance agreements, photographs, physical work records, statements of applicability, copies of industry standards, project record data, security / protection / safety data, and similar types of Submittals.

1.2.2.3 Certificates and Guarantees are those Submittals on equipment and materials where a written certificate or guarantee from the manufacturer or Supplier is called for in the Specifications.

1.2.2.4 Shop Drawings include custom-prepared data of all types including drawings, diagrams, performance curves, material schedules, templates, instructions, and similar information not in standard printed form applicable to other projects.

1.2.2.5 Product data include standard printed information on materials, products and systems; not custom-prepared for the Work under this Agreement, other than the designation of selections from available choices.

1.2.2.6 Samples include both fabricated and un-fabricated physical examples of materials, products, and Work; both as complete units and as smaller portions of units of Work; either for limited visual inspection or (where indicated) for more detailed testing and analysis. Mock-ups are a special form of samples, which are too large to be handled in the specified manner for transmittal of Sample Submittals.

1.3 Quality Requirements

1.3.1 Submittals shall be legible and of a quality for reproduction purposes. Drawings issued by electronic media shall be useable for further reproduction to yield a legible hard copy.

1.3.2 Supplier shall apply professional seal(s) to documents as required by the governing state laws, rules and regulations, where applicable.

1.4 Language and Dimensions

1.4.1 All dimensional units shall be in English units.

1.4.2 All words shall be in the English language, for use at the construction site.

1.5 Submittal Completeness

1.5.1 Submittals shall be complete with respect to dimensions, and other information specified to enable Company to review the information effectively.

1.5.2 Where standard drawings are furnished that cover a number of variations of the general class of equipment, each such drawing shall be highlighted to describe exactly which parts of the drawing apply to the equipment being furnished.

1.6 As-Built Requirements

1.6.1 All Drawing Submittals required for maintenance, operation and physical locations shall be conformed to as-built conditions.

1.6.2 As-built information shall be submitted at time of Acceptance.

2. COMPLIANCE SUBMITTALS.

2.1 General

The Compliance Submittals shall be broken down into two categories: Approval Required Compliance Submittals and Other Compliance Submittals.

2.2 Approval Required Compliance Submittals

2.2.1 All Approval Required Compliance Submittals shall be:

2.2.1.1 Approved by the Company.

2.2.1.2 Resubmitted on each revision for the number of times required to obtain compliance with the Agreement. Revisions by Company to re-Submittals shall be limited to those items that were not shown in the previous Submittals unless it is not in compliance with the Agreement. Any need for re-Submittals in excess of the number set forth in the accepted schedule, or any other delay for which Supplier is responsible, will not be grounds for extension of the Project Schedule.

2.2.2 Approval Required Compliance Submittal information categories developed by Supplier shall include the following data and information as applicable to the particular equipment and materials:

2.2.2.1 Equipment specifications.

2.2.2.2 General Arrangement drawings.

2.2.2.3 Piping and instrument diagrams for all systems, included in the Work.

2.2.2.4 Pump curves showing minimum, maximum and design point information.

2.2.2.5 Electrical one-line and three-line drawings.

2.2.2.6 Logic diagrams in SAMA (ISA) or IEC format.

2.2.2.7 All operating and maintenance manuals

2.2.3 If Supplier commences Work prior to approval, it shall be at Supplier's risk until the Submittal has been stamped "Submittal Accepted" or "Submittal Acceptable as Noted" by Company.

2.3 Other Compliance Submittals

2.3.1 Foundation Design Information- Not Required

2.3.1.1 Foundation loading and condensate pump center of gravity including weights of all accessories.

2.3.1.2 Details of foundation interface.

2.4.1.3 Structural loading data indicating the reactions transmitted to the foundation at each support location.

2.3.2 Test information:

2.3.2.1 Reports of factory and field tests.

2.3.2.2 Reports of factory and field inspections as specified in the technical specification divisions.

2.3.2.3 Test Reports:

a. Responsibilities of Supplier and Company regarding tests and inspections of equipment and materials and completed Work are set forth elsewhere in this Agreement.

b. The Party specified as responsible for testing or inspection shall in each case, unless otherwise specified, arrange for the testing laboratory or reporting agency to distribute test reports to all parties.

2.3.3 Instruction Books and Operating Manuals.

Equipment instruction books and operating manuals will contain the equipment Supplier's standard information and will follow the Supplier's standard format. They shall be prepared by the Suppler, or manufacturer, if applicable, including the following:

- Index and tabs.
- Instructions for installation, start-up, operation, inspection, maintenance, parts lists and recommended spare parts, and data sheets showing model numbers.
- Applicable drawings.
- Warranties and guarantees.
- Address of nearest manufacturer-authorized service facility.
- All additional data specified.

2.3.3.1 The electronic media equipment instruction books and operating manuals will utilize Company approved software. All information included in the manuals will be included in the electronic media document.

2.3.3.2 Installation, Operation, Maintenance and Spare Parts Manuals including inspection schedules shall be furnished containing the necessary information required to perform on-line and off-line routine maintenance and to maintain, overhaul, and repair all components of the plant.

2.3.3.3 Preventative maintenance activity schedules shall be provided that address operating and calendar hours, types of routine inspections, trouble-shooting check lists, replacement parts lists, and scheduling or inspection intervals.

2.3.4 Information listed above shall be bound into standard binders. Sheet size shall be (8-1/2 X 11). Binder color shall be selected by Supplier. Capacity shall be a minimum of 1-1/2-inches, but sufficient to contain and use sheets with ease. Provide with following auxiliaries:

- Label holder.
- Business card holder.
- Sheet lifters.
- Horizontal pockets.

2.3.5 The following information shall be imprinted, inserted or affixed by label on the binder front cover:

- Equipment name
- Manufacturer's name.
- Project name.
- Agreement Name and number.

2.3.6 The following information shall be imprinted, inserted, or affixed by label on the binder spine:

- Equipment name.
- Manufacturer's name.
- Volume number (if applicable).

2.4 Procedure for Compliance Submittals

2.4.1 Supplier shall prepare for Company's review and approval, a schedule for submission of Compliance Submittals specified for Company approval of the use of equipment and materials proposed for incorporation in the Work or needed for proper installation, operation, or maintenance. This schedule for Compliance Submittals will be agreed to prior to approval of the Agreement and attached to this Agreement Schedule.

2.4.2 The schedule shall indicate the required date for original submission of each item in the schedule and the anticipated date for Company's acceptance or comments thereof, and shall account for at least one resubmission of each item that requires Company approval.

2.5 Transmittal of Compliance Submittals

2.5.1 All Compliance Submittals shall be in an electronic format acceptable to the Company, .tif and / or .pdf is preferred.

2.5.2 All Compliance Submittals shall be accompanied with a Letter of Transmittal with the following information:

2.5.2.1 Supplier's file name / drawing number.

2.5.2.2 Supplier's revision number / letter.

2.5.2.3 Description of file / drawing title.

2.5.2.4 Sub-supplier's name (if applicable).

2.5.2.5 Sub-supplier's drawing number (if applicable).

2.5.2.6 Sub-supplier's revision number (if applicable).

2.5.3 Each drawing or sheet to be reviewed shall be in a separate file.

2.5.4 After checking and verifying, Supplier shall transmit all Compliance Submittals to Company and the Compliance Submittal or the Letter of Transmittal shall:

2.5.4.1 Identify each Compliance Submittal by project name and number, Agreement title and number, and the Specification Section and article number attached to the file and in a Letter of Transmittal file.

2.5.4.2 Check and annotate Compliance Submittals of Sub-supplier with Supplier's approval prior to transmitting them to Company. Supplier's stamp of approval shall constitute a representation to Company, that Supplier has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data, or Supplier assumes full responsibility for doing so, and that Supplier has coordinated each Compliance Submittal with the requirements of the Work and the Agreement.

2.5.4.3 At the time of each submission, call to the attention of Company in the Letter of Transmittal file any deviations from the requirements of the Agreement.

2.5.4.4 Direct specific attention in the Letter of Transmittal, or on revised Submittals, to changes other than the modifications called for by Company on previous Submittals.

2.5.5 Final Submittals.

2.5.5.1 After Submittals have been accepted, issue copies thereof for record. Files of accepted drawings transmitted for final distribution will not be further reviewed and are not to be revised. If errors are discovered

during manufacture or fabrication, correct the Submittal and resubmit for review.

2.5.5.2 All FINAL drawings are required prior to shipment of the equipment. FINAL drawings, instruction books, and manuals shall incorporate all approval corrections made to the approval submittals.

2.5.6 Quantity Requirements.

2.5.6.1 Except as otherwise specified, transmit all of Supplier's or any Sub-supplier's Compliance Submittals in the quantity as follows:

- Initial Submittal: One electronic file to Company. Comments will be returned to Supplier.
- Re-Submittals: One electronic file to Company. Comments will be returned to Supplier.
- Submittal for Final Distribution: Two electronic media copies plus six hard copies to Company.
- As-Constructed Prints: Electronic file plus 2 hard copies to Company.

2.5.6.2 Transmit Submittals of equipment instruction books and operating manuals as follows:

- Initial Submittal: One electronic file to Company. Comments will be returned to Supplier.
- Re-Submittals: One electronic file to Company. Comments will be returned to Supplier.
- Submittal for Final Distribution: Two electronic media copies plus six (6) hard copies to Company.

2.5.6.3 Transmit Submittals for Reference Only: One electronic copy to Company.

2.5.6.4 Company may copy and use for internal operations and staff training purposes any and all document Submittals required by this Agreement, whether or not such documents are copyrighted, at no additional cost to Company. Supplier shall be responsible for obtaining all licenses and approvals to enable Company to make such use of the Submittals.

2.6 Company Review

2.6.1 Company will review and comment on Compliance Submittals to Supplier when Submittals do not conform to the Agreement. Instruction books and similar Submittals will be reviewed by Company for general content but not for detailed substance.

2.6.2 Company's acceptance of Compliance Submittals will not relieve Supplier from its obligations as stated in the Agreement.

2.6.3 Supplier shall allow in its schedule for the Work, fourteen (14) calendar days turnaround time from the day the Company/Engineer receives the Compliance Submittals to when the Supplier shall receive returned Compliance Submittals. Compliance Submittals will be returned electronically.

2.6.4 Any need for re-submittals or any other delay for which Supplier is responsible, will not be grounds for extension of the Project Schedule.

2.7 Submittal Action Stamp - For Approval Required Compliance Submittals:

Company will attach its review comment annotation to each Approval Required Compliance Submittal when Company returns such Submittal to Supplier. The Company/Engineer will stamp each drawing with one of the following status codes which instruct the Supplier how to proceed with fabrication:

2.7.1 Status 1: No exception taken. Supplier/Contractor may proceed with fabrication or construction in accordance with specification.

2.7.2 Status 2: Supplier/Contractor may proceed with fabrication in accordance with specification based on making revisions as noted and resubmit.

2.7.3 Status 3: Results do not meet specification requirements. Revise as noted and resubmit. Hold fabrication.

2.7.4 Status 4: For information only, review not required.

3. MISCELLANEOUS SUBMITTALS.

3.1 General

3.1.1 Miscellaneous Submittals do not require Company's review for compliance with the Agreement. Miscellaneous Submittals will be submitted in electronic media. Miscellaneous Submittals include:

3.1.2 Instrumentation Information:

3.1.2.1 Tabulation of all instruments furnished, with each assigned a unique designation, including type of instrument, manufacturer and manufacturer's model number.

3.1.2.2 Complete manufacturer's specifications for each type and model number of instrument.

3.1.2.3 Each instrument shall be identified by its unique designation whenever it appears.

3.1.2.4 Maximum operating torque requirements for all dampers and vanes. Provide maximum torque requirements for each such damper at full open, full closed and at least one intermediate position. At least one of these points shall represent the maximum torque requirement of the damper. Also provide the maximum allowable torque and forces to prevent damage to the damper components.

3.1.2.5 Provide functional description of drive operation plus all design details required to define the inputs from control systems furnished by others such as thrust or torque for control drives, linkage data, type of input control signal, etc.

3.1.3 Equipment lay-down and pull space area requirements with component weights and overall dimensions that will be required during the installation of the pumps. This information may be included on the outline drawings with boxed out areas representing reserved areas.

3.1.4 Motor nameplate data for all motors furnished in the form of nameplate drawing or a completed proposal data form certified to be actual nameplate data.

3.1.5 Schematic control diagrams:

3.1.5.1 Complete elementary diagram of all control and alarm functions, both internal and external to the equipment.

3.1.5.2 Identification of all external connection terminals and terminal blocks.

3.1.5.3 Symbols conforming generally to ANSI or ISA or other industry accepted standards.

3.1.5.4 External connection wire colors and circuit designations on Field Construction wiring drawings.

3.1.6 Wiring diagrams:

3.1.6.1 Complete physically oriented diagram of all wiring internal to the equipment.

3.1.6.2 Conventional type wiring diagram with each wire or wire bundle shown by a line, or a point-to-point-type wiring diagram with individual wire destinations listed at the location of each termination.

3.1.6.3 Identification of all device and equipment terminals, and all internal and external connection terminal blocks.

3.1.6.4 All external wiring connections with wire colors and circuit designations.

3.1.7 Printed circuit board information if provided by Supplier:

3.1.7.1 Schematic diagram and physical wiring diagram of board, or Photographs with parts labeled in lieu of physical wiring diagram for each type of board when available.

3.1.7.2 Parts list containing complete description of all discrete components and integrated circuits when available.

3.1.7.3 May be included in instruction book in lieu of separate Submittal.

3.1.8 Device list, or bill of material of all instrument and control devices:

3.1.8.1 Tag numbers

3.1.8.2 Manufacturers.

3.1.8.3 Data or specification sheet numbers or cross reference stating what the device is.

3.1.9 Process Control Diagrams:

3.1.9.1 All major items and their correct functional relationships. Diagrams shall be accomplished in SAMA (ISA) or IEC format.

3.1.9.2 Tag numbers.

3.1.10 Data Sheets or Specification Sheets for each significant device furnished by this Agreement. These shall be the actual sheets used for ordering and fabrication, and shall include the primary manufacturer's own sheets where applicable in addition to the Supplier's purchase order forms, including:

3.1.10.1 Tag numbers.

3.1.10.2 Manufacturer.

3.1.10.3 Complete catalog or model number.

3.1.10.4 Scale range.

3.1.10.5 Complete electrical information, including current and voltage ratings, contact action (SPST, DPDT, etc.).

3.1.10.6 Other pertinent technical data.

3.1.10.7 All auxiliaries required such as capillary tubes, diaphragm seals, etc.

3.1.11 Outline drawings for each type of device furnished. One typical drawing may be used for all devices of the same type, but the drawing shall be marked to list the tag numbers of all devices to which it applies.

3.1.12 Electric motor data:

3.1.12.1 Nameplate data for motors rated 460 volts and above, including:

- Manufacturer's name and serial number.
- Horsepower rating.
- Time rating.
- Temperature rise and method indicated.
- Maximum ambient temperature.
- Insulation class.
- RPM at rated load.
- Frequency.
- Number of phases.
- Voltage.
- Rated load amperes.
- Power Factor at rated load.
- Efficiency at rated load.
- Locked rotor amperes or code letter.
- Service factor.

3.1.12.2 Wire and Cable Data:

- Engineering Data Sheets from the manufacturer for each type and size of cable supplied to the project. The data sheet is to indicate the conductor material, type of stranding, conductor coating, strand shielding for medium voltage cable, insulation material, insulation, insulation shielding, and jacket material.
- The national or international standards that were used as the specification for the cable is to be listed with the applicable paragraphs noted.
- The cable is to be marked to identify the manufacturer, conductor size, insulation and jacketing material, and any designations that apply from the cable standards followed.
- Cable pulling compounds approved by the cable manufacturer is to be listed for use by the installing Supplier.

3.1.12.3 All drawings, catalogs or parts thereof, manufacturer's specifications and data, samples, instructions, written guarantees and other information specified or necessary:

- For the proper erection, installation, operation and maintenance of the equipment and materials which Company will review for general content but not for substance.
- For Company to determine what supports, anchorages, structural details, connections and services are required for the equipment and materials, and the effects on contiguous or related structures, equipment and materials.

3.2 Transmittal of Miscellaneous Submittals

3.2.1 All Miscellaneous Submittals furnished by any Sub-supplier shall be submitted to Company by Supplier in electronic media acceptable to Company unless otherwise specified. Each submission of a Miscellaneous Submittal shall be accompanied by a Letter of Transmittal and shall:

3.2.1.1 Identify each Miscellaneous Submittal by project name and number, Agreement title and number, and the Specification section and article number marked thereon or in the Letter of Transmittal.

3.2.1.2 At the time of each submission, call to the attention of Company's in the Letter of Transmittal any deviations from the requirements of the Agreement.

3.2.2 Quantity Requirements:

3.2.2.1 Technical reports and administrative Submittals except as otherwise specified:

One electronic file and one hard copy to Company.

3.2.2.2 Written Certificates and Guarantees:

One electronic file and one hard copy to Company.

3.2.2.3 Transmit Submittals of product data as follows:

- Initial Submittal: Electronic file to Company. Comments will be returned to Supplier.
- Re-Submittals: Electronic file to Company. Comments will be returned to Supplier.
- Submittal for Final Distribution: Electronic file plus six hard copies to Company.

3.2.2.4 Transmit Submittals of material samples, color charts, and similar items as follows:

- Initial Submittal: Three (3) each to Company.
- Re-Submittals: Three (3) each to Company.
- Upon approval, One (1) Sample will be returned to Supplier.

3.3 Company's Review:

3.3.1 Company will review Miscellaneous Submittals for material deficiencies.

3.3.2 Company will respond to Supplier on those Miscellaneous Submittals that indicate Work or Equipment and material deficiency.

3.3.3 Supplier shall allow in its schedule for the Work, fourteen (14) calendar days turnaround time from the day the Company/Engineer receives the Miscellaneous Submittals to when the Supplier shall receive returned Miscellaneous Submittals. Miscellaneous Submittals will be returned electronically.

3.3.4 Any need for re-submittals or any other delay for which Supplier is responsible, will not be grounds for extension of the Project Schedule.

The following documents or notices shall be required as deliverables as indicated below:

[Specifier – Revise submittal dates per project requirements.]

Submittal Item for Relief Valves Documentation	Calendar Days		Event	LD
General Submittals				
Quality Assurance/Quality Control Plan, ISO 9000 certification			With Proposal	No
Insurance Certificates	20	After	Agreement Effective Date	No
Recommended Spare Parts List	20	Before	Shipment	No
Shipment Plan	20	Before	Shipment	No
Estimated Force Majeure delay	5	After	Beginning of force majeure event	
Information and estimated delay related to labor disputes		Upon	Knowledge	No
Status Reports	1st	Business Day	Monthly	No
Startup and Commissioning spare parts list	20	Before	Shipment	No
Pre-shipment inspection notice (including window of inspection) for shipments that Company requests to inspect	14	Before	Shipment	No
Bill of materials	20	Before	Arrival of first equipment on site	No

Submittal Item for Relief Valves Documentation	Calendar Days		Event	LD
Hazardous Materials Documentation	20	Before	Arrival on Site	No
Shipping Notice and detailed Packing List		Upon	Shipment	No
Safet Valve Submittals				
Master Document List (MDL)	20	After	Agreement Effective Date	No
Schedule	10	After	Agreement Effective Date	No
Valve Cut Sheets		With	Proposal	No
Valve Data Sheets		With	Proposal	No
Noise Calculations		With	Agreement Effective Date	No
Hydrostatic test report	7	After	Test	No
Seat leakage test report	7	After	Test	No
Certified Material Test Reports		Upon	Shipment	No
Storage Procedures for Equipment		Upon	Shipment	No
Operating and Maintenance Manual		Upon	Shipment	No

Note: Submittals listed are generic categories and some submittals may be combined or split apart as Supplier

Appendix 2

Proposal Data Requirements

DATA TO BE FURNISHED BY SUPPLIER

3.1 Performance

Variable	Unit	Data
Set Pressure	Psig	
Valve Capasity	lb/hr	
Temperature	Deg. F	
Over pressure	%	
Blowdown	%	
Back pressure	Psig	
Sound Power Level	dB(A)	

3.2 Design Data

Manufacturer		
Model Number		
Size and Type		
Body Style		
	Design Temp	
	Design Pressure	
	End Connection – In	
	End Connection – Out	
	Material	
	Orientation	
Trim Material		
	Seat	
	Disc	
	Spring	
	Bonnet	
Orifice Designation		
Accessories		
	Cap without Lever	
	Lifting Lever	
	Test Gag	
	Flame Arrestor	
Service Condition		
Process Fluid		
Code Designation		
Weight		

3.1 Valve Cut Sheet

To be included

END OF SECTION

Appendix 3
Performance guarantees

Section not required

APPENDIX 4
SITE CONDITIONS

1. SITE CONDITIONS.

1.1 Summary

1.1.1 This Schedule outlines the site conditions used as the basis for Performance Guarantees, Performance Tests and Facility demonstration tests.

1.1.2 During all such tests, the Facility is required to meet the Environmental Compliance Guarantees.

1.2 Site Location

Company's XXX Station site is located XXX

2. AMBIENT DESIGN CRITERIA.

2.1 Plant Elevation

The site elevation of the top of concrete of the HRSG operating floor will be elevation XXX

2.2 Temperature and Humidity

• Maximum Summer Extreme Temperature	XXX °F
• Summer Design Dry Bulb Temperature	XXX °F
• Summer Design Wet Bulb Temperature	XXX °F
• Winter Design Dry Bulb Temperature	XXX °F
• Minimum Winter Extreme Temperature	XXX °F
	XXX °F

2.3 Guarantee Point Conditions

• Dry Bulb Temperature	XXX °F
• Wet Bulb Temperature	XXX °F

2.4 Indoor Temperatures

• Summer design temperature (ventilated areas)	XXX °F
• Winter design temperature (heated areas)	XXX °F
• Winter design temperature (freeze protection)	XXX °F

2.5 Seismic Requirements

Site is located in a Seismiz zone X

APPENDIX 5
QA/QC

(Specifier, get with your QA/QC department for additional items for this section)

1. See section 2.10 for additional Quality Requirements.

Appendix 6

Startup, Commissioning, and Testing

1. Reference Section 2.15 for Startup and commissioning requirements.

2. **WORK SCHEDULE.**

2.1 General

2.1.1 Exhibit 4 sets the requirements for the Work Schedule. The Supplier shall use the critical path method (CPM) of scheduling to plan, manage and execute the Agreement Work. The Work Schedule will be used to report progress, evaluate changes and to validate progress payments in accordance with the Payment Schedule stated in Exhibit 5.

2.1.2 Supplier shall submit the Work Schedule to Company for review and acceptance. The Company shall review and comment on the schedule to ensure that the Supplier's plan meets the Project Schedule dates defined in Section 1.5 of this Exhibit 4 and does not conflict with any Company obligations. Upon agreement with Supplier concerning any necessary revisions, the Work Schedule will be accepted. The accepted Work Schedule shall become the Baseline Work Schedule and shall be binding to the Supplier. The Work Schedule will be updated at least once each month to show actual progress compared to the Baseline Work Schedule.

2.2 Definitions

2.2.1 "Activity" means, a separate and distinct part of the Agreement that can be identified for planning, scheduling, monitoring, and controlling the Work. Activities shall have a defined start date and finish date. The duration of an activity shall not normally exceed 30 calendar days. Activities shall not normally reflect the work of more than one discipline.

2.2.2 Critical Activities: Activities on the critical path, and have zero or negative total float.

2.2.3 Predecessor Activity: An activity that must start or finish before it's successor activity can start or finish.

2.2.4 Successor Activity: An activity that cannot start or finish until it's predecessor activity has started or finished.

2.2.5 "Baseline Work Schedule" means the original approved Work Schedule.

2.2.6 "Critical Path Method (CPM)" means a method of planning and scheduling a construction project where activities are arranged based on activity relationships and duration of each activity; and network mathematical calculations determine when activities can be performed and the critical path of the Work.

2.2.7 "Critical Path" means the longest continuous chain of activities through the Work Schedule that establishes the minimum overall duration from Full Notice To Proceed to Acceptance.

2.2.8 "Milestone" means a key or critical point in time for reference or measurement. A milestone has no duration.

2.2.9 "Total float" means the amount of time an activity can be delayed without adversely affecting an intermediate deadline or the Acceptance Date.

2.3 Work Schedule Requirements

2.3.1 The Work Schedule shall be developed and maintained in Primavera Project Planner (P3) version e/c. Use of P3 Enterprise is not an acceptable alternative. The activity code dictionary for the P3 Schedule shall be structured to allow codes for Phase, Discipline, Unit, Area, System, Component, Submittal Type / Number and Milestone Type / Number.

2.3.2 It is intended that the Work Schedule reflect the Supplier's actual plan for accomplishment of the Work.

2.3.3 The Work Schedule shall represent the entire Agreement Scope of Work.

2.3.4 The Work Schedule shall divide Work into separate detailed activities that define each major portion of the Work, with dates activities are expected to start and finish.

2.3.5 The Work Schedule shall address all phases of the Work including but not limited to engineering, design, procurement, manufacturing, shipment, prefabrication, installation, testing, startup, commissioning, and closeout.

2.3.6 The Work Schedule shall indicate times when submissions, reviews or approvals by Company are required.

2.3.7 The Work Schedule shall include all guaranteed agreement dates.

2.3.8 The Work Schedule shall be defined in more detail for critical and near critical path activities.

2.3.9 To the greatest extent practical, predecessors and successors shall be applied to all activities. Adequate consideration shall be given to these logical relationships to represent requirements for design evolution, procurement lead times, activity sequencing, commissioning strategy and overall resource leveling.

2.3.10 The Procurement / Production / Shipping Schedule shall be an integral part of the Work Schedule. Each line item in the Procurement / Production / Shipping Schedule shall be represented in the Work Schedule. At a minimum, procurement scheduling shall indicate the date each item will be needed at the Facility Site, the time required for delivery, the time required for manufacturing, the date the order is placed and dates for receipt of Supplier's drawings.

2.3.11 The Submittal Schedule, as set forth in Exhibit 2, shall be an integral part of the Work Schedule. Each line item in the Submittal Schedule shall be represented in the Work Schedule. At a minimum, activities for prepare, submit, review, comment, re-submit and approval shall be represented in the schedule.

2.3.12 The Payment Schedule, as set forth in Exhibit 5, shall be an integral part of the Work Schedule. Each line item in the Payment Schedule shall be represented in the Work Schedule and shall be cost-loaded with the associated value. These values shall sum to the total Agreement Price and shall accurately reflect fair and reasonable amounts and include all elements of cost.

2.3.13 Schedule Liquidated Damage milestones, as set forth in Exhibit 6, shall be an integral part of the Work Schedule.

2.4 Schedule Updates and Reportings

2.4.1 On the first Business Day of each month, Supplier shall submit to Company an updated Work Schedule reporting the progress from the previous month. The Baseline Work Schedule and each subsequent update shall be submitted electronically in a format allowing Company to maintain an integrated master project schedule. The Work Schedule provided by the Supplier to Company shall be the most detailed schedule it has available.

2.4.2 Work Schedule updates shall be furnished to the Company in the form of electronic reports, in various sorts, so that the Company may easily read and analyze the information. Work Schedule reports shall show the Work in a horizontal bar chart or other graphic format suitable for displaying scheduled and actual progress. Work Schedule reports shall clearly identify actual start and finish dates in direct comparison to baseline dates. In-progress activities shall indicate percentage completion. Work Schedule reports shall include as a minimum, early start, early finish, late start, late finish, original duration, and remaining duration. Narratives of the Work Schedule update identifying problems and proposed solutions shall be included in the Monthly Progress Report.

2.5 Project Schedule

2.5.1 The following Project Schedule sets forth the schedule requirements for executing the Work. Suppliers shall review the Project Schedule provided herein and develop their Work Schedule in accordance.

XXX PROJECT SCHEDULE	Start Date	End Date
Delivery Complete	XXX	XXX

APPENDIX 7
Packaging, Shipping and Storage

1. Reference Section 1.4 for additional shipping and storage requirements.

APPENDIX 8
Acceptable Suppliers

[Verify preapproved Suppliers with your regional sourcing supply chain management.]

	COMPONENT	**PREAPPROVED SUBSUPPLIER**
	Safety & Relief Valves	Anderson-Greenwood Consolidated Dresser Crosby Kunkle
1.	Indicators (Electronic)	Dixon (Ametek)
2.	Indicators (Local – Flow, Press., Temp.)	Ashcroft Barton (NuFlo) Dwyer Helicoid (Bristol Babcock) US Gauge (Ametek) Weksler
3.	Limit Switches (Proximity Type)	GO (Topworx)
4.	Media Converters and Managed Switches (Fiber Optic, Ethernet, etc.)	Hirschmann Weed Instruments
5.	Programmable Logic Controllers (PLC)	Square D Allen Bradley (Rockwell Automation)
6.	Solenoid Valves	MAC
7.	Switches (Pressure and Differential Pressure)	ASCO Ashcroft Barksdale Barton (NuFlo) SOR Square D
8.	Switches (Temperature)	Barksdale SOR Square D
9.	Switches, Level	Drexelbrook FCI Magnetrol
10	Tubing Fittings	Swagelok
11	Transmitters (Flow – Non Differential Pressure)	FCI Kurz Yokogawa
12	Transmitters (Level – Non Differential Pressure)	Drexelbrook (Ametek) Endress + Hauser KTEK Magnetrol Ohmart/VEGA
13	Transmitters (Pressure and Differential Pressure - SMART)	Rosemount (Model 3051, 4-20 mA output with HART protocol and LCD display)
14	Vibration Monitoring Equipment	Vibrex, PMC Beta, Vitec, Metrix, Bentley Nevada

APPENDIX 9
Safety Valves Data Sheets

		Project Title		Data Sheet No.		
				Issued by		
				Revision		
				Date		
Safety Valve Data Sheet						
Tag No.		QTY of Valves		Fluid		
Manufacturer		Service/Use			Installation	
Model Type		Design Code			Max. Noise	
Protected System					**Basis of Selection**	
Design Pressure		Psig			Code Requirement:	
Design Temperature		F				
Accumulation		%			Basis of Selection:	
Discharge to						
Safety Valve Location						
Line Size		Size		Schedule		
	Line		in.		in.	
	Branch In	By Supplier	in.		in.	
	Branch out	By Supplier	in.		in.	
Operating Conditions						
Fluid						
Required Capacity				lb/hr		
Max operating pressure				Psig		
Max operating temperature				F		
Valve Set Pressure				Psig		
Relieving Temperature				F		
Back pressure on valve				Psig		
Back pressure constant		Yes or No				
Back pressure variable		Yes or No				
Over pressure - % Set Pressure						
Spring Set Pressure hot-cold				Psig		
Cp/Cv						
Compressibility Factor						
Blowdown in % set pressure						
Calculated orifice area				Sq in		
Selected orifice area				Sq in		
Isentropic Exponent						
Capacity of Selected Valve				Lb/hr		
Valve Type				**Body**		
Type				Material		
Nozzle Type					End Conn.	Size/Class
Bonnet				Inlet		
Pilot				Outlet		
				Orifice Desig.		
Trim Material				Accessories		
Seat / Disc				Cap with Lever		
Springs				Lifing Lever		
Bellow				Test Gag		
				Flame Arrestor		
Supplier						
Manufacturer						
Model				Serial Number		
Weight				Cut Sheet Ref.		
Notes:						

MASTER SPECIFICTION
FOR

Pipe Supports and Hangers

REVISION HISTORY

Date	Revision	Change Description
11-19-2014	1.0	New

GENERAL

DEFINITIONS

Contractor/Bidder - The Company proposing to supply the materials, erection services to fulfill the bid requirements of this specification. Also, the company who accepts the Owner's contract and overall responsibility for fulfilling the installation requirements of this specification.

Owner - Xcel Energy, the Owner of the Equipment.

Pipe Supports – The term "pipe supports" includes all assemblies such as hangers, floor stands, anchors, guides, brackets, sway braces, vibration dampeners, positioners, and any supplementary steel required to attach pipe supports.

PPE – Personal Protective Equipment, the workers individual protective equipment provided to him by contractor that is necessary to do the work in compliance with the plant rules and all OSHA and EPA rules. (Hard hats, gloves, hearing protection, proper safety glasses, harnesses, respirators etc. used on the job)

SUMMARY

Introduction
This is a project to remove, furnish, and install Pipe Supports on the said project.

Scope Description
Contractor shall provide all materials, labor, and equipment to remove, furnish, and install all Pipe Supports per the provided SOW for the (System) servicing the _____ Station.

The work includes _____. Removal and proper disposal of all debris and materials; supply of all materials and consumables, erection in place of components and all construction, including warranties and guarantees described below.

APPLICABLE CODES AND STANDARDS

Codes and Standards

1. **Materials and Components**
   All pipe hanger and supports shall be designed and manufactured to the following codes and standards:
   1. American Society Mechanical Engineers (ASME)
   2. American National Standards Institute (ANSI)
   3. Manufactures Standardization Society (MSS)
   4. UL203 Standard for Pipe Hanger Equipment and Fire Protection Service
   5. Metal Framing Manufactures Association
   6. Local Building Codes.
   7. National Fire Protection Association (NFPA0

2. **Access and Safety**
   All provisions for access and safety shall comply with the latest requirements of OSHA, and any state and local ordinances and standards. Also, see section 6.3 for requirements of the contractor's dedicated safety officer. This project is identified as (**Risk Level)**; the awarded contractor shall submit a written site (project/job)-specific safety and health plan (SSSHP) that addresses each potential hazard identified in the assessment (See appendix B) to the Project/Contracting Manager and Safety Representative. This plan must be submitted to Xcel Energy for review, prior to work beginning. It is the responsibility of the contractor to inform their employees and subcontractors of the SSSHP.

TECHNICAL REQUIREMENTS

Demolition and Removal

1. **Demolition**
   The Contractor shall be responsible for all removed demolition debris from the existing Piping. During demolition, if any significant damage is caused by the Contractor of any existing plant materials or equipment the costs of repair will be paid by the Contractor. The cost of repair(s) will be directly deducted from the Contractor's invoice(s).
2. **Removal of Debris**
   The Contractor shall be responsible for removing all demolition debris from the jobsite, including disposal of hazardous material and any applicable environmental protection, as may be appropriate. The Contractor shall be responsible for all workers PPE during the demolition and removal process. Any hazardous materials; lead based, asbestos, PCB or other, will be handled according to their own requirements, stored and hauled away in compliance with Xcel Energy Environmental services.

   - The Contractor shall bear all handling and transportation costs for the materials to be delivered to the approved landfill.

- The Contractor shall be required to fill out any manifest(s) for transportation as required. Xcel Energy shall prepare and sign all source manifests as well as pay all disposal fees for the materials.

Engineering

1. **Pipe Support and Hangers**
   The specification, codes and standards are used as a reference and guide only. The final design is the design engineer's responsibility. Proper standards, load calculations, materials and hangar spacing are to be designed by the Contractor and approved by the Company. Codes and Standards applicable to this design are not limited to the ones listed above and it is the responsibility of the Contractor to verify the proper codes and standards are followed when engineering the Pipe Support and Hangers.

Materials of Construction

1. **Pipe Support and Hangers**
   Support component materials shall be suitable for service at the operating temperature of the pipe to which they are attached. Where support component temperature is below 750°F, component material shall be carbon steel or of an ASTM type having minimum yield strength of 35,000 psi, and a minimum ultimate strength of 58,000 psi.

   Where support component temperature is 750°F to 939°F, component material shall be chromium-molybdenum alloy steel having material, strength, and creep properties equal to or better than the pipe being supported. Where support component temperature exceeds 950°F, they shall be fabricated from materials having physical properties equal to or better than the following.

   These material requirements apply to parts that are wholly, or partially, within 9 inches of the outside of the pipe, including further extension of the part until it is completed:

Material nominally 2 1/4% chromium, 1% molybdenum	
Plate	ASTM A387 Grade 22
Pipe	ASTM A335 Grade P22
Material nominally 1% chromium 1/5% molybdenum	
Bolts, studs, and rod	ASTM A193 Grade B7
Nuts	ASTM A193 Grade 7
Material nominally 9% chromium, 1% molybdenum	
Plate	ASTM
Pipe	ASTM A335 Grade P91

On copper piping or tubing, the pipe clamp shall be of copper or copper-plated steel. Supports shall be of fireproof construction; no combustible materials shall be used. Malleable iron materials shall not be allowed. Miscellaneous support beams required for attaching supports to the building structure shall conform to ASTM A36. Recommended pipe support spacing is per ASME B31.1Welded pipe attachments are to be minimized.

2. **Mechanical Equipment**
   If it is necessary to remove the existing mechanical equipment, it shall be reused unless otherwise specified in the SOW document. Contractor shall install the existing mechanical components and align them as originally found.
3. **Access and Safety Provisions**
   Any ladders, lifts etc. needed to access the piping will be the responsibility of the contractor. Only certified individuals are allowed to operate machinery.

   Safety Provisions are the responsibility of the Contractor. The Contractor will follow all Xcel Energy Safety Rules stated in the Appendix B and have appropriate equipment on site for the job.

<u>Field Erection</u>

1. **Labor / Manpower**
   The Contractor shall provide sufficient skilled manpower in appropriate trades to execute the work in an efficient and practical manner in accordance with this specification, the schedule and the terms of the contract.
2. **Supervision**
   The Contractor shall provide a Site Superintendent who shall be responsible for supervising Contractor's work force, and for handling all responsibilities for payroll, scheduling, safety, and reporting on progress to the Owner's site representative. If the Contractor deems that a construction trailer is necessary for its operations, then it shall be provided at the Contractor's expense, including installation, removal, and all utilities. It is the responsibility of the Superintendent to have all personnel sign in and out of the plant each day on the main sign in sheet provided at main entrance of each station.
3. **Dedicated Safety Officer**
   The Contractor shall provide a Site Safety officer with considerable project experience who shall be responsible for training and supervision of the entire Contractor's work force including any subcontractors. The site safety officer will be responsible for making sure that all personnel under the Contractors direction are trained in the demolition & construction activities to be undertaken and are planned suitably in advance to be conducted in a safe manner. The site safety officer shall fill out weekly reporting, identify/record any unsafe behaviors, site conditions or work practices, and document these in writing to the Owner. Any near miss or other incident reporting will be required in the format directed by Xcel Energy.
4. **Equipment**
   The Contractor shall provide all equipment necessary to rig, hoist, load, store, or otherwise unload, handle or move materials in the safest, most expeditious means possible in order to meet the schedule.
5. **Other Items**
   Below is a list of project items that will be supplied by the Contractor as to safely complete the project.

   a. Receiving, unloading, storage and protection of delivered materials to Work Area
   b. Temporary scaffolding materials and associated labor for performance of the Work
   c. Temporary rigging for performance of the Work
   d. Containers for construction debris, and waste

e. Contractor's construction trailer
f. Construction crane, JLG, man-lift and qualified operators
g. Power source for Contractor's construction trailer only (supplied by Xcel Energy)
h. Sanitary facilities for the construction crews
i. Potable water, telephone service, lighting, ventilation, electrical service and hook-up
j. Final cleaning and inspection services after installed
k. All preparations for startup/commissioning before turnover of the new tower to Xcel Energy

- All of the above items shall be provided under the Contractor's work scope and in the Contractor's firm price quote. Any/all equipment, machinery, consumables, electrical work and all incidental items not specified or directly referenced herein that must be supplied or conducted for successful completion of the Scope of Work provided by the contractor.

Alternative Materials

- Bidders are invited to propose alternates in terms of materials, or construction, which will be evaluated by the Owner during the bid evaluation process.

Warrantee and Guarantee

1. **Materials and Workmanship**
   The Pipe Support work shall be warranted by the Contractor against any and all defects in materials and/or workmanship for a period of 1 years from the date of acceptance of the work by the Owner.
2. **Acceptance**
   For The purposes of payment under the contract, and for determining the warranty period, Acceptance shall be deemed to occur after mechanical completion, and when the Contractor has resolved any/all issues on a corrective list developed by the Owner. Payment to the contractor shall be forthcoming once all list items are resolved.

QA/QC (Including Inspection Test Plans)

Quality Control

a. The Contractor shall be responsible for implementation of a Quality Control program to ensure the installation meets the particular requirements of this Specification and industry standards. The independent monitoring activities performed by Xcel Energy shall not relieve the Contractor of this responsibility. The Contractor shall document and notify Xcel Energy of any non-conformance or deficient component condition. Any non-conformance of drawings or industry standard construction shall be documented by the Contractor and provided immediately in writing to Xcel Energy's representative. Non-conformances may also be initiated by Xcel Energy. The Contractor should present a disposition report with their recommendation/proposal on corrective action to Xcel Energy.

MASTER SPECIFICTION
FOR
PIPING and VALVES
INSULATION AND JACKETING

Revision 1.0
Date 10-21-14

Revision History

Approved 10-21-14	1.0	New

PIPING AND VALVES INSULATION AND JACKETING

GENERAL

Insulation and jacketing shall be provided on all piping and valves with surface temperatures above 140F. Insulation and jacketing shall also be provided on all piping and valves that are subject to freezing conditions after heat tracing has been installed to prevent freezing when not in operation or during intermittent service. Use of asbestos containing materials is not allowed.

SUMMARY

Specifier – Add discussion of project scope and criteria that must be addressed

APPLICABLE CODES AND STANDARDS

1. ASTM C547 – Standard Specification for Mineral Fiber Pipe Insulation
2. ASTM C335 – Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation
3. ASTM E96 – Standard Test Method for Water Vapor Transmission of Materials
4. ASTM C195 – Standard Specification for Mineral Fiber Thermal Insulating Cement
5. ASTM C449 – Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
6. ASTM C552 – Standard Specification for Cellular Glass Thermal Insulation
7. ASTM C578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
8. ASTM C610 – Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
9. ASTM C533 – Standard Specification for Calcium Silicate Bolck and Pipe Thermal Insulation
10. ASTM C177 -
11. ASTM C518 -
12. ASTM C547 – Standard Specification for Mineral Fiber Insulation
13. ASTM C612 – Standard Specification for Mineral Fiber Block and Board Thermal Insulation
14. ASTM C591 -
15. ASTM D2842 -
16. ASTM E84 -

17. ASTM D1056 -
18. ASTM D1667 -
19. ASTM C177 -
20. ASTM C921 -
21. ASTM B209 -
22. ASTM A36 -
23. ASTM C 1728 – Standard Specification for Flexible Aerogel Insulation

TECHNICAL REQUIREMENTS

Specifier – Add discussion of options and criteria that must be addressed

B.1 PIPING INSULATION

B.1.1 Qualifications

Applicator: Company specializing in performing the work of this Section with minimum 3 years experience.

B.1.2 Glass Fiber

Vendors:

- Johns Manville Model AP-T, or Company-approved equal
- Other acceptable vendors offering equivalent products:

Armstrong

Knauf

Owens Corning

Insulation: ASTM C547; rigid molded, non combustible.

- 'K' ('ksi') value : ASTM C335, 0.24 at 75°F
- Minimum Service Temperature: -20°F
- Maximum Service Temperature: ?
- Maximum Moisture Absorption: 0.2% volume

Vapor Barrier Jacket:

- White craft paper reinforced with glass fiber yarn and bonded to aluminized film.
- Moisture Vapor Transmission: ASTM E96; 0.02 perm.
- Secure with self sealing longitudinal laps and butt strips.
- Secure with outward clinch expanding staples and vapor barrier mastic.

All tie wires shall be 18-gauge stainless steel with twisted ends on maximum 12 inch centers.

The vapor barrier lap Adhesive shall be compatible with insulation.

Insulating Cement/Mastic:

- ASTM C195; hydraulic setting on mineral wool

Fibrous Glass Fabric:

- Cloth Weight: Untreated; 9 ounces per square yard (305 g/sq m)
- Blanket Density: 1.0 pounds per cubic foot (16 kg/cu m)

Indoor Vapor Barrier Finish:

- Vinyl emulsion type acrylic, compatible with insulation, white color

Outdoor Vapor Barrier Mastic:

- Vinyl emulsion type acrylic, compatible with insulation, white color

Insulating Cement:

- ASTM C449.

B.1.3 Cellular Glass

Vendors:

- Johns Manville or Company approved equal

Insulation: ASTM C552.

- 'K' ('ksi') value: 0.40 at 75°F
- Maximum Service Temperature: ?ASTM C552 indicates up to 800F?
- Maximum Water Vapor Transmission: 0.1 perm

B.1.4 Expanded Polystyrene

Vendors:

- Owens Corning or approved equal

Insulation: ASTM C578; rigid closed cell:

- 'K' ('ksi') value: 0.23 at 75°F
- Maximum service temperature: 180°F
- Maximum Water Vapor Transmission: 0.1 perm

B.1.5 Expanded Perlite

Vendors:

- Company Approved

Insulation: ASTM C610; granular poured

- 'K' ('ksi') value: 0.28 at 75°F
- Maximum Service Temperature: ?
- Maximum Water Vapor Transmission: 0.1 perm

B.1.6 Hydrous Calcium Silicate

Vendors:

- Johns Manville or Company-approved equal

Insulation: ASTM C533; rigid molded white; asbestos free

- 'K' ('ksi') value: ASTM C177 and C518; 0.44 at 300°F (0.060 at

147°C)

- Maximum Service Temperature: 1,500°F (815°C)
- Density: 13 pounds per cubic foot (208 kg/cu m)

All tie wires shall be 18-gauge stainless steel with twisted ends on maximum 12-inch centers.

Insulating Cement:

- ASTM C449

B.1.7 Mineral Fiber

Vendors:

- Certain Teed
- Eslin
- Company approved equal

Insulation:

- For pipe, ASTM C547, molded; for block ASTM C612, Class 3 with a density of 8 to 12 pounds per cubic foot.
- Maximum Service Temperature 1,200°F

All tie wires shall be 18-gauge stainless steel with twisted ends on maximum 12 inch centers.

B.1.8 Aerogel

Vendors:

Aspen Aerogel

Insulation:

ASTM C 1728

Maximum Service Temperature 1,200°F

Tie Wire:

18-gauge stainless steel on maximum 12-inch centers

B.1.8 Polyurethane Foam

Vendors:

- Company Approved

Insulation:

- ASTM C591, rigid molded modified polyisocyanurate cellular plastic.
- 'K' ('ksi') value: ASTM 518; 0.14 at 75°F
- Minimum Service Temperature: -250°F
- Maximum Service Temperature: 250°F
- Maximum Moisture Absorption: ASTM D2842; 0.054% by volume
- Moisture Vapor Transmission: 1.26 perm
- Maximum Flame Spread: ASTM E84; 20
- Connection: Waterproof vapor barrier adhesive

B.1.9 Polyethylene

Vendors:

- Company Approved

Insulation:

- ASTM D1056 or D1667; flexible, closed cell, polyethylene, slit tubing.
- 'K' ('ksi') Value: ASTM C177; 0.25 at 75°F
- Minimum Service Temperature: -90°F
- Maximum Service Temperature: 212°F
- Density: ASTM 1667; 2 pounds per cubic foot (32 kg/cu m)

- Maximum Moisture Absorption: 1.0% by volume
- Moisture Vapor Transmission: ASTM E96; 0.01 perm
- Maximum Flame Spread: ASTM E84; 25
- Maximum Smoke Developed: ASTM E84; 50
- Connection: Contact adhesive

B.1.10 Cellular Foam

Vendors:

- Company Approved

Insulation:

- ASTM C534; flexible, cellular elastomeric, molded or sheet
- 'K' ('ksi') Value: ASTM C177 or C518; 0.27 at 75°F
- Minimum Service Temperature: -40°F
- Maximum Service Temperature: 220°F
- Maximum Moisture Absorption: ASTM D1056; 1.0% (pipe) by volume, 1.0% (sheet) by volume
- Moisture Vapor Transmission: ASTM E96; 0.20 perm inches
- Maximum Flame Spread: ASTM E84; 25
- Maximum Smoke Developed: ASTM E84; 50
- Connection: Waterproof vapor barrier adhesive

Elastomeric Foam Adhesive:

- Air-dried, contact adhesive, compatible with insulation.

B.1.11 Jackets

PVC Plastic:

- Jacket: (ASTM C921) One (1) piece molded type fitting covers and

sheet material:

- Minimum Service Temperature: -40°F
- Maximum Service Temperature: 150°F
- Moisture Vapor Transmission: ASTM E96; 0.002 perm inches
- Maximum Flame Spread: ASTM E84; 25
- Maximum Smoke Developed: ASTM E84; 50
- Thickness: 30 mil
- Connections: Pressure sensitive color matching vinyl tape
- Cover Adhesive Mastic:

Compatible with insulation

ABS Plastic:

- Jacket: One piece molded type fitting covers and sheet material:

Minimum Service Temperature: -40°F

Maximum Service Temperature of 180°F

Moisture Vapor Transmission: ASTM E96; 0.012 perm

Thickness: 30 mil

Connections: Brush on welding adhesive

- Canvas Jacket: UL listed:

Fabric: (ASTM C921) 6 ounces per square yard (220 g/sq m), plain weave cotton treated with dilute fire retardant lagging adhesive.

Lagging Adhesive:

- Compatible with insulation

- Aluminum Jacket: ASTM B209:

Thickness: 0.020 inch for applications up to 13 inch outside diameter, and 0.024 inch for all other applications.

Finish: Stucco embossed

Joining: Longitudinal slip joints and 2-inch (50-mm) laps

Metal Jacket Bands: 3/8 inch (10 mm) wide, stainless steel

B.1.12 Examination

Verify that piping has been tested before applying insulation materials except for systems approved for initial service test in which case joints shall be exposed.

Verify that surfaces are clean, foreign material removed, and dry.

B.1.13 Installation

Install insulation type and thickness as specified on drawings.

Install materials in accordance with vendor's instructions.

On indoor exposed piping, locate insulation and cover seams in least visible locations.

Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature shall be insulated per following requirements:

- Provide vapor barrier jackets, factory applied or field applied.
- Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
- Finish with glass cloth and vapor barrier adhesive.
- PVC fitting covers may be used.
- Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
- Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

- Outdoor cold pipe insulation shall be protected with paint or lagging in accordance with Manufacturer's recommendations.
- Insulate cold pipes with elastomeric cellular thermal insulation.

Insulated pipes conveying fluids above ambient temperature shall be insulated per following requirements:

- Provide standard jackets, with or without vapor barrier, factory applied or field applied.
- Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Insulate with either molded insulation or by insulation fabricated from straight pipe insulation segments.
- Finish with glass cloth and adhesive.
- Provide aluminum lagging.
- For hot piping conveying fluids 140°F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- For hot piping conveying fluids over 140°F, insulate flanges and unions at equipment. Use calcium silicate molded insulation, molded mineral fiber insulation, or high density fiberglass rigid molded insulation.

Inserts and Shields:

- Application: Piping 2 inches diameter or larger.
- Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
- Insert Location: Between support shield and piping and under the finish jacket.
- Insert Configuration: Minimum 6 inches (150 mm) long, of same

thickness and contour as adjoining insulation; may be factory fabricated.

- Insert Material: Heavy density insulating material suitable for the planned temperature range.

Finish insulation at supports, protrusions, and interruptions.

For pipe exposed in finished spaces below 10 feet above finished floor, that require insulation finish with PVC jacket and fitting covers.

For exterior applications, provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side 45 degrees off center of horizontal piping. Installation shall protect insulation from the weather. All lagging shall be secured in place using panhead self-tapping screws fitted with neoprene washers. In addition to screws, outdoor lagging shall be secured by machine-attached stainless steel bands spaced on not greater than 24 inch centers

For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil (0.025 mm) thick aluminum foil sandwiched between three (3) layers of bituminous compound; outer surface faced with a polyester film.

For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum or stainless steel jacket with seams located on bottom side of horizontal piping. Provide permanent labels identifying line as heat traced visible from access ways at no greater than 20 foot intervals.

Blocks shall be reinforced on the exterior face with expanded metal, if necessary, to prevent sagging or cutting of insulation by lacing wire.

Vertical runs of piping shall utilize support lugs and collars to prevent slippage of the insulation.

All areas of contact between dissimilar metals shall be protected against galvanic corrosion by a suitable insulating coating.

All lagging on curved surfaces shall be machine rolled and formed to fit the insulation curvatures. All joints shall be lapped a minimum of 2 inches and placed to shed water.

Install insulation material and thickness per the drawings.

Top surfaces which are insulated and which could be subject to foot traffic shall also be capable of withstanding a live load of 100 lb/ft^2 without suffering permanent deformation.

No oil or lubrication piping, nor valves or fittings thereof shall be embedded in insulation or covered over with removable panels, flashing, etc.

Insulation of all surfaces shall be applied in two (2) layers using staggered joint construction.

All insulation shall be installed free of gaps and voids.

All insulated and metal lagged surfaces shall be completely water and weather tight, and shall be completely drainable with horizontal surfaces sloped.

Insulation materials shall be inhibited and have low halogen content. Insulation materials shall contain no asbestos.

Antisweat insulation shall be flexible elastomeric cellular thermal insulation. Outdoor antisweat insulation shall be protected with paint or lagging in accordance with the Manufacturer's recommendations.

Piping and small diameter cylindrical equipment insulation shall be hollow cylindrical shapes split in half lengthwise, or curved segments. Large diameter cylindrical equipment and other items of equipment shall be insulated with block or scored block insulation as required to obtain a close fit to the contour. Pipefittings and accessories shall be insulated using either molded insulation or by insulation fabricated from straight pipe insulation segments. Fittings on piping 4 inches and smaller shall be insulated with a fiberglass blanket, where permissible by system temperature, and then covered with preformed lagging.

Methods of fastening insulation, metal lagging, flashing, etc., shall prevent rattling and shall be structurally adequate so that forces due to expansion and contraction, vibration, wind, weight of insulation and lagging or other normal loads shall not loosen or break fasteners.

Spacing of fasteners shall be in a set pattern, both horizontally and vertically, forming straight lines, and shall be placed in order to prevent rattling of the panels or flashing vibration. Any areas of the insulation and metal lagging system noted by the Company to not meet this requirement shall be reworked at the sole cost to the Contractor.

All insulated surfaces of piping and valves shall be lagged except where antisweat insulation is used.

Except as otherwise specified herein, metal lagging for all walls shall be a minimum of 0.040-inch thick, with box-ribbed 4 inches center-to-center, 1 inch depth, ribbed aluminum type 3004.

Except as otherwise specified herein, metal lagging for all roofs and horizontal surfaces shall be a minimum of 0.050 inch thick, with box-ribbed, 4 inches center-to-center, 1 inch depth, ribbed aluminum type 3004.

Flashing and flat lagging, where required in panel work, shall be a minimum of 0.050 inch thick aluminum, type 3003, Alclad.

Outdoor lagging shall be installed to secure a weatherproof installation. Lagging shall be carefully fabricated and fitted to ensure a neat appearance. Open ends of all fluted sections shall be provided with tight-fitting closure pieces.

Removable insulated covers shall be provided over equipment requiring normal maintenance and all equipment manholes, nameplates, and code stampings. Access doors through lagging shall be provided as required.

The finish of all aluminum lagging shall be stucco embossed.

Structural Support Members:

- Structural steel shapes such as angles or Z-sections shall be constructed of ASTM A36 material.
- All hat sections shall be a minimum of 12-gauge aluminized steel.

Fasteners:

- Weld pins shall be 10-gauge capacitor discharge pins, 10-gauge carbon steel or type 304 stainless steel stored arc pins, lengths to suit.
- Insulation clips (speed washers) shall be 2 1/2 inch square for use with 10-gauge weld pins. Clips shall be carbon steel, except that type 304 stainless steel clips only shall be used on type 304 weld pins.
- The option exists of using cup head weld pins meeting the material specifications stated in the preceding two (2) paragraphs in place of pins and clips.
- Welded stud fasteners shall be end weld studs; 1/2 inch diameter by lengths required each with hex nut and standard washer.
- Screwed fasteners shall be No. 14 self-tapping, 410 cadmium plated stainless steel screws and neoprene sealing washers with a

minimum length of 3/4 inch. The washer material shall not stain the lagging material due to environmental or operating conditions and shall not deteriorate due to heat and vibration transferred through the screw from the ductwork or collector.

- The use of “pop” type rivets is not acceptable.
- No welding, pop rivets or friction fasteners shall be allowed for attachment of shop-fabricated panels or field-installed system.
- Any powder actuated or similar device to forcibly impact construction fasteners into the collector, ductwork, or insulation support stiffeners shall not be permitted.

Miscellaneous:

- Galvanized wire mesh shall be used for insulation backing. Mesh shall be 16-gauge, 2 inches by 2 inches, and shall be galvanized after forming.
- Aluminum foil backing for insulation systems shall be 0.0025 inch thick aluminum.
- Material for all siding closure strips shall be Ethylene-Propylene-Diene-Monomer (EPDM).
- Caulking and mastic for weatherproofing outdoor penetrations, laps, etc., shall be Childers, Chil-Joint CP-70 or Company-approved equal. All mastics shall bear the UL label.

Penetration Covers:

- Cover plates, boots, hoods, or flashing required because of penetrations for mechanical components, tubing or piping; and electric devices or conduit, shall be furnished and constructed of materials which are compatible with the specified insulation and metal lagging system.

- All hanger rods, pipes, or other items penetrating any of the insulation and metal lagging systems shall be provided with cover plates, boots, hoods, or flashing to prevent water from penetrating into the installed insulation and so none of the insulation is visible.
- All exterior instrument taps, test connection and other lagging penetrations shall be sealed using a flexible rubber boot seal to prevent the ingress of water. These flexible rubber boot seals shall be manufactured by Sealite Building Fasteners, Tyler, TX (800-352-4864), Construction Fasteners, Inc., Wyomissing, PA (800-CFI-4533) or Company-approved equal.

Insulation Classes for Piping:

- Insulation shall be designed for conditions of 75°F ambient, emissivity of 0.09, no incident solar heating, and 2 mph airflow velocity for a calculated surface temperature of 140°F. Additional insulation shall be provided as necessary to provide freeze protection.

TABLE OF PIPING INSULATION MINIMUM THICKNESS										
	Temperature Range °F									
Pipe Size	100-199	200-299	300-399	400-499	500-599	600-699	700-799	800-899	900-999	1000-1150
1 1/2 inch and Smaller	1	1 1/2	1 1/2	2	2	2	2	2 1/2	2 1/2	3
2 inch	1	1 1/2	1 1/2	2	2-	3	3	3	3	3 1/2
2 1/2 inch	1	1 1/2	1 1/2	2	2	3	3	3 1/2	4	4 1/2
3 inch	1	1 1/2	1 1/2	2	2	3	3	3 1/2	4	4 1/2
4 inch	1	1	1	2	2	3	3	3	4	4 1/2

		1/2	1/2					1/2		
6 inch	1	1 1/2	2	2	2 1/2	3	3	3 1/2	4 1/2	5
8 inch	1 1/2	1 1/2	2	2	2 1/2	3	3	4	5	5
10 inch	1 1/2	1 1/2	2	2 1/2	3	3 1/2	3 1/2	4	5	5
12 inch and Larger	1 1/2	1 1/2	2	2 1/2	3	3 1/2	3 1/2	4	5	5

Lagging Material and Thickness

Piping	0.02 inch aluminum
Valves and fittings	0.02 inch aluminum

The insulation and lagging system shall be designed for upset temperature conditions for periods of 1 hour shall be considered in the insulation and lagging system design for expansion and contraction, as well as to service limitations and insulation used.

The insulation, lagging, and sub-girt system shall be arranged to accommodate thermal expansion of insulated surfaces so all surfaces are effectively insulated whether in the hot or cold position. The system shall be arranged so as to prevent crushing and distortion of the insulation and lagging due to expansion and contraction of the equipment.

Thermal barriers (flue stops) shall be installed between all vertically oriented stiffeners at a maximum spacing of every 5 feet and at the top of all vertical runs. The barriers shall consist of the same type of insulation as used for the overall application, suitably supported by minimum 16-gauge steel plates welded between the stiffeners. The height of the thermal barriers shall be a minimum of 3 inches. The thermal barrier shall completely fill the gap between the insulation and the surface being insulated.

The insulation for piping accessories shall be of the same class as is indicated for the piping. Insulation materials for miscellaneous piping and equipment shall be suitable for the actual operating temperatures and shall be of the same insulation class as insulated main piping and equipment operating under similar temperatures.

B.1.14 Tolerance

Substituted insulation materials shall provide thermal resistance within 10% at normal conditions, as materials indicated.

APPENDICES TO SPECIFICATION

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.
****

1. PROPOSAL DATA REQUIREMENTS
2. DELIVERABLES (Documentation After Award)
3. PERFORMANCE GUARANTEES
4. SITE CONDITIONS AND REFERENCE MATERIALS
5. QA/QC (Including Inspection Test Plans)
6. STARTUP, TESTING, AND COMMISSIONING
7. PACKAGING, SHIPPING, AND STORAGE
8. ACCEPTABLE SUPPLIERS

APPENDICES

APPENDICES TO SPECIFICATION

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.
****

1. PROPOSAL DATA REQUIREMENTS
(To be inserted in the Bid Form)

PIPING AND VALVES INSULATION AND JACKETING

Manufacturer shall provide the following data applicable to the equipment in the proposed scope of supply.

DATA SHEETS			
INSULATION AND JACKETING			
Contractor Name & Address			
Project			
Facility Location			
Delivery Date			
	UNITS	REQUIRED	SUPPLIER RESPONSE
MSDS Forms for all Supplied Materials			

2. DOCUMENTATION AFTER AWARD
(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule B)

Seller's Data Submission Schedule

Specifier – Add discussion of options and criteria that must be addressed

Documentation

Specifier – Add discussion of options and criteria that must be addressed including drawings, parts lists, O&M manuals

The Contractor shall provide a complete listing of the insulation installed by line, and indicating the material and thickness utilized. Copies of applicable MSDS sheets shall be provided.

PERFORMANCE GUARANTEES

(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule #)

Specifier – Add discussion and criteria that must be addressed, include Acceptance Criteria

The installation shall maintain specified surface temperature under operating conditions with no indications of hot spots. Areas not meeting criteria will be reinsulated by the Contractor.

SITE AND AMBIENT CONDITIONS AND REFERENCE MATERIALS
(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule #)

Specifier – Add discussion and criteria that must be addressed along with drawings of the piping and valves to be insulated and a Table of design temperatures to be insulated to.

Maximum Temperature, F	
Minimum Temperature, F	
Humidity Range	
Site Elevation, ft	
Seismic Design Criteria	

Drawing List

Line List

Pipe Line	Design Temperature, F

QUALITY ASSURANCE

(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule #)

Specifier – Add discussion and criteria that must be addressed

3. STARTUP, TESTING, AND COMMISSIONING
(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule #)

Specifier – Add discussion and criteria that must be addressed

May be Not Applicable

4. PACKAGING, SHIPPING, AND STORAGE
(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule #)

Specifier – Add discussion and criteria that must be addressed with regard to storage and weather protection requirements.

5. ACCEPTABLE SUPPLIERS
(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule #)

Specifier – Add discussion and criteria that must be addressed

Insulation

Glass Fiber
Johns Manville Model AP-T
Knauf
Armstrong
Owens Corning
Cellular Glass
Johns Manville
Expanded Polystyrene
Owens Corning
Hydrous Calcium Silicate
Johns Manville
Mineral Fiber
Certain Teed
Aerogel
Aspen Aerogel

Jacketing

MASTER SPECIFICTION
FOR
Pre-Engineered Metal Building

Revision 1.0

REVISION HISTORY

Date	Revision	Change Description
3-4-2015	1.0	New

Pre-Engineered Metal Building

GENERAL

DEFINITIONS

Contractor/Bidder - The company proposing to supply, deliver, and erect a pre-engineered metal building matching the bid requirements of this specification.

Company - Xcel Energy, the Owner of the Equipment.

SUMMARY

Introduction

This is a specification for the minimum requirements for the supply, delivery, and erection of a pre-engineered metal building. The building and building components will be delivered to _____ per the provided Scope of Work and design documents. The building will be erected at the facility by _____. The foundation for the building will be provided by others utilizing design loads generated from the structural analysis as outlined in this specification. The certified building design loads will be provided to the Company by _____.

Specifier – The typical pre-engineered building is a metal building utilizing structural components noted below in Design Requirements. The building is dimensioned from architectural drawings provided by the Company. The same architectural drawings should include a code analysis completed by a registered architect which addresses all design occupancy requirements.

The supply and delivery of the pre-engineered building is by a sub-contractor to the general contractor capable of purchasing and erecting the metal building system. The general contractor may also be responsible for construction of the building foundation. The foundation design will be based on loads generated by the pre-engineered building structural analysis. This will require the contract for the building to be in-place prior to the design and construction of the foundation.

The building general contractor is determined from a best evaluated proposal based on this specification and thecorresponding architectural drawings. This package is provided by the Company.

This specification does not direct procurement and construction of the foundation. However, foundation design is dependant on the completion of the building's final design.

Scope Description

Contractor shall provide all materials for a complete pre-engineered metal building to include:

1. Pre-engineered, shop fabricated structural steel building frame, girts, purlins, and wind bracing.

2. Metal wall and sloped roof system including gutters, downspouts, and trim.

3. Framed openings for doors, windows, louvers, overhead doors, and miscellaneous openings for penetrations of equipment through the walls or roofs, including roof curbs.

4. Windows, frames, trim, and hardware. Fire rated where indicated on the drawings.

5. Exterior doors, frames, hardware, and trim.

6. Base angles, closures, flashings, sealants, trim, interior liner panels when required, and other miscellaneous metal building components, fasteners, or accessory items as required for a complete installation.

7. Batt insulation at wall and roof systems.

Specifier – Viable alternate insulation systems includes foam filled panels. The advantage to this type panel is ease of installation.

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8. Louvers with screens and hardware.

9. Skylight (translucent) panels.

APPLICABLE CODES AND STANDARDS

Applicable Codes and Standards

A. AISC - “Specification for Structural Steel for Buildings - Allowable Stress Design and Plastic Design”

B. AISC - Quality Certification Program, Category MB

C. ANSI A117.1 - Specifications for Making Buildings and Facilities Accessible To and Usable By Physically Handicapped People

D. ANSI A156.1 - Builders Hardware Manufacturers Association

E. ANSI/SDI-100 - Standard Steel Doors and Frames

F. ASCE 7-10 - Minimum Design Loads for Buildings and Other Structures

G. ASTM A36/A36M - Structural Steel

H. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

I. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware

J. ASTM A283/A283M – Low and Itermediate Tensile Strength Carbon Steel Plates

K. ASTM A325/A325M - High Strength Bolts for Structural Steel Joints

L. ASTM A446/A446M - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality

M. ASTM A525/A525M - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

N. ASTM A572/A572M – High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality

O. ASTM A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron-Alloy Coated (Galvannealed) by the Hot-Dip Process

P. ASTM C991 - Flexible Glass Fiber Insulation for Pre-Engineered Metal Buildings

Q. ASTM C1107 - Packaged, Dry, Hydraulic-Cement Grout (Non-shrink).

R. ASTM F1554 – Anchor Bolts, Steel, 36, 55, And 105 ksi Yield Strength

S. AWS A2.0 - Standard Welding Symbols

T. AWS D1.1 - Structural Welding Code – Steel

U. IBC – International Building Code

V. Door Hardware Institute (DHI) - The Installation of Commercial Steel Doors in Steel Frames, Insulated Steel Doors in Wood Frames, and Builder's Hardware

W. MBMA (Metal Building Manufacturers Association) - Metal Building Systems Manual, "Code of Standard Practices", and "Design Practices" Manual.

X. NFPA 80 - Fire Doors and Windows

Y. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual

Z. UL - Building Materials Directory - Roof Deck Construction

TECHNICAL REQUIREMENTS

Design Requirements

A. Structures and their members, components, and covering shall be designed in accordance with the International Building Code, AISC Allowable Stress Design, and Factory Mutual Loss Prevention Data, except where exceeded by other provisions of this document. The following loads shall be used for designing each structure as a minimum:

1. Roof Dead Load: Weight of the metal building system such as roof, framing, panels and other permanently attached construction.

2. Collateral Load: all additional dead loads, other than the weight of the metal building system, shall be a uniform load of at least 25 psf acting vertically on the horizontal projection

of the roof. Higher collateral loads may be indicated on design drawings. Additional concentrated equipment loads will be indicated on the drawings.

3. Roof Live Load: Loads induced by the use and occupancy of the building, not including wind load, snow load, seismic load, collateral load, or dead load. Minimum roof live load shall be 20 psf.

4. Elevated Floor Live Load: 100 psf.

5. Roof Snow Load: Compute snow loads in accordance with ASACE 7-10 and a snow importance factor of 1.10.

6. Seismic Load: Compute seismic forces in accordance with ASCE 7-10 and a seismic importance factor of 1.25.

7. Wind Load: Wind loads shall be computed in accordance with ASCE 7-10 for a Risk Category III. Account for building openings as appropriate.

B. Installed door assemblies should conform to NFPA 80 for fire rated class as scheduled in design drawings.

C. The basic design loads shall be applied and combined as specified in ASCE 7-10.

D. Gutters and downspouts shall be designed for a rainfall intensity of 4 in/hr applied for a duration of 5 minutes.

E. Auxiliary loads: Dynamic loads resulting from cranes, material, and material handling systems. Compute impact loads as a percentage of static loads:

Cranes – compute per ASCE 7-10.

Light machinery shaft or motor driven - 20%

Rotating and Reciprocating machinery - 50%

Hangers for floor - 33%

F. Size and fabricate wall and roof systems to be free of distortion or defects detrimental to appearance or performance.

G. The roof covering system design shall provide for thermal expansion joints. Design of expansion joints shall be as recommended by the building Manufacturer.

H. Lateral stability shall be obtained by pinned base rigid frames in one direction and braced bays in the other. Special bracing systems are allowed when diagonal bracing is not permitted in the plane of the sidewalls.

I. Calculations for deflection shall be done using only the bare frame method. Reductions based on engineering judgment using the assumed composite stiffness of the building envelope will not be allowed. Drift shall be limited to H/180.

J. Design and detail base plates to transfer lateral loads into the foundation with properly sized shear lugs. Transfer of lateral loads into the foundation with friction between the plate and the concrete surface shall be subject to Company approval.

K. Girts shall be designed to resist wind forces with a maximum deflection of 1/240 of the span. Roof framing shall be designed to deflect no more than 1/180 of the span when subjected to combined collateral and live loads.

L. Deflection of the roof panels shall not exceed 1/180 of a span when supporting a 200 pound concentrated load over a one square foot area or a 50 pound per square foot, uniformly distributed load.

Specifier – Design Requirement Section J. requires shear lugs to resist lateral reactions at the base plate. For a rigid framed structure, these loads can be significant especially when the column is subject to uplift. Proerly pretension anchors can resist the lateral loads through friction between the baseplate and the foundation. This alternate requires a full analysis by the building designer and should be subject to Company approval.

APPENDICES TO SPECIFICATION

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.
****

1. **DELIVERABLES**
2. **PROPOSAL DATA REQUIREMENTS**
3. **PERFORMANCE GUARANTEES**
4. **SITE CONDITIONS AND REFERENCE MATERIALS**
5. **QA/QC (Including Inspection Test Plans)**
6. **STARTUP, TESTING, AND COMMISSIONING**
7. **PACKAGING, SHIPPING, AND STORAGE**

1. DELIVERABLES

Submittals for Review

A. Product Data: Provide data on profiles, component dimensions, fasteners, and finishes.

B. Shop Drawings: Indicate assembly dimensions, locations of structural members, and openings; indicate wall and roof system dimensions, panel layout, general construction details, anchorages, and methods of anchorage; indicate method of panel and flashing installation and details for sealing watertight; indicate anchor bolt settings, requirements, and sizes; indicate anchor bolt locations from datum and foundation loads; indicate welded connections with AWS A2.0 welding symbols, including net weld lengths; provide professional seal and signature of an Engineer licensed to practice in the State of xxxxxxx.

Specifier – Building codes will require design data for building systems manufactured in a different location other than the final destination to be certified by an engineer registered in the State of the final erected location.

C. Samples: Submit two samples of pre-coated metal panels for each color selected, in 12 inch x 12 inch size, illustrating color and texture of finish. Also submit two samples of metal trim illustrating color and texture of finish. Panels and trim will be required to match existing buildings.

D. Submit complete design analysis calculations for all structural components for review. Calculations shall include lateral drift values for gravity loads and wind loads. Calculations shall be submitted with the shop drawings and shall bear the seal and signature of an Engineer licensed to practice in the State of xxxxxx. Foundation loads and foundation requirements shall be included with the calculation package.

E. Manufacturer's Instructions: Indicate foundation preparation requirements including shear lug and anchor bolt placement.

F. Erection Drawings: Indicate members by label, assembly sequence, and temporary erection bracing.

G. Foundation Load Drawings.

2. PROPOSAL DATA REQUIREMENTS

Specifier – Attachment to be subject to overall Project criteria.

3. PERFORMANCE GUARANTEES

Special Warranties

A. Provide a 20 year warranty to include coverage for exterior pre-finished surfaces and color coat against chipping, cracking or crazing, blistering, peeling, chalking, or fading. Warrant the roof panels will remain free from rupture, structural failure, or perforation due to corrosion under operating atmospheric conditions for a period of 10 years. The pre-engineered building Manufacturer will, during this period and at no additional cost to the Owner, provide labor and materials necessary to replace defective roof and wall panels. The total liability of the pre-engineered building Manufacturer for replacement of defective material shall not be limited during this period of this warranty.

B. Weather Tightness Warranty: Upon final acceptance of the project, the pre-engineered building Manufacturer shall furnish a warranty against defects in materials and workmanship for a period of 10 years. The pre-engineered building Manufacturer will during this period, and at no additional cost, maintain the installed work in a watertight condition and correct any defects which may develop as a result of operating atmospheric conditions in a manner which will restore the work to a leak-proof and/or comparable condition to that at the date of final acceptance of the project. The total liability of the pre-engineered building Manufacturer for replacement of defective materials or correction of defective workmanship shall not be limited during the period of this warranty.

C. A specimen copy of all warranties must accompany the bid, clearly stating the conditions under which the warranties are valid.

4. SITE CONDITIONS AND REFERENCE MATERIALS

PRODUCTS

Manufacturers – Building System

A. Ceco

B. Butler

C. Varco Pruden

D. Other Manufacturer's offering equivalent products subject to approval by the Owner and Owner's Engineer and subject to conformance with the specifications.

Materials - Framing

A. Structural Steel Members: ASTM A36, ASTM A572, ASTM A992 (Grades 42 and 50)

B. Plate or Bar Stock: ASTM A36 or ASTM A283 (Grades D)

C. Anchor Bolts / rods: ASTM F1554 (Grades 36, 55 including S1 supplementary requirements, 105), compatible nuts and washers galvanized to ASTM A153, Class C

D. Steel-to-steel Bolts, Nuts, and Washers: ASTM A325, ASTM A563, Grade DH, ASTM F436, Type 1 respectively, galvanized to ASTM A153, Class C

E. Welding Materials: AWS D1.1; type required for materials being welded

Materials – Wall and Roof System

A. Sheet Steel Stock: ASTM A446 Grade B, with 1 1/4 ounce galvanized coating. Minimum material thickness shall be 24 gauge for roofs and walls. Wall panels shall be approximately 36 inches wide. Configuration of panels shall be Manufacturer's standard nominal 1 1/2 inch deep profile. Wall panels shall be embossed.

B. Liner Panels: Full height liner panels shall be minimum 26 gauge, galvanized, roll formed, modular 16 inch wide units, with factory applied thermosetting enamel finish in standard colors. Panels shall be furnished with all required bases, eave trim, ceiling cove, girt covers, and trim at doors and windows.

C. Roof Panels: Roof panels shall be a standing-seam interlocking design with exposed fasteners at end laps only. Roof panel design shall allow for thermal expansion and contraction through the use of concealed

floating clips. Finish shall match wall panels, except that roof panels are non-embossed.

D. Roof Insulation: Insulation at the roof shall be reinforced white vinyl faced glass fiber insulation with a UL label, flame spread rating, of 25 or less. Thermal spacers shall be provided at each purlin. Insulation shall have a minimum R-value of 19.

C. Wall Insulation: Insulation at the walls shall be reinforced white vinyl faced glass fiber insulation with a UL label, flame spread rating, of 25 or less. Insulation to have a minimum R-value of 19.

D. Joint Seal Gaskets: Manufacturer's standard type.

E. Fasteners: Manufacturer's standard type, galvanized to ASTM A153 2.0 ounces per square foot, finish to match adjacent surfaces when exterior exposed. Use neoprene washers at exposed fasteners.

F. Metal Mesh: Galvanized steel wire, woven.

G. Trim, Closure Pieces, Caps, Flashings, Gutters, Downspouts, Corners: Same material, thickness, and finish as exterior sheets; brake formed to required profiles and coated to match existing buildings.

H. Closures: Provide sealing enclosures at top and bottom of all panels and where otherwise indicated or required. Sealing enclosures shall consist of brake formed metal caps and compressible closure strips.

I. Roof Curbs: Provide in size, quantity, and structural capacity as indicated on the drawings. Curbs shall be shop fabricated from materials recommended by the Vendor in a finish compatible with the roof panels.

J. Manufacturer shall provide extra stock sheeting and components for replacement due to damage during construction and for minor design changes.

Doors, Door Frames, Door Hardware

A. Doors, door frames, door hardware to be provided with separate specifications. Doors to conform to with architectural drawings.

B. Overhead doors to be provided with separate specifications. Overhead doors to conform to architectural drawings.

Windows

A. Windows shall be EFCO Corporation Series 2500, thermal break of nominal sizes indicated on the drawings. The thermal barrier shall be poured-in-place two part polyurethane. The depth of frame and sash shall not be less than 2 inches. Frame components shall be mitered, reinforced with an extruded aluminum corner key, hydraulically crimped, and "cold

welded" with epoxy adhesive and extruded aluminum sub-sill, No. 1507 with flashing lip shall be furnished and installed. Finish shall be clear anodized to finish Specification AA-M10-C22-A31/41.

B. Aluminum frames and sash members shall be 6063 alloy, minimum 0.062 inch thick extrusions.

C. Glazing shall be 1/2-inch tinted insulating glass. Window manufacturer's extruded aluminum glazing bead with gasket used in conjunction with butyl tape and silicone cap seal (DC 795 or equal) by EFCO. Window may be factory glazed using wet glaze system with silicone backbed compound (GE SCS-2511) or equal.

Plastic Skylights

A. Provide fiberglass reinforced translucent plastic skylight panels to cover a percentage of the roof area indicated by architectural design drawings. Skylights shall form an integral part of the roof system and shall be covered by the same warranty provisions as the remainder of the roof.

Louvers – Manually Adjustable

A. Storm proof design of the sizes indicated on the drawings.

B. Frames: Rectangular, 3 inches deep, from 18 gauge galvanized steel, complete with integral lintel and sill.

C. Slats: Z-shaped, pivoted slats, which are spring loaded through linkage in closed position. Slats shall be fabricated from 20 gauge galvanized steel.

D. Screens: No. 4 galvanized hardware cloth in removable frame fabricated of 24 gauge galvanized steel, mounted on the inside of the louver.

E. Pivot pins, chain link holder, chain, coil spring, fasteners, etc., shall be the Manufacturer's standard hardware.

F. Fabrication and Material: Galvanized steel with 1.25-ounce zinc coating conforming to ASTM A525. Factory paints or anodized louvers and frames to match the building trim.

Fixed Louvers

A. Storm proof design of the sizes as indicated on the drawings.

B. Frames: Rectangular, 3 inches deep, fabricated from 18 gauge galvanized steel with integral lintel and sill.

C. Fixed Louver Blades: Storm-proof design, 20 gauge galvanized steel.

D. Screens: No. 4 galvanized hardware cloth in removable frame of 26 gauge galvanized steel, mounted on inside face of louver.

E. Fabrication and Material: Galvanized steel with 1.25-ounce zinc coating conforming to ASTM A525. Factory paint or anodize louvers and frames to match the building trim.

Fabrication - Framing

A. Fabricate members in accordance with AISC Specification for plate, bar, tube, or rolled structural shapes.

B. Anchor Bolts: Comply with ASTM F1554, fabricated and galvanized for casting into concrete. Sizing requirements, projection, etc. shall be stipulated by the Manufacturer, the foundation anchor bolts will be provided by the General Contractor. Allow adequate clearance beneath base plates for grout bed unless noted otherwise on drawings.

C. Provide framed openings for personnel doors, overhead doors, louvers, roof curbs, and mechanical penetrations. Penetrations for equipment shown on design drawings must be framed to support the vertical and lateral loads induced by the equipment. Flashing and support details shall not void the Manufacturer's warranties.

Fabrication – Wall and Roof System

A. Girts/Purlins: Rolled formed structural shape to receive siding and roofing.

B. Internal and External Corners: Same material thickness and finish as adjacent material, profile brake formed to required angles.

C. Flashings, Closure Pieces, and misc. trims: Same material and finish as adjacent material, profile to suit system.

D. Fasteners: To maintain load requirements and weather tight installation, same finish as cladding, non-corrosive type, compatible with drift limits of structure.

Fabrication – Gutters and Downspouts

A. Fabricate of prefinished metal, same finish as wall panels.

B. Form gutters and downspouts of Manufacturer's standard profile, sized according to rainfall intensity to collect and remove water. Fabricate with connection pieces.

C. Form sections in maximum possible lengths. Hem exposed edges. Allow for expansion at joints.

D. Fabricate support straps of 16 gauge material, same finish as roofing metal. Attach straps to eave member at a maximum spacing of 3 feet.

Finishes

A. Framing Members - Finish according to architectural design drawings and the following:

1. Clean and prepare to SSPC-SP2 requirements, and prime according to SSPC 15, type 1, red oxide, 2.0 mils DFT requirements for painted members. Apply final coat according to manufacturer's standards.

2. Prepare and galvanize according to ASTM A123 for galvanized members.

B. Exterior surfaces of Wall Panels, Roof Panels, Components and Accessories, shall be baked-on polyvinylidene fluoride with a minimum of 70% Kynar 500 by weight. Finish shall carry a twenty (20) warranty against crazing, chipping, cracking, peeling, and loss of color.

C. Interior Panel Finish: Paint with USDA-approved interior white polyester paint.

5. QA/QC (Including Inspection Test Plans)

Quality Assurance

A. Manufacturer Qualifications: Not less than 5 years experience in the actual production of specified products.

1. Member of the Metal Building manufacturer's Association (MBMA).

2. Primary manufacturer of frames, secondary steel, roof and wall sheeting, and trim.

B. Installer/Erector Qualifications: Firm experienced in application or installation of systems similar in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer.

2. 3 year experience with systems.

3. Sucessfully completed not less than 5 comparable scale projects using similar systems.

C. Mock up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship:

1. Finish areas designated by architect.

2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.

3. Refinish mock-up area as required to produce acceptable work.

6. STARTUP, TESTING, AND COMMISSIONING

EXECUTION

Examination

A. Verify that foundation, floor slabs, mechanical and electrical utilities, and placed anchors are in the correct location. Discrepancies in this work shall be corrected before execution of the erection of the building is started. Commencement of erection represents acceptance of existing conditions.

Erection - Framing

A. Erect framing in accordance with AISC Specification.

B. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of erection and installation of permanent bracing.

C. Set column base plates and shear lugs with non-shrink grout to achieve full plate bearing.

D. Do not field cut or alter structural members without approval of the Manufacturer and the Owner.

E. After erection, prime welds, abrasions, and surfaces not shop primed, and clean all surfaces. Clean galvanized welds and coat with Sherwin-Williams Zinc Clad 5 or approved equal.

Erection – Wall and Roof Systems

A. Install in accordance with Manufacturer's instructions. Install roof and wall insulation with the white vinyl vapor barrier towards the building interior and in accordance with the Manufacturer's recommendations.

B. Exercise care when cutting prefinished material to ensure cuttings do not remain on finish surface. Stained or marred panels will require replacing.

C. Fasten cladding system to structural supports, aligned level and plumb.

D. Roof panels shall be continuous from ridge to eave, except where indicated otherwise. Laps are acceptable only for spans longer than 40 feet.

E. Locate end laps over supports. End laps shall be a minimum 6 inches.

F. Install sealant and gaskets to prevent weather penetration.

Erection – Gutter and Downspout

A. Rigidly support and secure components. Join lengths with formed seams sealed watertight. Flash and seal gutters to downspouts.

B. Apply bituminous paint on surfaces in contact with cementitious materials.

Installation – Accessories

A. Seal wall and roof accessories watertight with metal flashing and sealant.

Cleaning

A. Clean framing members and components of dirt, mud, foreign substances, debris, and other stains before erecting. Finished structure must be clean.

Tolerances

A. Framing Members: 1/4 inch from level; 1/8 inch from plumb

B. Siding and Roofing: 1/8 inch from true position

7. PACKAGING, SHIPPING, AND STORAGE

Delivery, Storage and Handling

A. Scheduling and coordinating of the work specified in this Section and that specified in other Sections shall be the responsibility of the Contractor.

B. Shipping and handling shall be accomplished in a manner which will prevent damage. Materials shall be clearly marked for identification.

C. Materials shall be stored off-the-ground on pallets, and if exposed to the weather, covered with a waterproof material, and shall be protected from damage until ready for use or installation. Surfaces of color coated materials shall be protected from stain.

D. Cut plastic packaging to prevent moisture from accumulating and damaging items prior to installation. Sealants shall remain in the Manufacturer's original unopened containers until ready for use. Sealants shall be protected from freezing.

MASTER SPECIFICTION
FOR
Reinforced Concrete

Revision History

Approved 2013	1.0	New

D.1 CONCRETE FORMWORK

D.1.1 General

D.1.1.1. Section Includes

Formwork for cast-in-place concrete with shoring, bracing, and anchorage.

Openings for other work.

Form accessories.

Form stripping.

D.1.1.2. Design Requirements

Design, engineer, and construct formwork, shoring, and bracing to conform to design and code requirements. Resultant concrete to conform to required shape, line, and dimension.

D.1.1.3. Quality Assurance

Perform Work in accordance with the current ACI 347 standards.

D.1.1.4. Regulatory Requirements

Conform to applicable federal and state codes for design, fabrication, erection, and removal of formwork.

D.1.1.5. Protection

Deliver and install void forms according to instructions proved by Manufacturer.

D.1.2 Products

D.1.2.1. Wood Form Materials

Form Materials: At the discretion of the Contractor.

Forms should produce a clean, uniform, durable finished surface.

D.1.2.2. Prefabricated Forms

Preformed Steel Forms: Minimum 16 gauge matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

Preformed Plastic Forms: Tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

Tubular Column Type: Round, surface treated with release agent, non-reusable, of sizes required.

Void Forms: Manufactured specifically for use as concrete formwork. Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete mix until initial set, 4 inches minimum thickness or as specified on drawings provided in the contract.

D.1.2.3. Formwork Accessories

Form Ties: Removable type, galvanized metal or plastic, fixed length, cone type, free of defects that could leave holes larger than 1 inch in concrete surface.

Form Release Agent: Colorless mineral oil, which will not stain concrete or absorb moisture.

Corners: Chamfered as shown on project drawings provided by Company.

Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

Waterstops: Embedded: Polyvinyl chloride (PVC), minimum 1,750 psi tensile strength, minimum 50°F to +175°F working temperature range, 6 inch wide, maximum possible lengths, ribbed profile, preformed corner sections, heat welded jointing.

Adhesive for application to hardened concrete: Single component, self-sealing plastic water stop manufactured by Synko-Flex Products, Inc. Houston, Texas.

D.1.3 Execution

D.1.3.1. Examination

Verify lines, levels, and centers before proceeding with formwork. Ensure that dimensions agree with project drawings provided by Company.

D.1.3.2. Earth Forms

Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

D.1.3.3. Erection - Formwork

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

Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

Align joints and make watertight. Keep form joints to a minimum.

Obtain approval from Company before framing openings in structural members which are not indicated on project drawings provided by Company.

Provide chamfer strips on exposed corners. Do not provide chamfer strips at joints, unless required by the project drawings provided by Company.

Install void forms in accordance with Manufacturer's recommendations. Protect forms from moisture or crushing.

Coordinate this Section with other Sections of Work which require attachment of components to formwork.

Ensure formwork provides for adequate concrete coverage over reinforcement.

D.1.3.4. Application - Form Release Agent

Apply form release agent on formwork in accordance with Manufacturer's recommendations.

Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

D.1.3.5. Inserts, Embedded Parts, And Openings

Provide formed openings where required for items to be embedded in or passing through concrete work.

Locate and set in place items which will be cast directly into concrete.

Coordinate with Work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

Install accessories in accordance with Manufacturer's instructions, straight, level, and plumb. Ensure items are not disturbed during concrete placement.

Install PVC waterstops in accordance with Manufacturer's instructions, continuous without displacing reinforcement. Heat and seal joints need to be watertight.

Install adhesive waterstops in accordance with Manufacturer’s instructions, using appropriate techniques and materials. Lap ends and corners to form a single, continuous waterstop. Do not remove protective paper from top of waterstop until immediately prior to concrete placement.

Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

D.1.3.6. Form Cleaning

Clean forms as erection proceeds, to remove foreign matter within forms.

Clean formed cavities of debris prior to placing concrete.

Flush with water or use compressed air to remove remaining foreign matter. Ensure that water, debris and mud drain to exterior through clean-out ports prior to concrete pour.

During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms. Use compressed air or other means to remove foreign matter.

D.1.3.7. Formwork Tolerances

Construct formwork to maintain tolerances required by ACI 301.

D.1.3.8. Field Quality Control

Inspect erected formwork, shoring, and bracing to ensure that Work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and other items are secure. Check that anchor bolts and other embedded anchorages are properly located and securely anchored.

Do not reuse wood formwork more than four (4) times for concrete surfaces to be exposed to view. Do not patch formwork.

D.1.3.9. Form Removal

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

Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

D.1.3.10. Schedules

Mats: Form exposed surfaces using plywood or metal forms coated with a form release agent.

Beams, Columns, Pedestals, Slabs and Equipment Pads: Form edges using wood or metal forms coated with a form release agent.

D.2 CONCRETE REINFORCEMENT

D.2.1 General

D.2.1.1. Section Includes

Reinforcing steel bars, wire fabric and accessories for cast-in-place concrete.

D.2.1.2. Quality Assurance

Perform Work in accordance with ACI 318.

D.2.2 Products

D.2.2.1. Reinforcement

Reinforcing Steel: Bent bars, sizes No. 14 and No. 18, shall conform to ASTM A706, grade 60. All other reinforcing steel shall conform to ASTM A615, grade

60, and Supplementary Requirements (S1). All reinforcing steel is to be unfinished unless specified on project drawings.

Welded Steel Wire Fabric: ASTM A185 Plain Type; unfinished.

Dowels: ASTM A615; 60 ksi yield grade, plain steel, unfinished.

D.2.2.2. Accessories

Tie Wire: Minimum 16 gauge annealed type.

Chairs, Bolsters, Bar Supports, Spacers for concrete not exposed to weather or moisture: Sized and shaped for strength and support of reinforcement during concrete placement.

Special Chairs, Bolsters, Bar Supports and Spacers for concrete surfaces exposed to weather: Plastic or plastic coated steel type; size and shape as required.

D.2.2.3. Fabrication

Fabricate concrete reinforcing in accordance with ACI SP-66.

Do not weld reinforcement without approval of Company.

Locate reinforcing splices not indicated on project drawings provided by Company at point of minimum stress, preferably in compression zones of concrete members. Splices should comply with ACI 318 and should develop full strength of reinforcement. Lap splices shall be Class B.

Stagger lap splices and detail as required by ACI 318 and CRSI 63.

D.2.3 Execution

D.2.3.1. Placement

Place, support and secure reinforcement against displacement. Conform to CRSI 63 and CRSI 65. Do not deviate from required position unless approved by company.

Use reinforcement at time of placement of concrete shall be free of mud, oil, ice, loose rust, mill scale, or other coatings that adversely affect bond.

Use metal reinforcement without kinks or non-specified bends. Straighten or repair bars in a manner that will not damage the bars or adjacent construction.

Accommodate placement of formed openings.

Conform to project drawings provided by Company for concrete cover over reinforcement. However, concrete cover must not be less than required by ACI 318.

D.2.3.2. Field Quality Control

Contractor QCI shall inspect for acceptability. Company shall be notified for inspection prior to placement of concrete.

D.2.3.3. Drawing Schedules

Reinforcement for footings, mats, grade beams, foundation walls, drilled piers, pier caps, drainage structures, structural beams and slabs, pedestals, equipment pads, concrete topping slabs over steel deck and slabs-on-grade: All deformed bars and wire fabric, unfinished, of dimensions shown on project drawings provided by Company.

D.3 CAST-IN-PLACE CONCRETE

D.3.1 General

D.3.1.1. Section Includes

All Cast-in-place concrete structures, including but not limited to the following: concrete footings, mats, grade beams, foundation walls, drilled piers, pier caps, drainage structures, structural beams and slabs, pedestals, equipment pads, concrete topping slabs over steel deck and slabs-on-grade.

Control, expansion and contraction joint devices associated with concrete work.

Electrical duct bank and vaults.

Lean concrete.

D.3.1.2. Quality Assurance

Perform Work in accordance with ACI 301.

Acquire cement and aggregate from same source for all Work. Verify and document that mix design is adequate if sources are changed during Work of this Section.

D.3.2 Products

D.3.2.1. Concrete Materials

Cement: ASTM C150, Type II - Portland Cement. (Specifier needs to evaluate the requirement for sulfate resistant concrete normally Type V cement may be required due to contact with high sulfate content soil. Specifier needs to select cement types based on recommendations in Geotechnical Report and other available Engineering Reports for concrete that is in contact with soil.)

Fine and Coarse Aggregates: ASTM C33.

Water shall be clean and free from injurious amount of oil, acids, salts, organic or other deleterious matters.

D.3.2.2. Admixtures

Air-entraining admixtures shall conform to ASTM C260, Darex AEA, or neutralized Vensol resin (NVX).

Water reducing admixture shall conform to ASTM C494, Type AD; WRDA, as manufactured by W.R. Grace and Company, or Pozzolith, manufactured by Master Builders Company.

Set-retarding admixture shall conform to ASTM C494, Type D, PSI-R PLUS or PSI-300R as manufactured by Gifford-Hill & Co. Inc.

Fly Ash: ASTM C618 Class F or Class C.

D.3.2.3. Accessories

Bonding Agent: Acrylic Latex Emulsion.

D.3.2.4. Joint Devices and Filler Materials

Joint Filler: ASTM D994; Asphalt impregnated fiberboard or felt, 1/2 inch thick; tongue and groove profile.

ASTM D1751 - Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

Concrete Mix (Specifier needs to evaluate the requirement for freeze and thaw resistant concrete, normally due to exposure to wet and freezing conditions. Specifier also need to evaluate the Maximum Fly Ash Content, if higher early strength concrete is needed, the fly ash content may need to be lower than 25%. Slump may also need to be changed due to specific application. For example, 4" ± 1" Footings 6" ± 1" Walls 7" ± 1" Walls Pumped)

D.3.2.5.)

Concrete mix designs shall be approved by the Company and shall not be changed without Company approval.

Air-entraining admixture, set-retarding admixture and water reducing admixture are the only admixtures that may be used.

Mix and deliver concrete in accordance with ASTM C94, Option C.

Select proportions for normal weight concrete in accordance with ACI 301.

Provide concrete to the following criteria except as noted:

Item	**Requirement**
Gradation of coarse aggregate	Size Number 57, 1 inch to No. 4
Compressive Strength (7 day)	3,000 psi
Compressive Strength (28 day)	4,000 psi
Maximum Water/Cement Ratio	0.48 by weight
Air Entrainment	6% ± 2% by volume
Maximum Fly Ash Content	25% of cement content
Slump	3 inches ± 1 inch

Provide concrete to the following criteria for concrete structures exposed to moisture and freezing:

Item	**Requirement**
Gradation of coarse aggregate	Size Number 57, 1 inch to No. 4
Compressive Strength (7 day)	3,000 psi
Compressive Strength (28 day)	4,500 psi
Maximum Water/Cement Ratio	0.45 by weight
Air Entrainment	6% ± 1% by volume
Maximum Fly Ash Content	25% of cement content
Slump	3 inches ± 1 inch

Use accelerating admixtures in cold weather only when approved by Company. Use of admixtures will not relax cold weather placement requirement

Do not use calcium chloride in concrete mixture.

Use set retarding admixtures during hot weather only when approved by Company.

Lean Concrete may be used to fill voids around permanent drilled pier casing, to correct over excavation, build mad matt for foundations, and to construct ductbank. Lean Concrete shall meet the following requirements:

Item	**Requirement**
Coarse Aggregate	"Pea gravel" - 3/8 inch maximum diameter
Compressive Strength (28 day)	2,000 psi
Flowable fill mix design	
Slump	7 inches ± 1 inch
Minimum Cement Content	4 sacks/cubic yard

D.3.3 Execution

D.3.3.1. Examination

Verify requirements for concrete cover over reinforcement.

Verify that anchors, anchor bolts, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete. Embedments must be supported by formwork or tied to reinforcement. Under no circumstances should embedments be welded to reinforcement.

D.3.3.2. Preparation

Concrete

- Prepare previously placed concrete by cleaning with steel brush or light sandblasting and applying bonding agent in accordance with Manufacturer's instructions.
- In locations where new concrete is doweled to existing Work, drill holes in existing concrete, clean holes, fill with an epoxy adhesive, and insert steel dowels and pack solid with non-shrink grout. The adhesive shall be Hilti HIT C-100 or Company-approved equal. Follow Manufacturer's instructions for details of application and curing.
- Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.
- Protect anchor bolts and embedments with tape and plastic wrap.

D.3.3.3. Placing Concrete

Place concrete in accordance with ACI 304.

Place steam turbine generator mat as monolithic mass following the guidelines of ACI 304 Paragraph 5.6 "Mass Concreting." Follow these guidelines for any other foundation more than 3 feet thick in least dimension.

Notify Contractor's QCM and Company a minimum of 24 hours prior to commencement of operations.

Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints, and water stops are not disturbed during concrete placement.

Separate slabs on grade from vertical surfaces of other structures with 1/2 inch thick joint filler. Locate joints along vertical edges of foundations whenever foundation creates re-entrant corner in paving or slab. If joint location is impractical, install one (1) Number 4 diagonal bar per each 6 inches of slab thickness at the re-entrant corner to prevent open cracks from forming.

Place joint filler in floor slab. Set top to required elevations. Secure to resist movement by wet concrete.

Extend joint filler from bottom of slab to within 1/4 inch of finished slab surface.

Install joint devices in accordance with Manufacturer's instructions.

Install construction joint devices in coordination with floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.

Install joint device anchors. Maintain correct position to allow joint cover to be flush with floor finish.

Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

Place concrete continuously between predetermined expansion, control, and construction joints.

Do not interrupt successive placement; do not permit cold joints to occur.

Place large floor slabs in long strips as described in ACI 302.

Screed slabs level, maintaining surface flatness of maximum 1/4 inch in 10 feet. Floors beneath folding partitions must be within a tolerance of 1/8 inch in 10 feet.

Hot Weather Requirements

- The maximum temperature of mixed concrete prior to and during placement shall be 90°F.
- Recommendations of ACI 305 shall be followed.

Cold Weather Requirements

- Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near freezing weather. All concrete materials and all reinforcements, forms, fillers, and ground with which the concrete is to come in contact shall be free from frost. No frozen materials or materials containing ice shall be used.
- Concrete shall be kept at minimum temperature of 50°F prior to placement and for the required curing period.
- Recommendations of ACI 306 shall be followed.

D.3.3.4. Finishing Concrete

Finish concrete surfaces in accordance with ACI 301.

Footings and other permanently buried structures do not require finishing. Ensure that concrete is level and provides adequate cover for reinforcing.

In areas with floor drains or trenches, maintain floor elevation at walls; pitch surfaces uniformly to drain structures as indicated on project drawings provided by Company.

Clean concrete from anchor bolts and other embedments and protect them from damage.

D.3.3.5. Curing and Protection

Concrete

- Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

- Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- Cure concrete in accordance with specified requirements if provided by Company.
- Do not permit traffic over unprotected floor surface during curing period.

D.3.3.6. Field Quality Control

Provide free access to Work and cooperate with appointed testing firm.

D.3.3.7. Patching

Allow Representative Contractor's QCM or QCI to inspect concrete surfaces immediately upon removal of forms.

Imperfections including excessive honeycombs, defects greater than 1 inch in depth and embedded debris in concrete are not acceptable. Notify Company and Contractor's QCM or QCI upon discovery.

After obtaining the approval from the Company, patch imperfections within 24 hours of form removal following the provisions of ACI 301. Cut defective area square to avoid feathering edges. Coat area to be repaired with a latex bonding agent pursuant to Manufacturer's instructions. Fill imperfections with mortar mixture and blend with surrounding concrete.

Patch indentations left by all form ties, including stainless steel ties, according to ACI 301.

D.3.3.8. Defective Concrete

Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

Repair or replacement of defective concrete will be determined by the Company and Contractor's QCM.

D.3.3.9. Finish Schedule (Specifier to provide Finish Schedule per specific project requirements. Following table is provided as template)

D.3.3.10.

Building Floors

Administration/Maintenance Addition	Steel trowel finish
Water Treatment Building	Steel trowel finish
Equipment Enclosures	Steel trowel finish
Chemical Storage Areas	Steel trowel finish
Containment Areas	Steel trowel finish
Paved Areas	Broom finish
Sidewalks	Broom finish

Equipment Bases Interior	Steel trowel finish
Equipment Bases Exterior	Steel trowel w/ light broom finish

D.4 CONCRETE CURING

D.4.1 General

D.4.1.1. Section Includes

Initial and final curing of all horizontal and vertical surfaces of concrete structures.

D.4.1.2. Quality Assurance

Perform Work in accordance with ACI 301 and ACI 302.

D.4.2 Products

D.4.2.1. Materials

Membrane Curing Compound Type 1-D Class A according to ASTM C309.

D.4.3 Execution

D.4.3.1. Examination

Verify that substrate surfaces are ready to be cured.

D.4.3.2. Execution - Horizontal Surfaces

Cure floor surfaces and large mat surfaces in accordance with ACI 308.

Membrane Curing Compound: Apply curing compound in accordance with Manufacturer's instructions in two (2) coats with second coat applied at right angles to first.

Water Curing: Concrete may be water cured by the continuous or frequent application of water by means of ponding, spraying, sprinkling, or fogging in accordance with ACI 308. Care shall be taken to prevent saturating the supporting soil causing softening and subsequent damage to the concrete.

D.4.3.3. Execution - Vertical Surfaces

Cure surfaces in accordance with ACI 308.

Membrane Curing Compound: Apply compound in accordance with Manufacturer's instructions in one (1) coat.

D.4.3.4. Protection of Finished Work

Do not permit traffic over unprotected floor surface.

APPENDICES

APPENDICES TO SPECIFICATION

Specifier – These appendices should all be considered for inclusion with the technical specification either as attachments to the technical specification for smaller contracts or incorporated into specific schedules as part of a large contract.
****

1. PROPOSAL DATA REQUIREMENTS
   (To be inserted in the Bid Form may include the following)

   - Total estimated concrete volume
   - Unit price for additional concrete
   - Unit price for additional rebar

2. DOCUMENTATION AFTER AWARD
(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule B)

Seller's Data Submission Schedule

Specifier – Follow are recommended list for submittals and requirements for submittals

1. Rebar shop drawings- Tie the submission to milestone deliverables and milestone payment.
2. Concrete mix design
3. QA/QC procedures at for ready mix concrete plant
4. Allowed minimum 5 days for the Company review and approval of submittals

Documentation

Specifier – Add discussion of options and criteria that must be addressed including format of drawings and delivery

1. All submitted documents shall be electronic and dated.
2. Senders of submittals are obligated to confirm the reception of documents by the intended receivers

PERFORMANCE GUARANTEES

(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule #)

Specifier – Add performance discussions and criteria that must be addressed, include Acceptance Criteria that is established on the project. Otherwise Xcel Energy standard terms and conditions (1 year warranty) are acceptable, and then this page becomes optional.

3. QUALITY ASSURANCE

(For Base Capital Projects to be attachment to the technical specification, for Major Capital Project to be included in Schedule #)

Specifier – Add discussion and criteria that must be addressed with the following recommended starting points

- Company shall retain inspection and testing agency for concrete sampling and lab cylinder compression tests. Selected bidder shall notify Company and its testing agency minimum 24 hours before any planned concrete pour.
- Cast-in-place concrete shall be sampled at one set of three cylinders per pour, one set of three cylinders per 150 cubic yard, or one set of three cylinders per 1500 square feet surface area of walls or slabs, whichever results in more frequent tests shall apply.

4. REFERENCE DRAWING LIST
(Make sure to include the drawing lists pertain the specified concrete work)

Specifier – This is optional if the general bid package include the drawing list, but it is a good practice to list applicable drawings pertaining the specified work

SECTION 03100

CONCRETE FORMWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Formwork for cast-in-place concrete, with shoring, bracing, and anchorage.

2. Openings for other work

3. Form accessories

4. Form stripping

B. Related Sections

1. Section 01300 - Submittal

2. Section 01400 - Quality Control

3. Section 01600 - Material and Equipment

4. Section 03200 - Concrete Reinforcement

5. Section 03300 - Cast-In-Place Concrete

1.2 SCOPE OF WORK

Design, engineer, and construct formwork, shoring, and bracing to conform to design and code requirements; resultant concrete to conform to required shape, line, and dimension.

1.3 REFERENCES

A. ACI 301 - Structural Concrete for Buildings

B. ACI 347 - Recommended Practice For Concrete Formwork

1.4 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals Procedures

B. Product Data: Provide data on void form materials.

1.5 QUALITY ASSURANCE

Perform work in accordance with ACI 347 standards.

1.6 REGULATORY REQUIREMENTS

Conform to applicable federal and state codes for design, fabrication, erection, and removal of formwork.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Transport, handle, store, and protect products in accordance with the provisions of Section 01600.

B. Deliver void forms and installation instructions in Manufacturer's packaging.

C. Store materials off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 PRODUCTS

2.1 WOOD FORM MATERIALS

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

B. Forms should produce a clean, uniform, and durable finished surface.

2.2 PREFABRICATED FORMS

A. Preformed Steel Forms: Minimum 16 gage matched, tight fitting; stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

B. Preformed Plastic Forms: Tight-fitting; stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

C. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting; stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

D. Tubular Column Type: Round; surface treated with release agent; non-reusable; of sizes required.

E. Void Forms: Manufactured specifically for use as concrete formwork. Moisture resistant treated paper faces; biodegradable; structurally sufficient to support weight of wet concrete mix until initial set; 2 inches minimum thickness.

2.3 FORMWORK ACCESSORIES

A. Form Ties: Removable type; galvanized metal or plastic; fixed length; cone type; free of defects that could leave holes larger than 1 inch in concrete surface.

B. Form Release Agent: Colorless mineral oil which will not stain concrete or absorb moisture.

C. Corners: Chamfered as shown on contract drawings.

D. Nails, Spikes, Lag Bolts, Through Bolts, and Anchorages: Sized as required; of sufficient strength and character to maintain formwork in place while placing concrete.

E. Waterstops: Embedded; polyvinyl chloride (PVC); minimum 1,750 pounds per square inch tensile strength; minimum 50°F to plus 175°F working temperature range; 6 inches wide; maximum possible lengths; ribbed profile; preformed corner sections; heat welded jointing.

F. Adhesive Waterstop for Application to Hardened Concrete: Single component, self-sealing plastic water stop manufactured by Synko-Flex Products, Inc. Houston, Texas.

PART 3 EXECUTION

3.1 EXAMINATION

Verify lines, levels and centers before proceeding with formwork. Insure dimensions agree with drawings.

3.2 EARTH FORMS

Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

3.3 ERECTION - FORMWORK

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

B. Provide bracing to insure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

D. Align joints and make watertight. Keep form joints to a minimum.

E. Obtain approval from Architect/Engineer before framing openings in structural members which are not indicated on drawings.

F. Provide chamfer strips on exposed corners unless exposed surface is to be used as a cold joint. An expansion joint will abut floor slabs or will provide one edge of a joint that will accept sealants.

G. Install void forms in accordance with Manufacturer's recommendations. Protect forms from moisture or crushing.

H. Coordinate this Section with other Ssections of work which require attachment of components to formwork.

I. If formwork is placed after reinforcement and results in insufficient concrete cover over reinforcement, before proceeding request instructions from Architect/Engineer.

3.4 APPLICATION - FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with Manufacturer's recommendations.

B. Apply form release agent prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.5 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for items to be embedded in passing through concrete work.

B. Locate and set in place items which will be cast directly into concrete.

C. Coordinate and work with other Sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.

D. Install accessories straight, level, plumb, and in accordance with Manufacturer's instructions. Insure items are not disturbed during concrete placement.

E. Install PVC waterstops in accordance with Manufacturer's instructions, continuous without displacing reinforcement. Heat seal joints watertight.

F. Install adhesive waterstops in accordance with Manufacturer’s instructions using appropriate techniques and materials. Lap ends and corners to form a single, continuous waterstop. Do not remove protective paper from top of waterstop until immediately prior to concrete placement.

G. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

H. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.6 FORM CLEANING

A. Clean forms as erection proceeds to remove foreign matter within forms.

B. Clean formed cavities of debris prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Insure water and debris drain to exterior through clean-out ports.

D. During cold weather, remove ice and snow from within forms. Notify Architect/Engineer of presence of ice or snow. Do not use de-icing salts. Do not use water to clean out forms. Use compressed air or other means to remove foreign matter.

3.7 FORMWORK TOLERANCES

Construct formwork to maintain tolerances required by ACI 301.

3.8 FIELD QUALITY CONTROL

A. Section 01400 - Quality Control: Field inspection

B. Inspect erected formwork, shoring, and bracing to insure work is in accordance with formwork design, and supports, fastenings, wedges, ties, and items are secure. Check that anchor bolts and other anchorages are properly located and securely anchored.

C. Do not reuse wood formwork more than four times for concrete surfaces exposed to view. Do not patch formwork.

D. Protect waterstop during backfill operations or any other operation which may damage the waterstop. Unacceptable or damaged waterstop shall be repaired or replaced.

3.9 FORM REMOVAL

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

B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

C. Store removed forms in such manner that surfaces in contact with fresh concrete will not be damaged. Discard damaged forms.

3.10 SCHEDULES

A. Mats: Form exposed surfaces using plywood or metal forms coated with a form release agent.

B. Slabs and Equipment Pads: Form edges using wood or metal forms coated with a form release agent.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

Deformed reinforcing steel bars, wire fabric and accessories for cast-in-place concrete.

B. Related Sections

1. Section 01300 - Submittals
2. Section 01400 - Quality Control
3. Section 02470 - Drilled Concrete Piers and Shafts
4. Section 03100 - Concrete Formwork
5. Section 03300 - Cast-in-Place Concrete

1.2 SCOPE OF WORK

Not used

1.3 REFERENCES

A. ACI 318 - Building Code Requirements for Reinforced Concrete

B. ACI SP-66 - American Concrete Institute - Detailing Manual

C. ASTM A185 - Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement.

D. ASTM A706/A706M - Low-Alloy Steel Deformed Bars for Concrete Reinforcement

E. CRSI 63 - Recommended Practice For Placing Reinforcing Bars

F. CRSI 65 - Recommended Practice For Placing Bar Supports, Specifications and Nomenclature

1.4 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals: Procedures for submittals

B. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel bending and cutting schedules, and supporting and spacing devices.

1.5 SUBMITTALS FOR INFORMATION

A. Section 01300 - Submittals: Procedures for submittals

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

C. Submit certified copies of mill test report of reinforcement materials analysis.

1.6 QUALITY ASSURANCE

A. Perform work in accordance with ACI 318.

B. Provide Architect/Engineer with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.

PART 2 PRODUCTS

2.1 REINFORCEMENT

A. Reinforcing Steel: All reinforcing shall conform to ASTM A706/A706M, Grade 60. All reinforcing steel is to be unfinished.

B. Welded Steel Wire Fabric: ASTM A185 Plain Type; unfinished.

C. Dowels: ASTM A706/A706M; 60 ksi yield grade, plain steel, unfinished.

2.2 ACCESSORIES

A. Tie Wire: Minimum 16 gage annealed type.

B. Chairs, Bolsters, Bar Supports, Spacers for concrete not exposed to weather or moisture: Sized and shaped for strength and support of reinforcement during concrete placement.

C. Special Chairs, Bolsters, Bar Supports and Spacers for concrete surfaces exposed to weather: Plastic or plastic coated steel type; size and shape as required

2.3 FABRICATION

A. Fabricate concrete reinforcing in accordance with ACI SP-66.

B. Do not weld reinforcement without approval of Architect/Engineer.

C. Locate reinforcing splices not indicated on drawings at point of minimum stress, preferably in compression zones of concrete members. Splices should comply with ACI 318 and should develop full strength of reinforcement. Lap splices shall be Class B.

D. Stagger lap splices and detail as required by ACI 318 and CRSI 63.

PART 3 EXECUTION

3.1 PLACEMENT

A. Place, support, and secure reinforcement against displacement. Conform to CRSI 63 and CRSI 65; do not deviate from required position.

B. Use reinforcement at time of placement which is free of mud, oil, ice, loose rust, mill scale, or other coatings that adversely affect bond.

C. Use metal reinforcement without kinks or nonspecified bends. Straighten or repair bars in a manner that will not damage the bars or adjacent construction.

D. Accommodate placement of formed openings.

E. Conform to Contract Drawings for concrete cover over reinforcement. However, concrete cover must not be less than required by ACI 318.

3.2 FIELD QUALITY CONTROL

A. Section 01400 - Quality Control: Field inspection

B. Architect/Engineer will inspect for acceptability.

3.3 SCHEDULES

Deformed bars and wire fabric, unfinished, of dimensions shown on design drawings

END OF SECTION

SECTION 03390

CONCRETE CURING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

Initial and final curing of horizontal and vertical concrete surfaces.

B. Related Sections

1. Section 01300 - Submittals
2. Section 01400 - Quality Control
3. Section 01600 - Materials & Equipment
4. Section 03300 - Cast-In-Place Concrete

1.2 SCOPE OF WORK

Not used

1.3 REFERENCES

A. ACI 301 - Structural Concrete for Buildings

B. ACI 302 - Recommended Practice for Concrete Floor and Slab Construction

C. ACI 308 - Standard Practice for Curing Concrete

D. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Provide data on curing compounds, compatibilities, and limitations.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301 and ACI 302.

B. Insure compatibility between curing methods and hardeners or finishing agents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products under provisions of Section 01600.

B. Deliver curing materials in Vendor's packaging including application instructions.

PART 2 PRODUCTS

2.1 MATERIALS

Membrane Curing Compound Type 1-D Class A according to ASTM C309

PART 3 EXECUTION

3.1 EXAMINATION

Verify that substrate surfaces are ready to be cured.

3.2 EXECUTION - HORIZONTAL SURFACES

A. Cure floor surfaces and large mat surfaces in accordance with ACI 308.

B. Membrane Curing Compound: Apply curing compound in accordance with Vendor's instructions in two coats, with second coat applied at right angles to first.

C. Water Curing - Concrete may be water cured by the continuous or frequent application of water by means of ponding, spraying, sprinkling, or fogging in accordance with ACI 308. Care shall be taken to prevent saturating the supporting soil causing softening and subsequent damage to the concrete.

3.3 EXECUTION - VERTICAL SURFACES

A. Cure surfaces in accordance with ACI 308.

C. Membrane Curing Compound: Apply compound in accordance with Vendor's instructions in one coat.

3.4 PROTECTION OF FINISHED WORK

Do not permit traffic over unprotected floor surface.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Structural steel framing members, support members and sag rods

2. Base plates

B. Related Sections

1. Section 01300 - Submittals

2. Section 01400 - Quality Control

3. Section 01600 - Materials and Equipment

4. Section 03300 - Cast-In-Place Concrete

5. Section 05510 - Metal Stairs and Handrail

1.2 SCOPE OF WORK

Not used

1.3 REFERENCES

A. AISC - Manual of Steel Construction, Allowable Stress Design (ASD), Ninth Edition

B. AISC - Manual of Steel Construction, Load and Resistance Factor Design (LRFD), Second Edition

C. AISC - Code of Standard Practice for Steel Buildings and Bridges, Adopted September 1, 1986

D. AISC - Structural Joints Using ASTM A325 or A490 Bolts, Approved November 13, 1985

E. ASTM A6 - General Requirements for Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use

F. ASTM A36 - Structural Steel

G. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

H. ASTM A123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

I. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware

J. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

K. ASTM A325 - High Strength Bolts for Structural Steel Joints

L. ASTM A490 - Heat Treated Steel Structural Bolts, Classes 150 ksi (1035 Mpa) Tensile Strength

M. ASTM A500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

N. ASTM A563 - Carbon and Alloy Steel Nuts

O. ASTM F436 – Hardened Steel Washers

P. ASTM F1554 – Anchor Bolts, Steel, 36, 55, And 105 ksi Yield Strength

Q. AWS A2.0 - Welding Symbols

R. AWS D1.1 - Structural Welding Code

S. CBC – 1998 California Building Code (comment-Building code is project specific. JAK)

T. RCSE – Research Council on Structural Connections

U. SDI - Steel Deck Institute, "Design Manual for Composite Decks, Form Decks and Roof Decks."

V. SJI – Steel Joist Institute, "Recommended Code of Standard Practice for Steel Joists and Joist Girders."

W. SSPC (Steel Structures Painting Council) – Painting Manual

1.4 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals Procedures

B. Shop Drawings

1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.

2. Connections detailed

3. Indicate welded connections with AWS A2.0 welding symbols.

C. Calculation Package for Structural Steel Connections:

1. Indicate that finished connections have adequate strength and stiffness to function according to project requirements.

2. Indicate that connection design complies with appropriate codes.

3. Calculations must be properly sealed by a Professional Engineer licensed to practice in the State of California.

1.5 SUBMITTALS FOR INFORMATION

A. Section 01300 - Submittals Procedures

B. Manufacturer's Mill Certificate: Certify that Products meet or exceed specified requirements.

C. Mill Test Reports: Indicating structural strength, destructive, and non-destructive test analysis.

1.6 QUALITY ASSURANCE

A. Materials and fabrication for structural steel shall be in accordance with AISC "Manual of Steel Construction." Steel plates and rolled shapes are to be from domestic mills only. Foreign materials may be used with written permission to the Engineer.

B. Fabricator: Company specializing in performing the work of this Section with minimum five (5) years documented experience. Fabricator is expected to adhere to quality control procedures that require material tracking and visual weld inspection.

C. Design and fabricate connections not detailed on design drawings per the requirements of AISC Code of Standard Practice. Shop drawings to include piece marks for steel erection.

D. Design structural details and connections under direct supervision of a Professional Structural Engineer experienced in design of the work and licensed to practice in the State of California. Submit calculation package sealed by a Professional Structural Engineer when submitting fabrication drawings to Engineer for review of compliance to drawings and specifications. A review of the submitted documentation is required by the California Energy Commission Chief Building Official (CBO). Utility Engineering Corporation will pass said documentation on to the CBO via submittal packets, which require approval prior to construction.

E. Approval of shop drawings by Engineer and CBO does not alleviate Fabricator from the responsibility for accurate fabrication and tolerances. Engineer will check drawings for engineering content only.

F. Certify welders employed for the work, verifying AWS qualification within the previous 12 months.

G. Welding Inspectors: Certify that personnel responsible for the inspection and acceptance of welds are currently certified as Certified Welding Inspectors (CWI) in accordance with AWS QC1.

PART 2 PRODUCTS

2.1 MATERIALS

The following materials shall conform to the requirements in ASTM as listed below:

Structural Steel Material

Material	Specification
Structural Steel	ASTM: A36
Structural Steel Plates, Shapes and Bars	ASTM: A36
Sag Rods	ASTM: A36
Structural Tubing	ASTM: A500, Grade B
Structural Pipe	ASTM: A53, Type E or S, Grade B
Components of high-strength steel fastener assemblies for use in structural steel joints.	
Bolts	ASTM: A325 [1], Type 1, Zinc Coated [2]
Nuts	ASTM: A563, Grade DH [3], Zinc Coated [2]

Hardened Washers	ASTM: F436, Type 1, Circular, Zinc Coated [2], including S1 supplementary requirements
Components of anchor rod assemblies for use in anchoring structural supports to concrete foundations [4]	
Hooked, headed, threaded and nutted anchor rods	ASTM: F1554; Grades: 36, 55 including S1 supplementary requirements, 105; Zinc Coated [5]
Nuts	ASTM: A563, including Appendix X1 [3], Zinc Coated [5]
Washers	ASTM: F436, Type 1, Circular, Zinc Coated [5], including S1 supplementary requirements

1 Certified Manufacturer's test reports required.
2 Hot-dipped galvanized per ASTM: A153, Class C. Obtain all fasteners from North American manufacturers only.
3 Zinc-coated nuts shall be furnished with a dry lubricant conforming to Supplementary Requirement S2 in ASTM Designation: A563
4 Other grades may be required for anchoring specific equipment
5 Hot-dipped galvanized per ASTM: A153, Class C
6 Welding Materials: AWS D1.1; type required for materials being welded

2.2 FABRICATION

A. Conform to AISC Manual of Steel Construction, AISC Code of Standard Practice, and ASTM A6.

B. Connection material shall be the same material as the member to which it attaches.

C. Fabricate and assemble structural steel members in the shop to the greatest extent practicable.

D. Cut surfaces shall be smooth and neat, without ragged edges, notches, or cracks.

E. Continuously seal joined members by continuous welds. Grind exposed welds smooth as required by drawings.

F. Fabricate connections for bolt, nut, washer connectors, and welded connections as shown on drawings. Unless otherwise noted, the minimum shear beam reaction for connection design shall be taken as one-half the total uniform load capacity determined from the tables of allowable

Uniform Load, Part 2 of the AISC "ASD Manual of Steel Construction."(comment-this criteria must be understood by the designer as well as the fabricator. JAK)

G. Steel beams used for monorails or crane rails shall be straight and level with no gaps or unevenness in splices. Stops made from angles shall be bolted in place on each end of each monorail beam to limit travel of the hoist.

H. Furnish bolts, nuts, and washers for all field connections with a 2% overage of each size and length of bolt.

2.3 FINISH

A. Prepare structural component surfaces to be coated in accordance with SSPC SP 6, commercial sandblast, according to schedule.

B. Hot-dip galvanize structural steel according to ASTM A123 as required by schedule. Provide minimum 1.25 ounces per square foot galvanized coating for shapes not covered by ASTM A123.

C. Shop coat structural steel members with 1 coat of Carbo Zinc 11 (CZ-11) as manufactured by Carboline, at 2.5 to 3.5 mils. DFT according to schedule.

D. Apply coating in accordance with SSPC-PA1 and Manufacturer's instructions.

E. Securely affix piece marks to steel members and assemblies for purposes of erection. Marking may be with paint, metal tags, adhesive labels, or with other approved means. Piece marks should be durable enough to remain legible after shipping, handling, and weather exposure.

2.4 SOURCE QUALITY CONTROL AND TESTS

Fabricator to provide shop testing and analysis of structural steel sections and welds.

PART 3 EXECUTION

3.1 ERECTION

A. Allow for erection loads and sufficient temporary bracing to maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing.

B. Field weld components indicated on contract drawings and shop drawings.

C. Field connect members with threaded fasteners. Threaded fasteners shall be installed in accordance with the AISC Specification for Structural Joints using ASTM A325 or A490 Bolts. Tighten bolts using a method approved by the AISC Specification, the Engineer, and the Owner. The Contractor is responsible for insuring that all fasteners are properly tightened through an ongoing Quality Assurance and Quality Control program.(comment-method of verifying tightening should be determined prior submittal of RFP documents. JAK)

D. Do not field cut or alter structural members without approval from the Engineer.

E. Thoroughly clean members and connections of dirt, mud, debris, and other foreign substances prior to erecting.

F. After erection, paint welds, abrasions, and surfaces to match shop painting. Surfaces to be in contact with concrete or surfaces to be covered with insulation do not require surface preparation or painting.

G. Grout under base plates in accordance with Section 03600 and the design drawings. Trowel grouted surface smooth. Splay edges neatly to 45 degrees.

3.2 ERECTION TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per level, non-cumulative except that the displacement of any column center line from the established column line shall be no more than 1 inch at any point in the total height of the column.

B. Maximum Offset From True Alignment: 1/4 inch

C. Comply with tolerances specified in AISC Code of Standard Practice for Steel Buildings and Bridges.

3.3 FIELD QUALITY CONTROL

Section 01400 - Quality Control

3.4 FINISH SCHEDULE

ITEM	SURFACE PREPARATION	SURFACE FINISH	COLOR
PIPE RACK	CLEAN	GALVANIZE	NONE
EXTERIOR PLATFORMS	CLEAN	GALVANIZE	NONE

(note: schedule is project specific. JAK)

END OF SECTION

SECTION 05540

STEEL H-PILES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. This Specification covers the requirements for material, installation, quality control, testing, and reporting for the steel piling.
2. Unless otherwise specified, the Contractor shall furnish all labor materials, equipment transportation, supervision, and facilities necessary to perform all work scoped and defined in construction drawings and this Specification.
3. All materials used and work performed by the Contractor shall be subject to approval by the Engineer inspector to ensure compliance with drawings and this Specification.
4. Unless otherwise specified, the acquisition of all required permits is the responsibility of the Contractor.
5. All applicable local, city or other required codes shall be adhered to by the Contractor. Any Conflicts between the requirements of such codes and these documents shall be brought to the attention of the Engineer for clarification or resolution.
6. Piles shall be driven to a pile cut-off elevation as shown on the design drawings.
7. The Contractor shall provide H-pile accessories such as H-pile points/splices. Uplift connectors shall be provided and installed by the foundation mat contractors.
8. Removal of existing above ground and below ground obstructions as required for the installation of piling will be by others.

1.2 SCOPE OF WORK

Not Used.

1.3 REFERENCES

A. American Society for Testing and Materials

1. ASTM A36-1988 - Structural Steel
2. ASTM D1143-87 - Piles Under Static “Axial Compressive Load”
3. ASTM D3689-83 - “Individual Piles Under Static Axial Tension Loads”
4. ASTM D3966-81 - “Method for Testing Piles Under Lateral Loads”

B. American Institute of Steel Construction

1. AISC-1989 - Specification for Structural Steel Buildings
2. AISC-1986 - Code of Standard Practice for Steel Buildings and Bridges
3. AISC-1989 - Manual of Steel Construction, Ninth Edition

C. American Welding Society

1. AWS A5.1-1981 - Specification for Mild Steel Covered Arc-Welding Electrodes
2. AWS A5.5-1981 - Specification for Low-Alloy Steel Covered Arc-Welding Electrodes
3. AWS D1.1-2002 - Structural Welding Code

1.4 DESIGN CRITERIA

A. Steel H-Piles - General

1. Location shown on the drawing, H-Type steel (ASTM A-36) bearing piles, shall be used to support the foundation mat.
2. H-piles shall be sized as shown on the drawings.
3. Splices in steel piles are to be welded. Welds to be as per AWS D1.1.
4. When the pile shall be spliced to develop adequate embedment length, all the necessary equipment shall be standing by so that when hammer is shutoff the splice can be quickly made.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 Pile Driving

A. Pile driving shall be accomplished using a hammer rated at 40,000 ft/lbs or greater. The size and capacity of the pile hammer is typically determined during the geotechnical investigation of the project. A description of the pile driving equipment shall be submitted to the Engineer for approval prior to the start of pile driving. Piles are to be driven to refusal. All piles shall employ rock shoes for protection when driving to bedrock.

B. After completion of driving, each pile shall be inspected to verify that the in-place pile is sound and without injury. Piles shall be driven continuously to the required penetration the same day they are started.

C. Where penetration of the pile is suddenly resisted by underground obstructions, the Contractor shall bring this condition to the attention of the Engineer for resolution.

D. When piles in large groups are to be driven, the Contractor must be alert to the danger of heaving and lateral displacement and select the proper driving sequence in order to minimize heaving and displacement.

E. As far as practicable, piles in large groups should be driven from the inside toward the outside. Piles, which drift off position and exceed the location tolerance criteria given in this Specification may be subject to rejection.

F. The Contractor shall measure and record heave and displacement of each pile after all piles in the group have been driven. Piles showing more than 1/2 inch of heave shall be re-driven until refusal and piles have been driven to or below the original pile tip elevation. Driving shall be done with fixed leads, which will hold the pile firmly in position and in axial alignment with the hammers. During driving, all precautions shall be taken to ensure that the piles are driven in their required positions. Any pile so out of position as to impair its intended usefulness shall be pulled and re-driven or an additional pile driven, as directed and at the expense of the Contractor.

G. Accurate driving records for each pile shall be maintained on a reproducible form by the Contractor and submitted to the Engineer on a daily basis. The driving record for each pile shall include the number of blows per foot used to drive the pile for its entire length.

H. The records shall also include the following information:

Pile Data

Number: _____

Location; _____

Type: _____

Dimensions of:

Butt

Tip _____

Length: _____

Elevation of:

Tip

Cutoff

Grade _____

Time and Date of Reason: _____

Equipment Data

Make and Model of Rig: _____

Weight of Striker _____

Weight of Hammer _____

Height of Fall or Stroke _____

Rated Energy _____

Cushion Type _____

Driving Interruption

Time: _____

Duration: _____

Tip Elevation: _____

3.2 Acceptance Criteria

A. The acceptance criteria for the position of driven piles is as follows:

1. Cut off elevation, ± 1 inch
2. Horizontal location, ± 3 inches
3. Alignment (vertical or batter), 2%

B. Suitable anvils, cushions, caps, mandrels, or containment bands shall be employed as necessary to protect the structural integrity of the pile tops against the impact forces of driving. Any pile damage, in the judgment of the Engineer, so as to impair the structural integrity of the pile with respect to its intended use shall be remedied by the Contractor at its expense. The remedy shall be as directed by the Engineer.

C. All piles shall be driven to bedrock. Extreme care should be taken during pile driving operations not to overstress the piles upon encountering bedrock

(Comment – Driven piles utilize a know energy input to determine the design depth of the foundation. The objective is to avoid pile damage or foundation cost overruns due to excessive driving. This can be achieved through wave equation analysis, dynamic monitoring of pile driving, and static load testing. It is incorrect to state that pile will be

driven to bedrock. The piles resist vertical loads through friction forces as well as end bearing.)

END OF SECTION

CIVIL/STRUCTURAL

D.1 Anchor Bolts

Shop Drawings:

- Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
- Connections detailed by Supplier.
- Indicate welded connections with American Welding Society (AWS) A2.4 welding symbols. Supplier's shop detail and erection drawings will clearly distinguish between shop and field welding.
- Approval of shop drawings by Company does not alleviate Fabricator from the responsibility for accurate fabrication and tolerances. Company will check drawings for engineering content only.

D.1.1 Quality Assurance

Materials and fabrication for structural steel shall be in accordance with American Institute of Steel Construction (AISC) "Manual of Steel Construction."

Manufacturer: Company specializing in performing the Work of this Section with minimum 5 years documented experience. Contractor shall ensure that Manufacturer adheres to quality control procedures that require material tracking and visual weld inspection.

Design and fabricate connections not detailed on the design drawings provided by Company, if applicable, to meet requirements of AISC Code of Standard Practice. Shop drawings are to include piece marks for steel erection.

For welding requirements see Attachment B.

Design structural details and connections under direct supervision of a Professional Civil Engineer experienced in design work and licensed to practice in the State of Colorado. When submitting fabrication drawings to Company for review of compliance to drawings and specifications, include calculation package signed and sealed by a Professional Civil Engineer licensed to practice in the State of Colorado

D.1.2 Materials

Anchor Bolts:

- ASTM F1554, grade as noted on design drawings. ASTM A563, Grade A, heavy hexagon nuts, ASTM F436 hardened steel washers.

- Other grades may be required for anchoring specific equipment.
- ASTM A36 Plate washers as required and noted on design drawings.

Welding Materials: AWS D1.1; type required for materials being welded.

Used or repaired materials shall not be used without the explicit approval of the Company.

D.1.3 Fabrication

Conform to AISC Manual of Steel Construction and ASTM A6M, and IBC.

Fabricate and assemble structural steel members in the shop to the greatest extent practical.

Cut surfaces shall be smooth and neat without ragged edges, notches or cracks.

Seal joined members by continuous welds where air-tight connection is required. Grind exposed welds smooth as required by design drawings provided by Company.

Fabricate connections for bolt, nut, and washer connectors or for welded connections as shown on design drawings provided by Company. Unless otherwise noted, the minimum shear beam reaction for connection design shall be taken as one-half the total uniform load capacity determined from the tables of Uniform Load Constants, Part 2 of the AISC "Manual of Steel Construction, Allowable Stress Design (ASD), Ninth Edition" (or later editions).

Steel beams used for monorails or for crane rails shall be straight and level with no gaps or unevenness in splices. Stops made from angles shall be bolted in place on each end of each monorail beam to limit the travel of the hoist.

Furnish bolts, nuts and washers for all field connections with a 2% overage of each size and length of bolt.

D.1.4 Bolting

High strength bolts shall conform to the requirements of this Section and to the requirements of the RCSC "Specification for Structural Joints Using ASTM A325 or A490 Bolts".

Except as otherwise specified in this Section, the methods, conditions, materials, and products specified herein apply to work whether performed in the shop or in the field.
Include an additional 2% overage for bolts, nuts and washers to be installed in the field.

Shoulder Bolts, fabricated from ASTM A325 material, shall be used for slotted

sliding connections.

Erection Bolts: Use ASTM A307.

Bolt holes shall be 1/l6 in. larger than the nominal diameter of the bolt.

Oversized or slotted holes will not be permitted, unless shown on Company Drawings.

Contractor shall insure the proper faying surface is provided at all connections for the class and type of connection specified in the design.

Nuts shall be fully engaged with the end of the bolt at least flush with the face of the nut.

The threaded part of the installed bolt shall not be in the shear plane.

For a slotted sliding connection using shoulder bolts, two nuts are required. Each nut shall be installed using an impact wrench. The first nut shall be installed up to the shank of the bolt, followed by the second nut. Both nuts shall be installed to a "snug-tight" condition.

Washers shall be used in accordance with the RCSC Specification.

Location of Bolt Heads:

- Columns: On outside faces of flanges.
- Beams and Girders: On upper sides of flanges.

Snug-tight bolt tensioning of bearing connections are preferred and will be utilized to the maximum extent possible unless other bolt tightening requirements are specified by Supplier using method approved by the AISC specification. Bolts in bearing type connections not requiring fully tensioned bolts need only be tightened to the snug tight condition as defined in Section 4.1 and 8.1 of the AISC "RCSC" Specification for Structural Joint Using ASTM A325 or A490 Bolts.

When pre-tensioned bolts are required for bearing or slip critical connections, the Fabricator and Erector may utilize their preference of any of the four AISC approved installation methods when properly used in accordance with RCSC requirements: 1) the turn-of-nut method, 2) the calibrated wrench method, 3) the twist-off type tension control bolt, and 4) the direct tension indicator method. Fabricator and Erector shall demonstrate compliance of preferred method to Company.

Inspection, examination and "Special Inspections" indicated in Chapter 17 of IBC, if required, shall be performed by the Contractor's independent Testing and Inspection Agency.

Contractor's Work is subject to inspection and examination by Company and the testing and inspection agency for full compliance with all the requirements specified herein.

Contractor shall provide, and pay for, access and all rigging required for the examinations performed by Company or the testing and inspection agency. Contractor shall also provide personnel required to assist Company or the testing and inspection agency at no additional cost to Company.

Company's inspection will not relieve Contractor of its obligation for inspection. Company's testing and inspection agency will not be available for Contractor's use.

Inspection of High-Strength Bolting:

- Contractor shall furnish and install a tension calibrating device, such as a Skidmore-Wilhelm calibrator. The device furnished shall bear a certification as to the accuracy of the device. Such certification shall be dated not more than 30 days prior to the first actual use of the device for inspection of the Work.

- Inspection procedures shall be in accordance with Section 9 of the RCSC "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts", including the provisions for arbitration inspection specified therein. The Contractor shall provide a procedure and associated documentation, signed by Contractor's QA/QC Manager, to indicate that the inspection requirements of the RCSC specification have been performed.

- When alternative washer-type indicating devices, squirter type DTIs, are used, detailed installation and inspection instructions shall be prepared by the Contractor, per RCSC requirements and approved by Company prior to installation. The instructions shall be augmented by the test procedures performed to establish the volume and appearance of the orange silicone liquid squirted out from the collapsed bumps on the face of the DTI.

SITE GRADING

D.1 ROUGH GRADING

Cutting, grading and filling the site to establish subgrade contours.

Prior to placement of fill, any vegetation and organics in areas to be graded shall be removed. Coal shall be removed underlying proposed structures. Exposed ground shall be scarified to a depth of 8 inches, moisture conditioned and compacted.

D.1.1 Project Record Documents

Accurately record actual locations of remaining utilities by horizontal dimensions, elevations of inverts, and slope gradients.

D.1.2 Examination

Verify that survey benchmark and intended elevations for the Work are as indicated.

D.1.3 Preparation

Identify required lines, levels, contours and datum plane.

Identify known underground, above ground, and aerial utilities. Stake and flag locations.

Protect above and below grade utilities which are to remain.

Protect benchmarks, existing structures, and paving to remain from excavation equipment and vehicular traffic.

Install erosion and sediment control per the Storm Water Management Plan (SWMP) prepared by others.

Proof roll subgrade with pneumatic-tired roller (20-ton minimum weight) with at least four (4) equally loaded tires after clearing site. Proof roll the entire site in perpendicular passes to expose soft or weak areas of soil. Over-excavate areas of the subgrade that are determined to be inferior due to softness, pumping or excessive deflection. Excessive deflection is defined as rutting of more than 1 inch measured from the top of the construction grade to the bottom of the rut. Replace excavated material with structural fill and compact according to the provisions of these Specifications to attain a firm, uniform surface. Final density of the reworked area must equal or exceed density of adjacent material.

Permanent slopes constructed at the site shall have a maximum inclination of 3:1 (horizontal to vertical).

D.1.4 Subsoil Excavation

Excavate subsoil form areas to be further excavated or re-graded for building pads or paving.

Remove excess subsoil from the site to an area designated by the Company.

Do not excavate saturated topsoil.

D.1.5 Filling

Fill placed at the site, other than structural fill, shall be compacted to a minimum 95% of the standard Proctor (ASTM D698) density at a moisture content within 2% of optimum. Fill may consist of on-site materials. Excavated claystone shall be broken down prior to use as fill. Fill shall not contain particles greater than 4 inches in maximum dimension in the upper 6 feet. Excavated claystone shall not be placed as fill beneath foundations or pavements. Fill areas to contours and elevations with unfrozen materials.

Subsoil Fill: Place and compact fill material in continuous layers not exceeding 8 inches loose. Inaccessible areas should be compacted using hand equipment in 3-inch loose lifts.

Maintain optimum moisture content of fill materials per test requirements to attain required compaction density.

If subgrade material or previously placed subsoil fill has deteriorated due to weather exposure, scarify the top 6 inches of material to establish an acceptable interface for the materials prior to placing any additional fill.

Slope grade away from buildings a minimum of 6 inches in 10 feet, unless noted otherwise. Grade site to promote drainage for surfaces that are to remain exposed for an extended period of time to prevent water accumulation and subsequent softening.

Make grade changes gradual. Blend slope into level areas and match existing paving that will remain.

All graded areas, slopes, and ditches which will not be paved or otherwise surfaced shall be provided with permanent seeding.

Remove surplus fill materials from site, or dispose of in designated disposal areas.

D.1.6 Tolerances

Top Surface of Subgrade: ± 1/10 foot.

D.1.7 Field Inspection and Testing

Field inspection and testing of soils will be performed by independent Testing Service hired by Supplier.

D.2 EXCAVATION AND FILL

D.2.1 Design Criteria

Foundations shall conform to the requirements provided in the Geotechnical Report provided in Appendix H. Earthwork shall be coordinated in an effort to support foundation design and construction.

Supplier shall provide to the Company, for approval, a Production Sequencing Plan which coordinates earthwork and foundation construction efforts. The plan shall address foundation design requirements as provided by the Geotechnical Report.

D.2.2 Field Measurements

Verify that survey benchmark and intended elevations for the Work are as indicated.

D.2.3 Preparation

Identify known underground, above ground, and aerial utilities. Stake and flag locations.

Protect above and below grade utilities that are to remain.

Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

Recent geotechnical investigation efforts encountered groundwater at varying elevations and are likely to impact underground excavations and drilled pier construction. Supplier shall use existing soil borings in his area of excavation as part of his excavation plan.

Install erosion and sediment control per the SWPP prepared by others.

Review geotechnical investigation for groundwater conditions that may impact foundation construction and fill placement.

D.2.4 Excavation

Construction excavations in fill and natural soil should be inclined not steeper than two (2) horizontal to one (1) vertical or as recommended by OSHA 1926 Subpart P, App. B. These soils will classify as Type C soils. Weathered claystone and claystone bedrock classify as Type A soils and may slope 1:1 or steeper if determined appropriate by Supplier’s safety

personnel. Excavators into bedrock shall require ripper teeth, hoerams, and extra effort.

Take special precautions as required preserving condition and integrity of existing structures.

Blasting shall not be allowed.

Excavate subsoil required to accommodate building foundations, slabs-on-grade, and paving.

Use precaution during final excavation to subgrade level to prevent disturbance and remolding of subgrade material. Hand trim excavation as required. Remove loose material.

Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard measured by volume.

Grade top perimeter of excavation to prevent surface water from draining into excavation.

Notify the Company of unexpected subsurface conditions or hazardous materials encountered and discontinue affected Work in area until notified to resume work.

Correct unauthorized excavation.

Correct areas over-excavated by error.

It is the Supplier's responsibility to comply with applicable state and federal regulations on excavation, shoring, and trenching.

D.2.5 Fill Course Placement

Fill areas to contours and elevations with unfrozen materials. Temporary and permanent cut and fill slopes shall be constructed no steeper than three (3) horizontal to one (1) vertical.

Maintain optimum moisture content of all fill materials at test requirements to attain required compaction density.

Do not mix fill types beneath foundations.

If subgrade material or previously placed subsoil fill has deteriorated due to weather exposure, scarify the top 6 inches of material to establish an acceptable surface prior to placing any additional fill.

Slope grades away from building a minimum of 2 inches in 10 feet, unless noted otherwise. Grade site to promote drainage for surfaces that are to

remain exposed for an extended period of time to prevent water accumulation and subsequent softening.

Make grade changes gradual. Blend slope into level areas and match existing paving that will remain.

All graded areas, slopes, and ditches which will not be paved or otherwise surfaced shall be provided with permanent seeding.

Remove surplus fill materials from site or dispose of in designated disposal areas.

D.2.6 General

Blading and rolling shall be done alternately, as necessary, to obtain a smooth, even, and uniformly compacted course.

The final surface should be smooth and uniform and should conform to the required cross section and established grade. Tolerance for the finished surface: ± 1/10 foot.

Provide for visual inspection of bearing surfaces.

D.2.7 Protection

Protect excavations by methods required preventing cave-in or loose soil from falling into excavation.

Remove water which enters excavations.

Protect soil adjacent to and beneath existing foundation from freezing.

It is the Supplier's responsibility to comply with applicable state and federal regulations in protecting open excavations.

D.3 BACKFILL

D.3.1 Fill Materials

Sand: Natural river or bank sand; washed, free of silt, clay, loam, friable, or soluble materials, or organic matter; graded in accordance with ANSI/ASTM C136, within the following limits:

Sieve Size	Percent Passing
No. 4	100
No. 40	30 to 50

Excavated Subsoil: On-site low density clay soils, if any, are not acceptable as structural fill material. Areas not requiring structural fill may accept excavated site material. This material shall be compacted to a

minimum 95% of standard Proctor density at a moisture content within 2% of optimum. The excavated claystone, if any, shall be broken down prior to use as fill material. Fill shall not contain particles greater than 4 inches in maximum dimension in the upper 6 feet.

Structural Fill: Free of loam, friable, or soluble materials. Non-swelling, impervious engineered (structural) fill shall be constructed of soil with 100% finer than 4 inches, 15% minimum of minus No. 200 sieve sizes, and a plasticity index of 15% or less. Bottom Ash material shall not be considered Structural Fill.

Coarse Aggregate Fill: Washed stone: Free of shale, clay, friable material and debris; graded in accordance with ASTM D2487 Group Symbol "GW."

Fly Ash: Class C Fly Ash.

Final fill course in unpaved or unsurfaced areas shall be topsoil capable of establishing vegetative groundcover.

Controlled Low-Strength Materials (CLSM) as defined by, and in accordance with, ACI-229R-99 may be used in place of fill materials in certain situations with prior approval of the Company.

D.3.2 Examination

Verify fill materials to be used are acceptable to Company.

D.3.3 Preparation

Subgrade soils beneath foundations, floor slabs, and pavements shall be scarified to a minimum depth of 8 inches, moisture conditioned to within 3% of optimum moisture content, and compacted. The moisture and compaction shall be maintained until construction of the foundation, slab, or pavement.

Cut out soft areas of subgrade not capable of in-situ compaction that are determined to be inferior due to excessive deflection defined as rutting of more than 1 inch measured from the top of the construction grade to the bottom of the rut. Backfill with fill and compact to density equal to or greater than requirements for subsequent backfill material.

Prior to placement of aggregate base course material at paved areas, compact subsoil to 95% of its maximum dry density within ± 3% of optimum moisture content determined in accordance with ASTM D698.

D.3.4 Filling and Backfilling

Backfill areas to contours and elevations with unfrozen materials. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

Granular Fill: Place and compact materials in continuous loose layers not exceeding 8 inches loose depth.

Engineered (structural) fill shall be placed and compacted in horizontal lifts not exceeding 8 inches in loose thickness, using equipment and procedures that will produce recommended moisture contents and density throughout the cross section of the fill area. Required compaction criteria for structural fill materials and scarified subgrade soils are as follows:

Materials	Minimum Percentage (ASTM D698)
Scarified Subgrade Soils	
Beneath floor slabs and pavement	95
Beneath foundations	95
Structural Fill Soils	
Beneath floor slabs, pavement, and rail	100
Beneath mat/spread foundations	100
Other	95

Structural fill shall be compacted within a moisture content within 2% of optimum moisture content.

Building Pad: Movement sensitive floors shall be designed as structural floors with a minimum 6-inch void space between the underlying soil and floor. Building loads are to be transferred to drilled piers.

Comply with ASTM D2321 for backfill around High Density Poly-Ethylene (HDPE) and other flexible piping in trenches.

Employ a placement and compaction method that does not disturb or damage utilities in trenches.

Maintain optimum moisture content of backfill materials to attain required compaction density.

Slope grade away from building a minimum of 2 inches in 10 feet, unless noted otherwise.

Make grade changes gradual. Blend slope into level areas.

All graded areas, slopes, and ditches which will not be paved or otherwise surfaced shall be provided with permanent seeding.

Remove surplus backfill materials from site or dispose of in designated disposal areas.

Fill to restore over-excavation/unauthorized excavation shall be placed and compacted in continuous layers not exceeding 8 inches loose depth. Compact to 95% standard Proctor density.

D.3.5 Tolerances

Top Surface of Backfilling Under Paved Areas: ± 1/2 inch from required

elevations.

D.3.6 Compaction

Proof roll compacted fill surfaces under slabs-on-grade and site paving with pneumatic-tired roller (20 ton minimum) with at least four (4) equally loaded tires. Rework loose or soft areas to attain firm, uniform surface. Final density of reworked areas must equal or exceed density of adjacent material. Any clay and claystone encountered at the site will provide poor pavement support. The expansive properties of the subsurface material shall be verified in case treatment is required to prevent pavement or railroad distress.

D.3.7 Protection of Finished Work

Protect finished Work.

Scarify and recompact fills subjected to vehicular traffic.

D.4 TRENCHING

D.4.1 General

D.4.1.1 Field Measurements

Verify that survey benchmark and intended elevations for the Work are as shown on project drawings provided by Company.

D.4.2 Execution

D.4.2.1 Examination

Verify fill materials to be reused are acceptable by Supplier's QCM.

D.4.2.2 Preparation

Identify required lines, levels, contours, and datum plane.

Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

Protect above and below grade utilities which are to remain.

Install erosion and sediment control features per SWMP prepared by others.

Cut out soft areas of subgrade not capable of in situ compaction. Backfill and compact to density equal to or greater than requirements for subsequent backfill material.

D.4.2.3 Excavation

Excavate subsoil required for connection to existing utilities.

Cut trenches sufficiently wide to enable installation of utilities and allow inspection.

Excavation shall not interfere with normal 45 degree bearing splay of foundations.

Remove rocks to a minimum clearance of 8 inches around the bottom and sides of pipe, conduit, and duct.

Hand trim excavation. Remove loose matter.

Keep trenches dewatered.

Correct unauthorized excavation and areas over-excavated by error.

Stockpile excavated material in area designated on site.

D.4.2.4 Bedding

Support pipe and conduit, if necessary, during placement and compaction of bedding fill, according to design drawings. Compact to 95% Standard proctor density at ± 2% of optimum moisture content.

Bedding material shall provide continuous support for pipe between joints

.D.4.2.5 Backfilling

Backfill trenches to proper contours and elevations with unfrozen materials.

Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

Sheeting, forms, and bracing may not be left in place unless written permission has been received from the Company.

Employ a placement method that does not disturb or damage conduit or pipe in trench.

Comply with ASTM D2321 for backfill around HDPE piping. Work fill material underneath haunches of pipe with a shovel and hand tamp under haunches to provide firm, uniform support of pipe.

Place remaining backfill in continuous

layers not exceeding 8 inch loose lifts and compact to 95% Standard

Proctor Density at ± 2% of optimum moisture content.

Backfill around sides and top of rigid pipe with fill, tamped in place in 8 inch loose lifts and compacted to 95% Standard Proctor density at ± 2% of optimum moisture content.

Allow 24 hours minimum cure time for concrete encasements prior to backfilling.

D.4.2.6 Tolerances

Top surface of backfilling under paved areas: ± 1/2 inch from required elevations.

Top Surface of General Backfilling: ± 1 inch from required elevations.

D.4.2.7 Field Inspection and Testing

Field inspection and testing of soils will be performed by independent Testing Service hired by Supplier.

D.4.2.8 Protection of Finished Work

Protect finished Work.

Recompact fill disturbed by vehicular traffic.

SECTION 05501
METAL STAIRS, HANDRAILS, RAILINGS, AND GRATING

PART 1: GENERAL

1.01 DESCRIPTION

A. Work included in this section shall be performed in accordance with the following paragraphs and the provisions of the other Agreement Documents.

B. Work covered under this section includes providing all materials, equipment, and labor for miscellaneous stair, ladder, handrails, and grating as shown on drawings.

1.02 REFERENCES

A. The following are complete titles of references cited in this section:

1. American Society for Testing and Materials (ASTM) A36, "Specification for Structural Steel"

2. ASTM A53, "Specification for Hot-Dipped, Zinc-Coated Welded and Seamless Steel Pipe"

3. ASTM A123, "Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products"

4. ASTM A153, "Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware"

5. ASTM A283, "Specification for Carbon Steel Plates, Shapes, and Bars"

6. ASTM A307, "Specification for Carbon Steel Externally Threaded Standard Fasteners"

7. ASTM A500, "Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes"

8. ASTM E985, "Standard Specification for Permanent Metal Railing Systems and Rails for Buildings"

9. ASTM F593, "Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs"

10. American Welding Society (AWS) A2.0, Standard Welding Symbols

11. AWS D1.1, Structural Welding Code

1.03 SUBMITTALS

A. Shop Drawings. Shop drawings showing fabrication and installation of handrails and railing systems including plans, elevations, sections, details of components, and attachments to other

units of Work. Shop drawings shall be submitted to the Company two weeks prior to start of Work. Review will be for general design and arrangement only, and fabricator shall be responsible for correctness of sizes, details, dimensions, and quantities

B. Product data for formed metal bar grating, metal stairs, manufacturer's clips and anchorage devices for gratings.

C. Shop drawings detailing fabrication and erection of gratings. Include plans, sections, and details of connections. Show anchorage and accessory items.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Care shall be utilized throughout the delivery, storage, and handling so as to not scratch, bend, wrap, or otherwise damage the components.

B. Metal chokers, cable, or straps likely to damage the surface shall not be used.

C. Components shall be stored aboveground on level timbers or other material which will not stain, corrode, scratch, or otherwise damage the components.

PART 2: PRODUCTS

2.01 MATERIALS

A. Structural Steel Shapes and Plates. Steel shapes and plates shall be the size and shape shown on the drawings and shall conform to the latest ASTM Designation A36. Components shall be hot-dipped galvanized.

B. Rectangular Hollow Steel Sections. Rectangular hollow steel sections shall be the size and shape shown on the drawings and shall conform to the latest ASTM Designation A500 Grade B with a minimum yield stress of 46 ksi. Components shall be hot-dipped galvanized.

C. Bolts. Bolts shall be the size and shape shown on the drawings and shall conform to the latest ASTM Designation A307, except as otherwise specified on the drawings, and shall be hot-dipped galvanized.

D. Fasteners into Concrete. Hilti HVA capsule adhesive anchoring system with a stainless HAS rod which meets the requirements of ASTM F593 (304/316).

E. Stair Treads. Stair treads shall be serrated grating with checkered plate nosing and hot-dipped galvanized.

F. Heavy Duty Serrated Grating. W-22-4 (1½ x ¼) hot-dipped galvanized steel: 1½-by-¼-inch bearing bars at 1-3/8 inches o.c., and crossbars at 4 inches.

2.02 FABRICATION

A. General. Structural and architectural metal shall be fabricated in accordance with the Drawings and in a neat workmanship manner.

B. Structural Steel. Structural steel components shall be fabricated and erected in accordance with the applicable requirements set forth by the American Institute of Steel Construction (AISC) publications, "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings," Section 1.23 entitled "Fabrication," and "Code of Standard Practice for Steel Buildings and Bridges," and Section 6 entitled "Fabrication and Delivery."

1. Members shall be straight with no bends or kinks. Steel shall be accurately cut with shears, mechanically-guided torches capable of forming smooth cut, or hand-guided torches. Hand-guided cuts or other rough surfaces, which are exposed or visible, shall be ground smooth. Exposed sharp edges and corners shall be machine filleted or chamfered. Bolt holes shall be accurately located and orientated normal to the bolting surfaces.

C. Handrails and Guards

1. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.

2. Provide weepholes, or another means to evacuate entrapped water, in hollow sections of railing members that are exposed to exterior or to moisture from condensation or other sources.

3. Fabricate joints that will be exposed to weather in a manner to exclude water.

4. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.

5. Where indicated, provide toe boards at railings around openings and at the edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

6. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.

D. Grating

1. Provide for anchorage per manufacturer's recommendations. Fabricate and space anchoring devices to secure gratings, frames, and supports rigidly in place and to support loads.

2. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

E. Welds. Welds for the structural components shall conform to the applicable standard specifications set forth by the American Welding Society (AWS) publication "Structural Welding." Welds shall be of the type and size shown on the drawings.

F. Handrails, guards, base plates, bolts, rods, studs, nuts, washers, ladders, platform, cages, grating and other miscellaneous angles and plates shall be hot-dipped galvanized, as set forth in ASTM A123 after cut and fabricated.

G. Damage caused to galvanized surfaces by transport, erection, welding, or other operations shall be field repaired using a cold galvanizing process. Galvanizing Repair Paint: high-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

H. Quality Control

1. The manufacturer or fabricator shall maintain a documented quality control program. The quality control program shall conform to the AISC Specifications and Code of Standard Practice.

2. Welders shall conform to the requirements set forth in AWS 01.1, Section 5 for the work performed. Welds shall be inspected in accordance with AWS D1.1, Section 6.

PART 3: EXECUTION

3.01 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Care shall be utilized throughout the delivery, storage, and handling so as to not scratch, bend, warp, or otherwise damage the components.

B. Metal chords, cable, or straps likely to damage the galvanized coating shall not be used.

C. Components shall be stored aboveground on level timbers or other materials.

3.02 ERECTION

A. General. Metal components shall be erected in a neat workmanship-like manner. Components shall be plumb, horizontal at the designated slope, and square, as appropriate.

B. Structural Steel. Structural steel shall be erected in accordance with the AISC Specifications, Section 1.25 entitled "Erection," the Code of Standard Practice Section 7 entitled "Erection," and commentaries. This includes the tolerance requirements.

C. Field Connections. Field connections shall be performed in a neat workmanship-like manner. Applicable welding requirements set forth in Part 2 of this section for fabrication shall also pertain to the erection.

D. Anchor Bolts. Hilti HVA anchor bolt system shall be drilled into hardened concrete and fastened in accordance with manufacturer's recommendations.

E. Handrails and Guards. Handrails and guards shall be installed in accordance with the details shown on the Construction Drawings. Vertical components of handrails and guards shall be plumb and all horizontal components shall be parallel to the walls.

F. Gratings

1. Install gratings to comply with recommendations of NAAMM grating standard referenced under Part 2 that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

2. Secure non-removable and removable units to supporting members with type and size of clips and fasteners indicated, or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

3. All removable grating panels shall be outlined in yellow paint.

G. Touch up surfaces and finishes after erection.

1. Galvanized Surfaces: clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780

H. Handrail and Guard Connections

1. Use fully welded joints for permanently connecting steel railing components.

2. Install expansion joints not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond the joint on each side, fasten internal sleeve securely to 1 side and locate joint within 6 inches of post.

3.03 FIELD CONTROL QUALITY

A. Contractor shall establish and maintain quality control for work under this section to assure compliance with Agreement requirements and maintain records of his quality control for all construction operations.

3.04 PROTECTION

A. Protect finishes of handrails and railing systems from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of completion.

B. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05501