BIG RIVERS ELECTRIC CORPORATION

Filed December 3, 2014

Application of Big Rivers Electric Corporation

For Approval to Issue Indebtedness

Single paper copy of Exhibit # 5

EXHIBIT 5

807 KAR 5:001 Section 18(1)(e)

The property in detail that is to be acquired, constructed, improved, or extended with its cost, a detailed description of the contemplated construction, completion, extension, or improvement of facilities established in a manner whereby an estimate of the cost may be made, a statement of the character of the improvement of service proposed, and of the reasons why the service should be maintained from its capital. If a contract has been made for the acquisition of property, or for construction, completion, extension, or improvement of facilities, or for the disposition of the securities, notes, bonds, stocks, or other evidence of indebtedness that it proposes to issue or the proceeds thereof and if a contract has been made, copies thereof shall be annexed to the petition;

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Green Station

Proposed MATS System

System Description

Big Rivers Electric Corporation is installing Dry Sorbent Injection ("DSI") and Activated Carbon Injection ("ACI") systems for Robert D. Green Generating Station ("Green Station") Units 1 and 2. The addition of the DSI and ACI systems are intended to reduce mercury ("Hg") emission to levels compliant with the Mercury Air Toxic Standards ("MATS"). DSI systems will be used to reduce SO3 levels as necessary to improve the Hg removal efficiency of activated carbon. The DSI system will utilize hydrated lime for the reagent. The ACI system will utilize powdered activated carbon ("PAC"). A complete system for receiving, storing, and injecting dry sorbent for SO3 removal, and activated carbon for mercury removal will be installed on each Green unit.

Dry Sorbent Injection System

Each unit is provided with the following equipment for injection of sorbent. The design sorbent is hydrated lime.

Truck unloading station - with Kamlock fitting, actuated isolation valve, local operator panel, conveying pipe, target box, and bin vent with exhaust blower mounted on the receiving silo. The bin vent features top access for bag removal. Sorbent is delivered by truck.

Storage silo- including pressure/vacuum relief valve, top-mounted continuous level transmitter, one high level switch, two low level switches, bin activator, and bin discharge isolation valve. The storage silo has a useable capacity of about 80 tons of hydrated lime, providing over five days of storage at design feed rate. The silo is 13' 11" in diameter, permitting shop assembly and shipment by truck.

Access to the roof and mezzanine levels of all four silos (carbon and lime, Units 1 and 2) is provided from a common stair tower. Silos include heat, ventilation, and lighting.

A motorized bin activator is used rather than fluidizing air, to avoid introducing unnecessary air into the silo. Excessive contact with air can result in a loss of reactivity by converting calcium hydroxide to calcium carbonate.

The single outlet from the bin discharger is equipped with a manual slide gate and an actuated valve to control refill of either of the two, redundant feeder trains. In normal operation, both the bin activator and refill valve operate on demand from the distributed control system ("DCS") to

refill the active feed train weigh hopper. Storage silo level switch status and continuous level transmitter signal are displayed to the operator. A cone angle of 70 degrees in the transition from the silo to the bin discharger, and a single outlet in the discharger center, ensure mass flow.

2 x 100% feeder trains - each with an actuated selection valve, vented weigh hopper, variable-speed rotary feeder, vented surge hopper, and fixed-speed rotary valve discharging to conveying air. Both the weigh hopper and surge hopper are vented through integral pulse-cleaned filters, operating from local timer boards whenever the feeder train is active. Level switches in the weigh hopper, backed up by hopper weight, automatically control the operation of the refill (silo discharge) valve. An automated valve in each feeder train inlet is used to select a feeder for operation or standby.

The feed rate is set by an output from the DCS, based on a function of steam flow, with an operator-selected bias based on current fuel blend. A control panel local to the weigh feeder modulates the rotary valve speed to achieve the desired feed rate, and returns a measured feed rate back to the DCS. The weigh hopper is designed with 70 degree sloped sides to ensure mass flow without flow assist devices. An air powered vibrator may be activated automatically based on deviation of feed rate from the established rate vs. speed characteristic, or, momentarily during refill.

2 x 100% conveying air systems- each including a dehumidifier with pre- and post-cooling, a positive displacement blower in sound enclosure, silencer, check valve, post-blower heat exchanger, pressure transmitter, temperature transmitter, blow-through adaptor for sorbent pick-up, and actuated isolation valve. Fully redundant trains ensure that dry, cool air is available for conveying. Selection of an operating conveying air system is tied to selection of the feeder train.

Distribution system- consisting of single conveying line to the unit area, a splitter to two smaller lines, each line serving one economizer outlet duct, and for each duct, a splitter to two additional lines, each serving one injection lance. The lances, full bore, open-ended pipe, are highly resistant to plugging. Each lance line is equipped with a flow switch to detect loss of solids flow and generate an alarm to the DCS. Manual valves allow isolation and compressed air purging of individual lances with the remaining lances in operation.

Sorbent is injected immediately after the turn of the economizer outlet duct from horizontal to vertical in order to allow the maximum possible sorbent residence time upstream of the air heater and subsequent carbon injection.

Activated Carbon Injection System

Each unit is provided with the following equipment for injection of powdered activated carbon.

Truck unloading station - with Kamlock fitting, actuated isolation valve, local operator panel, conveying pipe, target box, and bin vent with exhaust blower, mounted on the receiving silo. The bin vent features top access for bag removal. PAC is delivered by truck.

Storage silo - including pressure/vacuum relief valve, top-mounted continuous level transmitter, one high level switch, two low level switches, bin activator, and bin discharge isolation valve. The silo has a useable capacity of about 25 tons, providing over five days of storage at design feed rate.

The silo is 13' 11" in diameter, permitting shop assembly and shipment by truck.

Access to the roof and mezzanine levels of all four silos (carbon and lime, Units 1 and 2) is provided from a common stair tower. Silos include heat, ventilation, and lighting.

A motorized bin activator is used rather than fluidizing air to avoid introducing unnecessary air into the silo. Contact with air can result is loss of activity due to oxidation, and in some circumstances, to self- heating of carbon. In this system, the silo discharges intermittently to refill a weigh hopper. The bin activator operates only on refill, so there is no potential for product compaction.

The single outlet from the bin discharger is equipped with a manual slide gate and an actuated valve to control refill of either of the two, redundant feeder trains. In normal operation, both the bin activator and refill valve operate on demand from the DCS to refill the active feed train weigh hopper. Level switch status and continuous level transmitter signal are displayed to the operator. A cone angle of 70 degrees in the transition from the silo to the bin discharger, and a single outlet in the discharger center, ensure mass flow.

2 x 100% feeder trains- each with an actuated selection valve, vented weigh hopper, variable speed screw feeder, vented surge hopper, and fixed speed rotary valve discharging to conveying air. Both the weigh hopper and surge hopper are vented through integral pulse-cleaned filters, operating from local timer boards whenever the feed train is active. Level switches in the weigh hopper, backed up by hopper weight, automatically control the operation of the refill (silo discharge) valve. An automated valve in each feed train inlet is used to select a feeder for operation or standby.

The feed rate is set by an output from the DCS, based on a function of steam flow, with feed-back trim using the plant mercury CEMS signal. A control panel local to the weigh feeder modulates the screw feeder speed to achieve the desired feed rate, and returns a measured feed rate back to the DCS. The feed rate is set by an output from the DCS, based on a function of steam flow, with operator-input bias based on current fuel blend.

The weigh hopper is designed with 70 degree sloped sides to ensure mass flow without flow assist devices. An air powered vibrator may be activated automatically based on deviation of feed rate from the established rate vs. speed characteristic, or, momentarily during refill.

2 x 100% conveying air systems- each including a positive displacement blower in sound enclosure, silencer, check valve, pressure transmitter, temperature transmitter, blow-through adaptor for carbon pick-up, and actuated isolation valve. One train is selected for operation to convey activated carbon to the injection lances. Fully redundant trains ensure that air is available for conveying. Selection of an operating conveying air system is tied to selection of the feeder train.

Distribution system- consisting of single conveying line to the unit area, a splitter to two smaller lines, each line serving one air heater outlet duct, and for each duct, a splitter to three additional lines, each serving one injection lance. The lances, full bore, open-ended pipe, are highly resistant to plugging. Each lance line is equipped with a flow switch to detect loss of solids flow and generate an alarm to the DCS. Manual valves allow isolation and compressed air purging of individual lances with the remaining lances in operation.

Activated carbon is injected immediately after the air heater in order to allow the maximum possible carbon residence time upstream of the electro-static precipitator and removal of particulate from the flue gas. Existing platforms provide access to the lances.

Compressed Air System

Two, I00% compressed air systems are provided for all MATS project equipment compressed air requirements. Each system will supply air for the ACI and DSI systems on both units. Each system includes an oil-free compressor package, heatless desiccant dryer, and vertical air receiver tank. Compressed air requirements for the MATS equipment are limited to vent filter cleaning air, and minor amounts for valve actuators. The minimum available capacity for an oil-free compressor exceeds the system requirement, and could provide compressed air to the plant.

Mercury Monitors

Green 1 is equipped with a process Hg Continuous Emissions Monitoring System ("CEMS") to confirm mercury compliance at the stack level. The Hg CEMS will be utilized for process control purposes to gauge and adjust both the ACI System and DSI System to meet MATS compliance parameters.

Green 2 will be equipped with an Hg Sorbent Trap System to confirm mercury compliance at the stack level. The sorbent traps will be pulled on a weekly basis and analyzed per USEPA

Method 30B to determine compliance on a 30-day rolling average. Furthermore, a process Hg monitor will be installed and utilized for process control purposes to gauge and adjust both the ACI System and DSI System to meet MATS compliance parameters.

Wilson Station

Proposed MATS System

System Description

Big Rivers Electric Corporation is installing a complete system for receiving, storing, and injecting dry sorbent on the Wilson unit.

Dry Sorbent Injection ("DSI") System

The unit is provided with the following equipment for injection of sorbent. The design sorbent is hydrated lime.

Truck unloading station - with Kamlock fitting, actuated isolation valve, local operator panel, conveying pipe, target box, and bin vent. The bin vent features top access for bag removal. Sorbent is delivered by truck.

Storage silo - including ladder and cage, top rail, hoist system, crossover platform from silo to stair tower, bin vent filter, target box, pressure/vacuum relief valve, top-mounted continuous level transmitter, one high level switch, two low level switches, air sweep system, bin discharger, manual knife gates, pneumatic butterfly valves, two-way diverter, and bin discharge isolation valve. The storage silo has a usable capacity of about 140 tons of hydrated lime, providing nearly five days of storage at design feed rate. The silo is 14' in diameter and 103' tall, permitting shop assembly and shipment by truck.

Access to the roof and mezzanine levels of the silo is provided from a stair tower. The silo includes heat, ventilation, and lighting.

Connected to the DSI silo are two (2) 100% feed capacity weigh hopper systems. The silo discharge incorporates a mechanical bin discharger and a cone aeration system to feed material to the weigh hoppers. When a weigh hopper calls for material, a set of butterfly valves direct material to the appropriate weigh hopper and the aeration system starts. A bin discharger uses an on/off sequence to keep material flowing. If material does not flow properly, a cone aeration system starts until flow is regained, then shuts off. Since the material is hygroscopic, the use of air is kept to a minimum. When the hopper becomes full, as noted by the level indicator or weight, the butterfly valve closes and the bin discharger stops.

Each hopper evacuates blow back and redistribute sorbent back into the weigh hoppers or vented to the silo roof for filtration. The hoppers batch fill based on preset weights. A set of external vibrators are provided for each hopper to enhance material flow. Each weigh hopper discharge

incorporates a double rotary feeder system with a vent box between the feeders. This provides accurate material flow and minimal blowback from the conveying system.

Sorbent is fed into the air conveying system through this series of rotary feeders. The first rotary feeder ("rotary feeder") is variable speed and is used to meter the material. The second rotary feeder ("rotary airlock") is a drop through, constant speed valve that injects the material into the convey line. Desired feed rate is set in the control system. The weigh hoppers provide feedback of the real time material weight in the hopper during system operation. The control uses this feedback to calculate the actual feed rate and compares the actual to the desired feed rate. The rotary feeder speed is automatically adjusted to maintain the desired feed rate. Rates can change based on bulk density, air blowback, humidity, etc. and must be monitored. All automated valves have limit switches to monitor valve position. The compressed air system will provide the DSI system with the required 100 PSI, -40°F dew point instrument quality air.

3 x 100% conveying air systems - each including a dehumidifier , a positive displacement blower with VFD speed control in a separate blower building, silencer, check valve, post-blower heat exchanger, pressure transmitter, temperature transmitter, blow-through adaptor for sorbent pick-up, and actuated isolation valve. Fully redundant trains ensure that dry, cool air is available for conveying. Selection of an operating conveying air system is tied to selection of the feeder train.

Distribution system - consisting of a single conveying line to each SCR outlet duct The lances, full bore, open-ended pipe, are highly resistant to plugging. Each lance line is equipped with a flow switch to detect loss of solids flow and generate an alarm to the DCS. Manual valves allow isolation and compressed air purging of individual lances with the remaining lances in operation.

Power Control Module ("PCM") Enclosure - The PCM is pre-assembled, piped, wired and houses the MCC's, DCS cabinet (to be provided by others), space for future ACI MCC, main DSI control panels and various instrumentation. The PCM is complete with HVAC, fan ventilation and work station. Wiring and piping of all equipment within the PCM enclosure is installed in the factory.

Blower & Compressed Air System Enclosure - The blower systems, compressed air systems and various instrumentation will be housed in a new enclosure and shipped to the site pre-assembled, ready for installation on the permanent foundation. The blower and compressor enclosure is complete with HVAC, fan ventilation, work station, is sized and designed to provide enough air to accommodate blower usage and to keep the room at a constant 70°F. The blower inlet air is pulled through a dehumidifier which removes moisture. The blower discharge is connected to an air to air aftercooler, keeping the conveying air temperature under 120°F. Wiring and piping of all equipment within the enclosure is installed in the factory. After-coolers shall be placed outdoors, adjacent to the enclosure.

Compressed Air System

Two, 100% compressed air systems are provided for all DSI project equipment compressed air requirements. The system will supply air for the DSI system. Each system includes an oil-free compressor package, heatless desiccant dryer, and vertical air receiver tank. Compressed air requirements for the DSI equipment are limited to vent filter cleaning air, and minor amounts for valve actuators.

Mercury Monitors

The Wilson unit will be equipped with an Hg Sorbent Trap System to confirm mercury compliance at the stack level. The sorbent traps will be pulled on a weekly basis and analyzed per USEPA Method 30B to determine compliance on a 30-day rolling average.

HMP&L Station Two

Proposed MATS System

System Description

Big Rivers Electric Corporation is installing mercury ("Hg") monitors on the Station Two units owned by Henderson Municipal Power and Light ("HMP&L").

Mercury Monitors

Each of the two Station Two units owned by HMP&L will be equipped with an Hg Sorbent Trap System to confirm mercury compliance at the stack level. The sorbent traps will be pulled on a weekly basis and analyzed per USEPA Method 30B to determine compliance on a 30-day rolling average.

Big Rivers
ELECTRIC CORPORATION

Your Touchstone Energy® Cooperative

Mercury and Air Toxics Standard (MATS) Compliance Project

General Construction
Contract 8320

RFQ #GN-14-030

Table of Contents
RFQ # GN-14-030

ATTACHMENTS

Documents:
73827.00400.Bid Form.xls
73827.00400.Unit Price Breakdown.xls
73827.00420.Clarifications and Exceptions.xls

Additional reference drawings will be available via a web link identified in a separate email.

PROJECT SUMMARY

Big Rivers Electric Corporation (Owner) is installing Dry Sorbent Injection (DSI) and Activated Carbon Injection (ACI) systems for Robert D. Green Generating Station (Green Station) Units 1 and 2. The addition of the DSI and ACI systems are intended to reduce mercury (Hg) emission to levels compliant with the Mercury Air Toxic Standards (MATS). DSI systems will be used to reduce SO_3 levels as necessary to improve the Hg removal efficiency of activated carbon. The DSI system will utilize hydrated lime for the reagent. The ACI system will utilize powdered activated carbon (PAC).

This Contract sets forth the requirements for the General Construction Contractor to perform and provide the following:

A. Furnish all construction labor, supervision, equipment, tools, rigging, blocking, scaffolding, material, supplies, transportation, project management, construction management (including scheduling and cost control), and services necessary to:

   1. Receive, protect, store, haul, assemble, erect, install, and place into service Equipment and Material furnished by other contracts including, but not limited to:

      a. Dry Sorbent Injection (DSI) System

      b. Activated Carbon Injection (ACI) System

      c. Compressed air system

      d. Power control module (PCM)

      e. Structural and support steel for all equipment and piping

      f. Stair tower

      g. DCS cabinets

   2. Procure, fabricate, deliver, receive, protect, store, haul, assemble, erect, install, and place into service Equipment and Material in accordance with the requirements of this Contract. The Equipment and Materials include, but are not limited to, the following:

      a. All cables in the Cable Schedule

      b. Instrument and control cables

      c. Power feeds

      d. Ground connections

e. Lighting

f. Raceway systems

g. Pull boxes and junction boxes

h. Fire stops

i. Heat trace and insulation

B. Provide start-up, commissioning, and field testing activities.

C. Obtain the services of a testing subcontractor to perform third party electrical tests.

D. Preform grading and leveling as required to install asphalt paving.

1. DEFINITIONS

1.1. "Addenda" - written or graphic changes or interpretations of the Contract Documents issued by Owner prior to the opening of Bids.

1.2. "Administrator" shall mean the Administrator of the Rural Utilities Service of the United States of America and his or her duly authorized representative or any other person in whom or authority in which may be vested the duties and functions which the Administrator is now authorized by law to perform.

1.3. "Agreement" or "Contract" - the written agreement between Owner and Bidder covering the Work to be performed. Other Contract Documents are attached to the Contract and made a part thereof as provided therein.

1.4. "Application for Payment" - the form acceptable to Owner and Engineer which is to be used by Bidder during the course of the Work in requesting progress or final payments and which is to include such supporting documentation as is required by the Contract Documents.

1.5. "Bid" - the formal offer of the Bidder submitted on the prescribed Bid Form and all information submitted with the Bid that pertains to performance of the Work.

1.6. "Bidder" – Prior to Contract award, "Bidder" is any person, firm, or corporation submitting a Bid for the Work or their duly authorized representative. Upon Contract

award, "Bidder" is the person, firm or corporation with whom the Owner has entered into the Contract.

1.7. "Change Order" - a written document recommended by Engineer which is signed by Owner and Bidder and authorizes an addition, deletion, or revision in the Work, or an adjustment in the Contract Price or the Contract Time or other material provision issued on or after execution of the Contract.

1.8. "Company" – Big Rivers Electric Corporation, also referred to as "BREC", "Big Rivers", or "Owner".

1.9. "Contract" or "Agreement" - the written agreement between Owner and Bidder covering the Work to be performed. Other Contract Documents are attached to the Contract and made a part thereof as provided therein.

1.10. "Contract Documents" - RUS Form 198 or RUS Form 200, all documents referenced in the table of contents, exhibits, attachments, affidavits, bonds, insurance requirements and documents, releases, Specifications, drawings, and Change Orders or signed amendments issued to the Contract.

1.11. "Contract Time" - the number of days or the dates stated in the Contract Documents for the completion of the Work.

1.12. "Contractor" - is the person, firm or corporation with whom the Owner has entered into the Contract.

1.13. "Date of Contract" - the date on which the Contract is signed and executed by the Owner.

1.14. "Day" or "Days" - a calendar day of 24 hours measured from midnight to the next midnight.

1.15. "DDP" (Delivered Duties Paid) (Incoterms 2000) Point of Delivery - The Contract Price includes all costs of transporting Equipment and Materials to the named Point

of Delivery, including but not limited to any duties, permits, and insurance for the full value of the Equipment and Materials being delivered.

1.16. "Defective" - an adjective which when modifying the words Equipment and Materials, or Field Services refers to Equipment and Materials or Field Services which do not conform to the Contract Documents, or do not meet the requirements of any inspection reference standard, test, or approval referred to in the Contract Documents.

1.17. "Effective Date of the Contract" – the date of Acceptance of Contract by Owner or if approval by the Administrator is required, the date of approval by the Administrator in accordance with RUS Form 198 or RUS Form 200.

1.18. "Engineer" shall mean the Engineer employed by the Owner to provide engineering services for the project and said Engineer's duly authorized assistants and representatives. For this Project, "Engineer" means Burns & McDonnell Engineering Company, Inc. a Missouri Corporation, with offices at 9400 Ward Parkway, Kansas City, Missouri 64114.

1.19. "Equipment" - a product with operational or nonoperational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

1.20. "Field Services" - services to be furnished by Contractor at the Site as required by the Contract Documents.

1.21. "Final Acceptance" - shall mean the point after Substantial Competition when Contractor has (i) completed all punch list items; (ii) delivered to Owner all final documentation; and (iii) met all requirements associated with Liquidated Damages or paid the applicable damages.

1.22. "Force Majeure" - any condition, event or circumstance, including the examples set forth below, but only if, and to the extent (i) such condition, event or circumstance is not within the reasonable control of the Party affected, (ii) such condition, event or circumstance, despite the exercise of reasonable diligence, cannot be prevented,

avoided or removed by such Party, (iii) such condition, event or circumstance materially adversely affects the ability of the affected Party to fulfill its obligations under this Agreement, (iv) the affected Party has taken all commercially reasonable precautions, due care and commercially reasonable alternative measures in order to avoid the effect of such condition, event or circumstance on the affected Party's ability to fulfill its obligations under this Agreement and to mitigate the consequences thereof and (v) such condition, event or circumstance is not the result of any failure of such Party to perform any of its obligations under this Agreement. By way of example, such events, conditions and circumstances shall include war, rebellion, sabotage, riots, insurrection, public disorder, fires, floods, volcanic eruption, tidal wave, earthquake, quarantine, explosions or other natural catastrophes or Acts of God, and changes in applicable Laws or Regulations after the Effective Date of the Contract.

1.23. "Laws and Regulations"/ "Laws or Regulations" - laws, rules, regulations, ordinances, codes and/or orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

1.24. "Liquidated Damages" – payments which the Contractor shall make to the Owner for the value of damages experienced by the Owner to compensate for additional operational expenses or missed delivery schedules defined within the Contract.

1.25. "Materials" - products substantially shaped, cut, worked, mixed, finished, refined, or otherwise fabricated, processed, or installed to form a part of the Work.

1.26. "Notice to Proceed" - the written notice by Owner to Bidder fixing the date on which the Contract Time will commence to run and on which Bidder shall start to perform Bidder's obligation under the Contract.

1.27. "Owner" – Big River Electric Corporation, also referred to as "BREC", "Big Rivers", or "Company".

1.28. "Point of Delivery" – the place designated where the Equipment and Materials are to be delivered, being:

1.28.1. Big Rivers Electric Corporation, Green Station, 9000 HWY 2096, Robards, KY 42452.

1.29. "Parties" - Owner and Bidder, each of which is individually a "Party".

1.30. "Payment and Cancellation Schedule" - the detailed listing of activities or milestones with an associated payment percentage of the total Contract Price which accurately reflects payment for Work accomplished and cancellation percentage of the total Contract Price which reflects the payment(s) agreed to between the Parties in the event of cancellation. This schedule shall be jointly developed and agreed to by Owner and Contractor.

1.31. "Project" - the total construction of which the Work to be provided under the Contract may be the whole, or a part as indicated elsewhere in the Contract.

1.32. "Reference Drawings" - drawings not specifically prepared for this Contract, but which contain information pertinent to the Work.

1.33. "Samples" - physical examples of Equipment, Materials, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

1.34. "Shop Drawings" - all drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

1.35. "Site", "Job Site" or "Point of Delivery" - the Owner's Station where Material and Equipment is being delivered, being:

1.35.1. Big Rivers Electric Corporation, Green Station, 9000 HWY 2096, Robards, KY 42452.

1.36. "Specifications" - those portions of the Contract Documents consisting of written technical descriptions of the Work, and covering the Equipment, Materials, workmanship, performance and certain administrative details applicable thereto.

1.37. "Subcontractor" - an individual, firm, or corporation having a direct contract with Contractor to perform a portion of the Work.

1.38. "Submittals" - all Shop Drawings, product data, and Samples which are prepared by Contractor, a Subcontractor, manufacturer or Supplier, and submitted by Contractor to Owner and Engineer as a basis for approval of the use of Equipment and Materials proposed for incorporation in the Work or needed to describe proper installation, operation, and maintenance, or technical properties.

1.39. "Substantial Completion" - the event when, as determined in Owner's reasonably exercised discretion, (i) erection or installation of the Equipment and Materials furnished under the Contract has been completed by the installing Contractor and required Field Services have been furnished; (ii) all testing of the Work has been completed and all test data properly evaluated; (iii) the guarantees have been verified by Owner and Engineer and the warranty period has commenced; and (iv) Contractor has delivered to Company any operating instructions, maintenance manuals, and warranties.

1.40. "Supplier" - a manufacturer, fabricator, supplier, distributor, material man, or vendor of Bidder or Contractor.

1.41. "Work" - the goods and all services required by the Contract, and includes all labor, Materials, Equipment and services provided or to be provided by the Contractor to fulfill the Contractor's obligations herein. The Work may constitute the whole or a part of the Project.

2. OVERVIEW

2.1. The Contractor shall furnish, deliver (DDP Point of Delivery), and install all Equipment and Material in accordance with the requirements of this Contract.

2.2. Robert D. Green Generating Station consists of Unit 1 and Unit 2 which are 250 MW and 242 MW pulverized coal-fired balanced draft natural circulation, wall fired units provided by Babcock & Wilcox in 1976. Both units have two air preheaters and two electrostatic precipitators downstream of the economizers, and two wet FGD scrubbers which run at all times the units are online. The Green Station units burn a blend of bituminous coal and petroleum coke with a range of 0% - 27% petroleum coke in the blend.

2.3. If any conditions, circumstances or occurrences not covered in the Specification are encountered, or if there are any doubts as to the meaning, please contact the Rob Toerne at (270) 844-6029 or rob.toerne@bigrivers.com. Clarifications or explanations may result in an addendum to the RFQ.

2.4. The Contractor shall abide by the items in this Specification unless Big Rivers agrees in writing to any changes. Changes must be made in the form of a written request.

2.5. Big Rivers Electric Corporation reserves the right to reject any or all Bids, to waive informalities therein and to consider exceptions and clarifications therein in order to determine the lowest and best bid; to reject any or all non-conforming, non-responsive, unbalanced or conditional Bids; to reject the Bid of any Contractor that it would not be in the best interest of the Project to make an award to that Contractor, whether because the Bid is not responsive or the Contractor is unqualified or of doubtful financial ability, or fails to meet any other pertinent standard or criteria established. The Company also reserves the right to negotiate contract terms with the successful Contractor. By submitting a Bid, the Contractor agrees that such procedures will be without liability for any damage or claim brought by the Contractor because of such rejections or procedures, nor will the Contractor seek any recourse of any kind against the Company because of such rejections or procedures.

The filing of any Bid in response to this Invitation will constitute an agreement of the Contractor to these conditions.

3. PROPOSAL PREPARATION AND SUBMITTAL

3.1. A mandatory pre-bid meeting will be held on May 20, 2014 at Big Rivers Green Station starting at 8:30 AM CT.

3.2. All bids will be valid for ninety (90) days from the opening of the bid.

3.3. The Bidders must complete and submit all documents identified as submittals within this document including, but not limited to;

a. Document 00400 - BID FORM for Contract 8320 included in the Engineer's Specification
b. Document 00401 - UNIT PRICE BREAKDOWN form for Contract 8320 included in the Engineer's Specification
c. Document 00420 - Clarifications and Exceptions for Contract 8320 included in the Engineer's Specification
d. Big Rivers Contractor Safety Credentials Assessment Program
e. RUS Equal Opportunity Form 270
f. RUS Certification Relating to Lobbying
g. RUS Certification Regarding Debarment Form AD-1048
h. Big Rivers New Vendor Information Form
i. IRS Form W-9

3.4. The Bidders must submit a preliminary Payment Schedule paired with readily identifiable milestone events.

3.5. The Bidder must submit a list of any Subcontractors that might be used for this project for pre-approval. The submittal must include experience lists and reference contacts for all proposed Subcontractors.

3.6. Any deviations from or exceptions to the attached Specification, terms and conditions, or the Submittals may impact the evaluation of the Bidder's proposal. If

there are no exceptions or clarifications please so indicate on the Clarifications & Exceptions Form. Any exception taken to the Specification must be justified in writing, i.e., safety, reliability, efficiency, and increase or decrease in cost and identified on Clarifications & Exceptions Form.

3.7. Any addenda to this request for quotation (RFQ) shall be signed by the Bidder and will be returned with the proposal.

3.8. The Bidder will submit sufficient information and detail with the bid to permit full understanding and evaluation of the Equipment, Materials, and services being offered.

3.9. The proposal shall be submitted by post, courier, or hand delivered in a sealed envelope marked prominently with the RFQ number GN-14-030. **Bid Proposal must be received no later than June ~~13~~30, 2014 by 3:00 p.m. (Central Time).** Bid proposals received after this date and time will be returned and will not be considered. The bid proposal shall consist of three hard copies and one electronic copy (DVD, CD or thumb drive) and shall be submitted to the Big Rivers Supply Chain Department at the following address:

3.9.1. Big Rivers Electric Corporation
Attn: Robert F. Toerne
201 Third Street
Henderson, KY 42420

3.10. This inquiry implies no obligation on the part of Big Rivers. The Bidder offers the prices, terms, and delivery freely and without bias.

3.11. All expenses incurred by the Bidder in the development of this bid are the sole responsibility of the Bidder.

3.12. The Contractor will, within 14 days after Notice to Proceed, submit a Certificate of Insurance naming Big Rivers Electric Corporation as the holder of the certificate. The certificate will also show Big Rivers Electric Corporation and Engineer as additional insureds. Insurance coverage must meet as a minimum, the insurance requirements as specified in Section 7.21 of this document.

3.13. The Contractor will, within 10 business days after Notice to Proceed, submit performance and payment bonds (Bonds), each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of all of Bidder's obligations under the Contract Documents.

3.13.1. All Bonds shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury.

3.13.2. The Bonds shall be automatically increased in amount and extended in time without formal separate amendments to cover full and faithful performance of the Contract in the event of Change Orders, regardless of the amount of time or money involved. It is Contractor's responsibility to notify its surety of any changes affecting the general scope of the Work or change in the Contract Price or Contract Time. All Bonds signed by an agent must be accompanied by a certified copy of the agent's authority to act.

3.13.3. If at any time during the continuance of the Contract, the surety on any Bond becomes unacceptable to Owner for financial reasons, Owner has the right to require additional and sufficient sureties, which Contractor shall furnish to the satisfaction of Owner within ten (10) Days after notice to do so.

3.13.4. If the surety on any Bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of the Contract, Contractor shall within five (5) Days thereafter substitute another Bond and surety, both of which must be acceptable to Owner.

3.14. The evaluation methodology that will be used to identify the winning bid includes, but is not limited, to the following four elements: Non-Responsiveness Evaluation, Price Evaluation, Qualification/Certification Evaluation, and Technical Evaluation.

The purpose of each element and the process employed in each are described in the following sections.

3.14.1. Non-Responsiveness Evaluation: The Non-Responsiveness Evaluation is designed to identify and eliminate any proposal that has not provided the requested information in a proper format to allow an equitable evaluation to occur or that does not meet the requirements set forth in this RFQ. A bid deemed non-responsive by Big Rivers may be rejected. Bidders are subject to disqualification for such things as failure to submit the proposal on or before the designated time and date. Big Rivers Electric Corporation may, in its discretion, disqualify a bid and drop it from further consideration for failure to submit a complete proposal in the form required or failure to provide additional supporting documentation or any clarification that may be requested by Big Rivers subsequent to the submission of the proposal.

3.14.2. Price Evaluation: The Price Evaluation is designed to identify and eliminate bids which are clearly more expensive than other compliant proposals received. This will be accomplished by ranking the bids, as well as the designated options, against each other according to price. Preliminary estimates of production cost effects, operation and maintenance costs, and other pertinent costs will be made and added to each proposal for evaluation purposes. The evaluation will also include an estimate of the negative impact of deviations or exceptions, if any, to the terms and conditions in the proposed Contract or in other agreements contemplated to be entered into. Big Rivers expects the bid to contain an early payment discount structure which terms will also be part of the evaluation.

3.14.3. Qualification/Certification Evaluation: The Qualification/Certification Evaluation is designed to identify and eliminate bids that clearly demonstrate a lack of understanding or an inability to meet the intended Specification for this project. Big Rivers Electric Corporation requires all on-site contractors to complete the Contractor Certification process before any on-site work is awarded.

3.14.4. Technical Evaluation: The Technical Evaluation will consist of a comprehensive review that considers a number of price and non-price factors. The goal of the Technical Evaluation is to determine the options that best meet the needs of Big Rivers for this project and technical options which improve the facility's overall cost, reliability and availability.

4. SCHEDULE REQUIREMENTS

4.1. The time of completion of the Work is a basic consideration of the Specification. Time is of the essence of this Agreement. The proposal will be based upon completion of the Work as referenced by Section 011100, Entry 1.08 of the Engineer's Specification. Contractor's preliminary schedule and support requirements must be defined and submitted to Big Rivers and the Engineer for approval. A final, mutually agreed and approved schedule must be met.

4.2. The Contractor will provide a ~~bi-~~weekly project status update per Section 013~~2~~100 to the designated Big Rivers representative and Engineer's representation. The project status update report may be adjusted more or less often based on the Contractor's performance or Project requirements.

4.3. The Contractor will adhere to the schedule. Schedules provided with the proposal or within this Specification may be updated prior to the start of the Project. The Contractor will take any and all actions necessary to ensure scheduled completion.

4.4. The Contractor shall maintain, throughout the duration of the job, a schedule with the work progression of individual job elements. The schedule will be up-dated regularly and will be available to Big Rivers for review at any time. The schedule will be broken down to show individual job elements.

4.5. If at any time during the progress of the Work it is determined that the scheduled completion date cannot be met, Big Rivers reserves the right to take any action it deems necessary to ensure timely completion.

5. PLANT SITE REQUIREMENTS

5.1. Big Rivers is committed to procuring safe results for all Purchase Orders. The Contractor and every on-site employee must be certified through and current with Big Rivers' Contractor Safety Credentials Assessment Program (C-SCAP). Contractor will comply with all applicable OSHA, KOSHA, EPA, Big Rivers' rules or other safety practices, rules and regulations that govern work while on the Big Rivers' sites.

5.1.1. The Contractor's on-site employees will be in compliance with all C-SCAP requirements.

5.1.2. Big Rivers may stop work and/or remove the offending party from the worksite if that party fails to observe safety requirements.

5.2. The Contractor will provide all necessary supervision, labor, job management, Materials, tools, Equipment and consumables deemed necessary to ensure safe, proper and timely completion of the specified work.

5.3. The Contractor will utilize all of the information presented in this document to be fully prepared to begin work at the specified commencement date and time. The Contractor will ensure that a copy of this document has been reviewed by and is in the possession of the on-site manager.

5.4. The Contractor will ensure that all instructions and emergency warnings can be effectively and immediately communicated to all employees. Unless otherwise instructed Big Rivers requires that one (1) interpreter be provided for every eight (8) non-English speaking employees.

5.5. The Contractor will provide all necessary personnel protective equipment for each of its employees along with documentation of proper training in the use of said equipment.

5.6. The Contractor will provide for the safety and protection of existing property. Any damage to existing facilities resulting from construction operations will be reported immediately to Big Rivers thereof and promptly repaired or replaced by the Contractor.

5.7. The Contractor will protect its own employees and its Subcontractors' employees and be responsible for their work until Big Rivers' acceptance of the entire Project, and to protect Big Rivers' facilities, property, employees and third parties from damage or injury.

5.8. The Contractor will inform Big Rivers of any hazardous chemicals that will be transported or used on the plant site. Material Safety Data Sheets (MSDS) must be provided to the Owner's Site safety representative prior to use on the plant site and must be available at all times while on the plant site.

5.9. The Contractor will comply with the latest or amended version of the followings standards and codes, and with any and all other standards and codes that may be applicable:

5.9.1. National Fire Protection Association (NFPA)

5.9.2. National Electrical Code (NEC)

5.9.3. National Electrical Manufacturers Association (NEMA)

5.9.4. Electrical Apparatus Service Association (EASA)

5.9.5. International Electrical Testing Association (NETA)

5.9.6. Factory Mutual (FM)

5.10. The Contractor will notify the designated Big Rivers representative upon completion of each phase of the Work.

5.11. The Contractor will ensure that all discarded material and trash is removed from the site or placed in an approved dumpster.

~~5.11.1. Big Rivers may provide on-site dumpsters for the disposal of non-hazardous waste material. Debris must not be stacked beyond the top of the dumpster.~~

[Contradicts technical Section 015700 – 3.03.D]

5.12. The Contractor will not discharge petroleum products anywhere on the plant site. Fuel, lubrication products and any other liquid consumables stored on-site will be in an appropriate tank or container with proper labeling. Use of the proper container and the Big Rivers' approval of such containers in no way releases the Contractor from its responsibility to clean up any spills, discharges, or other releases.

5.13. The Contractor will provide for the safety and protection of existing property. Any damage to existing facilities resulting from construction operations will be reported immediately to Big Rivers and promptly repaired or replaced by the Contractor. During the project, unanticipated repairs or work may be encountered. If such needs are discovered during the project, they will be communicated to the designated Big Rivers representative by the Contractor's on-site supervisor as soon as possible.

5.13.1. The Contractor will obtain sufficient information to present a firm dollar quote for any emerging work for this project.

5.13.2. No additional work will be performed until the Contractor has been given written authorization to proceed by the Big Rivers.

5.14. The Contractor will exercise care in the protection of Materials and Equipment furnished under this Contract.

5.15. The Contractor will provide for the safety and protection of existing property. Any damage to existing facilities resulting from construction operations will be reported immediately to Big Rivers thereof and promptly repaired or replaced by the

6. PLANT SITE SUPERVISION

6.1. The Contractor will designate an on-site contact person with the authority to make decisions, correct problems and generally oversee the Contractor's equipment. In the event the contact person is absent from the job site, an alternate contact person with full authority to make decisions will be available onsite during all activities relating to this project.

6.1.1. There will be a designated Big Rivers representative on site, during day shift, to coordinate work schedules, safety issues, etc.

6.2. The Contractor will provide in writing the name and phone number (office, home, pager and mobile as applicable) of the contact person and the alternate contact person(s) prior to the start of Work hereunder and within one working day of any changes in the previously designated contact person.

6.3. To the extent possible, the on-site contact person will be the same from week to week to ensure job continuity.

6.4. The Contractor will provide an after-hours, emergency 24-hour per day contact list. The list will be prioritized as to the order that should be followed in notifying the Contractor.

7. COMMERCIAL TERMS

7.1. Submittal based Liquidated Damages will be assessed at a rate of $500 per day for the first five days and $1,000 per day upon and after six days, retroactive to the first day for each of the items referenced in Appendix 013300-A of the Engineer's Specification as being subject to Liquidated Damages.

7.2. The time of the completion of this General Construction Contract 8320 is of great importance to the Project. Should the Bidder neglect, refuse, or fail to deliver and install the ~~foundations~~ equipment as provided in and defined by this RFQ within the time herein agreed upon, after giving effect to extensions of time, if any, then, in that event and in view of the difficulty of estimating with exactness damages caused by such delay, the Owner shall have the right to deduct from and retain out of such moneys which may be then due, or which may become due and payable to the Bidder the amounts defined within this section for each and every day that such completion is delayed beyond the specified time, as liquidated damages and not as a penalty; if the amount due and to become due from the Owner to the Bidder is insufficient to pay in full any such liquidated damages, the Bidder shall pay to the Owner the amount necessary to effect such payment in full: Provided, however, that

the Owner shall promptly notify the Bidder in writing of the manner in which the amount retained, deducted or claimed as liquidated damages was computed. In no event shall Contractor be liable for delay damages if Company's ability to conduct commercial operations of its unit(s) is not harmfully reduced, impeded, delayed or otherwise adversely affected by Contractor's failure to achieve the schedule guarantees herein. Liquidated Damages will be assessed at the rate for each of the items listed below as referenced in Section 011100, Entry 1.09 of the Engineer's Specification:

7.2.1. Section 011100, Entry 1.08; Item C.8. Green Unit 2 Outage Date: Work that must be done during the unit outage shall be done within the defined outage time frame for Green Unit 2. Any cause by the contractor for the delay of returning the unit to service shall be assessed at $10,000 per day.

7.2.2. Section 011100, Entry 1.08; Item C.9~~. Green Unit 1 Outage Date: Work that must be done during the unit outage shall be done within the defined outage time frame for Green Unit 1. Any cause by the Contractor for the delay of returning the unit to service shall be assessed at $10,000 per day.~~

7.2.3. Section 011100, Entry 1.08; Item C.10. Substantial Completion: Any cause by the Contractor for the delay of meeting Substantial Completion assessed at $10,000 per day.

7.3. Retention

10% of the Contract value will be held as retention until Owner and Engineer have determined the Project to be Substantially Complete with Final Acceptance.

7.4. Warranties

7.4.1. All Materials and Equipment furnished hereunder shall be subject to the inspection, tests, and approval of the Owner and the Engineer, and the Contractor shall furnish all information required concerning the nature or source of any Materials and Equipment and provide adequate facilities for

testing and inspecting the Materials and Equipment at the plant of the Contractor.

7.4.2. Contractor warrants that:

a. the Work will conform to any applicable Specification; and any Materials and Equipment supplied in connection therewith shall be new, unused, and free from defect;

b. the Work will be suitable for the purposes specified by Company and will conform to each statement, representation, and description made by Contractor to Company;

c. the Work is not and shall not be subject to any encumbrance, lien, security interest, patent, copyright or trademark claims, infringements, or other defects in title; and

d. any labor or services performed pursuant to this Agreement shall be performed in a competent, diligent, and timely manner in accordance with the highest professionally accepted standards.

7.4.3. The Work furnished hereunder shall become the property of the Owner upon delivery, provided, however, that the Owner or the Engineer, within two years after initial operation of the Project, or within the period for which the Material and Equipment is guaranteed, whichever is longer, may reject any Materials or Equipment which does not comply with the Specifications made a part hereof or with the guarantees, if any, of the Contractor and the manufacturer. Upon any such rejection, the Contractor shall repair or replace such defective Material or Equipment within a reasonable time after notice in writing from the Owner. If any such defective Materials, Equipment, or workmanship so replaced or repaired is found to be defective within two years after the completion of the replacement or repair, the Contractor shall replace or remedy such defective Materials, Equipment, or workmanship. In the event of failure by the Contractor so to do, the Owner may make such replacement and the cost and expense thereof shall be paid by and recoverable from the Contractor.

7.4.4. Contractor shall respond in writing to any warranty claim by Company within five (5) business days of the delivery of notice of such claim to Contractor.

7.4.5. All manufacturers' guarantees of Equipment, if any, shall be transferred and assigned to the Owner upon delivery of any Equipment and before final payment is made for such Equipment.

7.4.6. The term of the Warranty is two years from the time of acceptance by the Owner and Engineer.

7.5. Materials and Supplies.

In the performance of this Contract there shall be furnished only such unmanufactured articles, Materials, and supplies as have been mined or produced in the United States or in any eligible country, and only such manufactured articles, materials, and supplies as have been manufactured in the United States or in any eligible country substantially all from articles, materials, or supplies mined, produced or manufactured, as the case may be, in the United States or in any eligible country; provided that other articles, materials, or supplies may be used in the event and to the extent that the Administrator shall expressly in writing authorize such use pursuant to the provisions of the Rural Electrification Act of 1938, being Title IV of Public Resolution No. 122, 75th Congress, approved June 21, 1938. For the purposes of this section, an "eligible country" is any country that applies with respect to the United States an agreement ensuring reciprocal access for United States products and services and suppliers to the markets of that country, as determined by the United States Trade Representative. The Bidder agrees to submit to the Owner such certificates with respect to compliance with the foregoing provision as the Administrator from time to time may require.

7.6. Conditions of Risk and Work

Unless the applicable Statement of Work expressly provides otherwise, Contractor agrees that before beginning any Work, Contractor shall carefully examine all conditions relevant to such Work and its surroundings, and, unless Contractor notifies Company in writing that it will not perform the Work under such conditions, Contractor shall assume the risk of such conditions and shall, regardless of such conditions, the expense, or difficulty of performing the Work, fully complete the Work for the stated Contract Price applicable to such Work without further recourse

to Company. Without limiting the foregoing, Contractor specifically recognizes that Company and other parties may be working concurrently at the site. Information on the site of the Work and local conditions at such site furnished by Company in Specifications, drawings, or otherwise is made without representation or warranty of any nature by Company, is not guaranteed by Company, and is furnished solely for the convenience of Contractor. All drawings and other documents, if any, required to be submitted to Company for review shall be submitted in accordance with the mutually agreed to schedule, and, if no schedule applies, such drawings or other documents shall be submitted by Contractor without unreasonable delay. No Work affected by such drawings and other documents shall be started until Contractor is authorized to do so by Company. In case of a conflict between or within instructions, Specifications, drawings, schedules, or Purchase Order(s), Company shall resolve such conflict; and Company's resolution shall be binding on Contractor.

7.7. Company Changes in Work

The scope of and conditions applicable to the Work shall be subject to changes by Company from time to time. Such changes shall only be enforceable if documented in a writing executed by Company. Except as otherwise specifically set forth in this Agreement, changes in the scope of or conditions applicable to the Work may result in adjustments in the Contract Price and/or the Work schedule in accordance with this Article. If Contractor believes that adjustment of the Contract Price or the Work schedule is justified, whether as a result of a change made pursuant to this Article or as a result of any other circumstance, then Contractor shall (a) give Company written notice of its claim within five (5) business days after receipt of notice of such change or the occurrence of such circumstances and (b) shall supply a written statement supporting Contractor's claim within ten (10) business days after receipt of notice of such change or occurrence of such circumstances, which statement shall include Contractor's detailed estimate of the effect on the Contract Price and/or the Work schedule. Contractor agrees to continue performance of the Work during the time any claim hereunder is pending. Company shall not be bound to any adjustments in the Contract Price or the Work schedule unless expressly agreed to by Company in writing. Company will not be liable for, and Contractor waives, any claims of Contractor that Contractor knew or should have known and that were not reported by Contractor in accordance with the provisions of this Article.

7.8. Force Majeure

Neither party shall be liable to the other for any damages for any failure to perform or for any delays or interruptions beyond that party's reasonable control in performing any of its obligations under this Agreement due to Force Majeure, unless the time to perform is expressly guaranteed. Contractor shall advise Company immediately of any anticipated and actual failure, delay, or interruption and the cause and estimated duration of such event. Any such failure, delay, or interruption, even though existing on the date of this Agreement or on the date of the start of the Work, shall require Contractor to within five (5) days submit a recovery plan detailing the manner in which the failure, delay, or interruption shall be remedied and the revised schedule. This Article shall apply only to the part of the Work directly affected by the particular failure, delay, or interruption, and shall not apply to the Work as a whole or any other unaffected part thereof.

7.9. Contractor Delays

Contractor agrees to cooperate with Company in scheduling the Work so that the Project and other activities at Company's site will progress with a minimum of delays. Company shall not be responsible for compensating Contractor for any costs of overtime or other premium time work unless Company has provided separate prior written authorization for additional compensation to Contractor, and, if Company provides such written authorization, such additional compensation shall be limited to Contractor's actual cost of the premium portion of wages, craft fringe benefits, and payroll burdens. Contractor shall be liable for all failures, delays, and interruptions in performing any of its obligations under this Agreement which are not (a) caused by Company and reported in accordance with Article 7.~~8~~7, (b) excused by Article 7.~~9~~8, or (c) directed by Company pursuant to Article 7.~~11~~10. Contractor shall, without adjustment to completion date or Contract Price, be obligated to make up time lost by such failures, delays, or interruptions. Company may suspend payments under this Agreement during the period of any such failure, delay, or interruption.

7.10. Company Extensions

Company shall have the right to extend schedules or suspend the Work, in whole or in part, at any time upon written notice to Contractor (except that in an emergency or

in the event that Company identifies any safety concerns, Company may require an immediate suspension upon oral or written notice to Contractor). Contractor shall, upon receipt of such notice, immediately suspend or delay the Work. Contractor shall resume any suspended Work when directed by Company. If Contractor follows the requirements of Article 7.87, a mutually agreed equitable adjustment to the Contract Price or to the schedules for payments and performance of the remaining Work may be made to reflect Company's extension of schedules or suspension of the Work. Contractor shall provide Company all information Company shall request in connection with determining the amount of such equitable adjustment.

7.11. Right of Inspecting and Testing

Company reserves the right, but shall not be obligated, to appoint representatives to follow the progress of the Work with authority to suspend any Work not in compliance with this Agreement. The appointment or absence of an appointment, of such representatives by Company shall not have any effect on warranties. Acceptance or approval by Company's representative shall not be deemed to constitute final acceptance by Company, nor shall Company's inspection relieve Contractor of responsibility for proper performance of the Work. Inspection by Company's representative shall not be deemed to be supervision or direction by Company of Contractor, its agents, servants, or employees, but shall be only for the purpose of attempting to ensure that the Work complies with this Agreement. In the event Contractor fails to provide Company with reasonable facilities and access for inspection when advised, and if in the opinion of Company it becomes necessary to dismantle the Work for such inspection, then Contractor shall bear the expenses of such dismantling and reassembly.

7.12. Right of Auditing

Contractor shall maintain complete records relating to any cost-based (i.e., Work not covered by firm prices) components of the Work billed under this Agreement or relating to the quantity of units billed under any unit price provisions of this Agreement (all the foregoing hereinafter referred to as "Records") for a minimum of five years following the latest of performance of, delivery to Company of, or payment by Company for, such Work or units. All such Records shall be open to inspection and subject to audit and reproduction during normal working hours, by

Company or its authorized representatives to the extent necessary to adequately permit evaluation and verification of any invoices, payments, time sheets, or claims based on Contractor's actual costs incurred in the performance or delivery of Work under this Agreement. For the purpose of evaluating or verifying such actual or claimed costs, Company or its authorized representative shall have access to said Records at any time, including any time after final payment by Company to Contractor pursuant to this Agreement. All non-public information obtained in the course of such audits shall be held in confidence except pursuant to judicial and administrative order. Company or its authorized representative shall have access, during normal working hours, to all necessary Contractor facilities and shall be provided adequate and appropriate work space to conduct audits in compliance with the provisions of this Article. Company shall give Contractor reasonable notice of intended audits. The rights of Company set forth in this paragraph shall survive the termination or expiration of this Agreement.

7.13. Use of Tools and Equipment

Company, in its sole discretion, may allow Contractor to use Company's tools and equipment for the Work and related activities at designated Company locations. Contractor shall indemnify and hold harmless Company and its Affiliates, including their respective officers, directors, shareholders, agents, members and employees (each an "Indemnified Party"), from and against any and all claims, damages, losses or liabilities arising out of, relating to, or in connection with, the use of Company's tools and equipment by Contractor, its agents, servants, employees or subcontractors, and will reimburse each Indemnified Party for all expenses (including attorney's fees and expenses) as they are incurred in connection with investigating, preparing or pursuing or defending any action, claim, suit or investigation or proceeding related to, arising out of, or in connection with, the use of Company's tools and equipment by Contractor, its agents, servants, employees or subcontractors, whether or not threatened or pending and whether or not any Indemnified Party is a party. Contractor, on behalf of itself or its agents, affiliates, officers and directors, and all of their predecessors, successors, assigns, heirs, executors and administrators, hereby irrevocably release, discharge, waive, relinquish and covenant not to sue, directly, derivatively or otherwise, Company and/or its Affiliates and each of their respective directors, officers, shareholders, members, partners (general or limited), employees

and agents (including, without limitation, its financial advisors, counsel, proxy solicitors, information agents, depositories, consultants and public relations representatives) and all of their predecessors, successors, assigns, heirs, executors or administrators, and all persons acting in concert with any such person , with respect to any and all matters, actions causes of action (whether actually asserted or not), suits, damages, claims, or liabilities whatsoever, at law, equity or otherwise, arising out of, relating to, or in connection with the use of Company's tools and equipment by Contractor, its agents, servants, employees or subcontractors. Company shall in no event be liable for any claim whatsoever by or through Contractor, its employees, agents and/or subcontractors or by any third party, for any inoperability or failure of the tools and equipment to perform as designed or intended, whether such claim is based in warranty, contract, tort (including negligence), strict liability or otherwise and whether for direct, incidental, consequential, special, exemplary or other damages. Contractor shall ensure that its employees, agents, subcontractors or servants shall inspect, exercise the appropriate level of care in the use, maintenance and repair of the tools and equipment, so as to minimize the incidence of casualties and injuries occurring in connection therewith.

7.14. Applicable Laws and Safety

Contractor agrees to protect its own and its Subcontractors' employees and be responsible for their Work until Company's acceptance of the entire Project and to protect Company's facilities, property, employees, and third parties from damage or injury. Contractor shall at all times be solely responsible for complying with all applicable Laws and Regulations and facility rules, including without limitation those relating to health and safety, in connection with the Work and for obtaining (but only as approved by Company) all permits and approvals necessary to perform the Work. Without limiting the foregoing, Contractor agrees to strictly abide by and observe all standards of the Occupational Safety & Health Administration (OSHA) which are applicable to the Work and Company's Contractor/Subcontractor safety policy and any other rules and regulations of the Company. Contractor shall maintain the Work site in a safe and orderly condition at all times. Company shall have the right but not the obligation to review Contractor's compliance with safety and cleanup measures. In the event Contractor fails to keep the work area clean, Company shall have the right to perform such cleanup on behalf of, at the risk of and at the expense of

Contractor. Contractor shall require all of its Subcontractors to complete the safety and health questionnaire and checklists provided by Company and shall provide a copy of such documents to Company upon request. Contractor shall conduct, and require its Subcontractors to conduct, safety audits and job briefings during performance of the Work. In the event a Subcontractor has no procedure for conducting safety audits and job briefings, Contractor shall include the Subcontractor in its safety audits and job briefings. All safety audits shall be documented in writing by the Contractor and its Subcontractors. Contractor shall provide documentation of any and all audits identifying safety deficiencies and concerns and corrective action taken as a result of such audits to Company semi-monthly.

7.15. Hazards and Training

Contractor shall furnish trained, qualified, and experienced personnel and appropriate safety and other equipment in first-class condition, suitable for performance of the Work. Such personnel shall be skilled and properly trained to perform the Work and recognize all hazards associated with the Work. Without limiting the foregoing, Contractor shall participate in any safety orientation or other of Company's familiarization initiatives related to safety and shall strictly comply with any monitoring initiatives as determined by Company. Contractor shall accept all equipment, structures, and property of Company as found and acknowledges it has inspected the property, has determined the hazards incident to working thereon or thereabouts, and has adopted suitable precautions and methods for the protection and safety of its employees and the property.

7.16. Drug and Alcohol

No person will perform any of the Work while under the influence of drugs or alcohol. No alcohol may be consumed within four (4) hours of the start of any person's performance of the Work or anytime during the workday. A person will be deemed under the influence of alcohol if a level of .02 percent blood alcohol or greater is found. In addition to the requirements of the drug testing program, as set forth in Company's rules and regulations, all persons who will perform any of the Work will be subject to drug and alcohol testing under either of the following circumstances: (i) where the person's performance either contributed to an accident or cannot be completely discounted as a contributing factor to an accident which

involves off-site medical treatment of any person; and (ii) where Company determines in its sole discretion that there is reasonable cause to believe such person is using drugs or alcohol or may otherwise be unfit for duty. Such persons will not be permitted to perform any Work until the test results are established. Contractor shall be solely responsible for administering and conducting drug and alcohol testing, as set forth herein, at Contractor's sole expense. As applicable and in addition to any other requirements under this Agreement, Contractor shall develop and strictly comply with any and all drug testing requirements as required by applicable Laws or Regulations.

7.17. Status of Contractor

Contractor, in performing the Work, shall not act as an agent or employee of Company, but shall be and act as an independent contractor and shall be free to perform the Work by such methods and in such manner as Contractor may choose, doing everything necessary to perform such Work properly and safely and having supervision over and responsibility for the safety and actions of its employees and the suitability of its equipment. Contractor's employees and Subcontractors shall not be deemed to be employees of Company. Contractor agrees that if any portion of Contractor's Work is subcontracted, all such Subcontractors shall be bound by and observe the conditions of this Agreement to the same extent as required of Contractor.

7.18. Equal Employment Opportunity

To the extent applicable, Contractor shall comply with all of the following provisions, which are incorporated herein by reference: (i) Equal Opportunity regulations set forth in 41 CFR § 60-1.4(a) and (c), prohibiting employment discrimination against any employee or applicant because of race, color, religion, sex, or national origin; (ii) Vietnam Era Veterans Readjustment Assistance Act regulations set forth in 41 CFR § 60-250.4 relating to the employment and advancement of disabled veterans and Vietnam era veterans; (iii) Rehabilitation Act regulations set forth in 41 CFR § 60-741.4 relating to the employment and advancement of qualified disabled employees and applicants for employment; (iv) the clause known as "Utilization of Small Business Concerns and Small Business Concerns Owned and Controlled by Socially and Economically Disadvantaged

Individuals" set forth in 15 USC § 637(d)(3); and (v) the subcontracting plan requirement set forth in 15 USC § 637(d).

7.19. Indemnity

Contractor shall indemnify and hold harmless the Company and Engineer and their agents and employees from and against all claims, costs, losses, and damages (including reasonable attorney's fees and court costs) arising from and to the extent of the violation of law, negligence, acts, errors, omissions, or intentional misconduct of Contractor or any firm, entity, or other persons for whose acts or omissions the Contractor is responsible, including any Subcontractors. Company shall indemnify and hold harmless Contractor and its directors, officers, employees, and agents from and against all claims, costs, losses, and damages (including reasonable attorney's fees and court costs) arising from and to the extent of the violation of law, negligence, acts, errors, omissions, or intentional misconduct of Company.

7.20. Environmental Control:

As required under the OSHA Hazard Communication Standard (29 CFR 1910.1200) and certain other applicable Laws or Regulations, Contractor or its Subcontractors shall provide Material Safety Data Sheets ("MSDS") covering any hazardous substances and materials furnished under or otherwise associated with the Work under this Agreement. Contractor and its Subcontractors shall provide Company with either copies of the applicable MSDS or copies of a document certifying that no MSDS are required under any applicable Laws or Regulations in effect at the worksite. No asbestos or lead containing materials shall be incorporated into any Work performed by Contractor or otherwise left on the Work site without the prior written approval of Company. Contractor and its Subcontractors shall be solely responsible for determining if any chemical or material furnished, used, applied, or stored or Work performed under this Agreement is subject to any applicable Laws or Regulations.

7.20.1. Contractor and its Subcontractors shall label hazardous substances and materials and train their employees in the safe usage and handling of such substances and materials as required under any applicable Laws or Regulations.

7.20.2. Contractor and its Subcontractors shall be solely responsible for the management of any petroleum or hazardous substances and materials brought onto the Work site and shall prevent the release of petroleum or hazardous substances and materials into the environment. All petroleum or hazardous substances and materials shall be handled and stored according to Contractor's written Spill Prevention Control and Countermeasures Plan or Best Management Practices Plan as defined under the provisions of the Clean Water Act, as amended, if either such Plan must be maintained pursuant to applicable Laws or Regulations. Contractor shall provide secondary containment for the storage of petroleum or hazardous substances and materials. The prompt and proper clean-up of any spills, leaks, or other releases of petroleum or hazardous substances and materials resulting from the performance of the Work under this Agreement and the proper disposal of any residues shall be Contractor's sole responsibility, but Contractor shall give Company immediate notice of any such spills, leaks, or other releases. Contractor shall be solely responsible for the storage, removal, and disposal of any excess or unused quantities of chemicals and materials which Contractor causes to be brought to the Work site.

7.20.3. Unless Company and Contractor expressly agree otherwise in writing, Contractor and its Subcontractors shall be solely responsible for any wastes generated in the course of the Work, and Contractor shall handle, store, and dispose of such wastes in accordance with any Applicable Laws.

7.21. Contractor's Insurance Obligation: Contractor shall provide and maintain, and shall require any Subcontractor to provide and maintain, the following insurance which shall be primary (and, except with regard to Workers' Compensation), naming Company and Engineer as additional insureds and waiving rights of subrogation against Company, Engineer and Company's insurance carrier(s), and shall submit evidence of such coverage to Company prior to the start of the Work. Contractor's liability shall not be limited to its insurance coverage.

7.21.1. Contractor shall furnish certificates of insurance, in the name of the Big Rivers Electric Corporation, evidencing insurance coverage of the following types of minimum amounts:

a. Workman's compensation and employer's liability insurance covering all employees who perform any of the obligations under the Contract or Purchase Order, in the amounts required by law. If any employer or employee is not subject to the workers compensation laws of the governing state, then insurance shall be obtained voluntarily to provide coverage to the same extent as though the employer or employee were subject to such laws.

b. Comprehensive general liability insurance covering all operation under the Contract or Purchase Order: bodily injury - $1,000,000 each occurrence and aggregate; property damage - $1,000,000 each occurrence and aggregate. A combined single limit of $1,000,000 for bodily injury and property damage liability is acceptable. The insurance may be in a policy or policies of insurance. A primary policy and an excess policy including the umbrella or catastrophe form is acceptable. Coverage should include contractual liability, broad form property damage liability, Owner's and Contractor's protective (independent contractor's) liability, products and completed operations hazard, explosion, collapse, and underground property damage hazard.

c. Automotive liability insurance on all motor vehicles used in conjunction with the Contract or Purchase Order, whether owned, nonowned, or hired; bodily injury - $1,000,000 each person and $1,000,000 each occurrence; property damage $1,000,000 each occurrence. A combined single limit of $1,000,000 for bodily injury and property damage liability is acceptable. The insurance may be in a policy or policies of insurance. A primary policy and an excess policy including the umbrella or catastrophe form is acceptable.

d. Certificates evidencing the insurance coverage's must be furnished before the commencement of Work. If any work to be performed under this Contract or Purchase Order is sublet, the Contractor will be required to furnish proof of insurance from all Subcontractors evidencing equal to or better coverage.

7.21.2. The above policies to be provided by Contractor shall be written by insurance companies which are both licensed to do business in the state where the Work will be performed and either satisfactory to Company or having a Best Rating of not less than A-. These policies shall not be materially changed or canceled except with thirty (30) days written notice to Company from Contractor and the insurance carrier. Evidence of coverage, notification of cancellation or other changes shall be mailed to: Attn: Manager, Supply Chain, Big Rivers Electric Corp., P.O. Box 24, Henderson, KY 42419.

7.21.3. Company reserves the right to request and receive a summary of coverage of any of the above policies or endorsements; however, Company shall not be obligated to review any of Contractor's certificates of insurance, insurance policies, or endorsements, or to advise Contractor of any deficiencies in such documents. Any receipt of such documents or their review by Company shall not relieve Contractor from or be deemed a waiver of Company's rights to insist on strict fulfillment of Contractor's obligations under this Agreement.

7.21.4. Contractor shall provide notice of any accidents or claims at the Work site to Company's Manager, Risk Management at Big Rivers Electric Corporation, P.O. Box 24, Henderson, KY 42419 and Company's site safety representative.

7.22. Intellectual Rights and Patents

Contractor shall pay all royalties and license fees which may be payable on account of the Work or any part thereof. In case any part of the Work is held in any suit to constitute infringement and its use is enjoined, Contractor within a reasonable time shall, at the election of Company and in addition to Contractor's obligations under Article 7.19, either (a) secure for Company the perpetual right to continue the use of such part of the Work by procuring for Company a royalty-free license or such other

permission as will enable Contractor to secure the suspension of any injunction, or (b) replace at Contractor's own expense such part of the Work with a non-infringing part or modify it so that it becomes non-infringing (in either case with changes in functionality that are acceptable to Company).

7.23. Release of Liens

Contractor hereby releases for itself and its successors in interest, and for all Subcontractors and their successors in interest, any and all claim or right of mechanics or any other type lien upon Company's or any other party's property, the Work, or any part thereof as a result of performing the Work. Contractor shall execute and deliver to Company such documents as may be required by applicable Laws or Regulations to make this release effective and shall give all required notices to Subcontractors with respect to ensuring the effectiveness of the foregoing release against those parties. Contractor shall secure the removal of any lien that Contractor has agreed to release in this Article within five (5) working days of receipt of written notice from Company to remove such lien. If not timely removed, Company may remove the lien and charge all costs and expenses to Contractor, including without limitation costs of bonding off such lien.

7.24. Assignment of Agreement; Subcontracting

Contractor shall not, by operation of law or otherwise, assign and/or subcontract any part of the Work or this Agreement without Company's written approval. Such approval, if given by Company, shall not relieve Contractor from full responsibility for the fulfillment of any and all obligations under this Agreement. Under any and all circumstances, any permitted assignee of Contractor, whether or not such assignee shall be a division, subsidiary and/or affiliate entity of Contractor, shall also be fully bound by the terms of this Agreement and, furthermore, upon request by Company, each of Contractor and its permitted assignee shall provide sufficient financial information, as determined by Company in its sole discretion, necessary to validate such assignee's credit worthiness and ability to perform under this Agreement.

7.25. Invoices and Effects of Payments

7.25.1. Invoices: In accordance with the Payment and Cancellation Schedule, Contractor shall submit an invoice to Company that complies with this Article. Payments shall be made within thirty (30) days of Company's receipt of Contractor's proper invoice, and, in the event that Company's payment is overdue, Contractor shall promptly provide Company with a notice that such payment is overdue. Contractor's invoices shall designate the Company location which is the responsible party. Such invoices shall reference the Contract / Purchase Order number and shall also show labor, material, taxes paid (including without limitation sales and use taxes, duties, fees, and other assessments imposed by governmental authorities), freight, and all other charges (including without limitation equipment rental) as separate items. All invoices shall be submitted with supporting documentation and in acceptable form and quality to Company's authorized representative. Should Company dispute any invoice for any reason, payment on such invoice shall be made within thirty (30) days of the dispute resolution. Payment of the invoice shall not release Contractor from any of its obligations hereunder, including but not limited to its warranty and indemnity obligations. Invoices shall not be delivered with goods, unless expressly authorized by the Company, but all correspondence and packages related to this Agreement shall reference the Purchase Order / Contract number assigned by Company.

7.25.2. Surcharges: All charges must be pre-approved and referenced within the Purchase Order or Contract. Unapproved charges will not be accepted and will cause the invoice to be rejected and returned. This includes, but is not limited to, surcharges, packing charges, core charges, deposits, and/or any other added costs.

7.25.3. Sales and Use Taxes

a. Projects: If Company provides Contractor with an exemption certificate demonstrating an exemption from sales or use taxes in Kentucky, then Contractor shall not withhold or pay Kentucky sales or use taxes to the

extent such exemption certificate applies to the Work (such exemption does not and shall not apply to any materials consumed by Contractor in performing the Work). If Company does not provide Contractor with an exemption certificate demonstrating an exemption from sales or use taxes in Kentucky, Contractor shall be solely responsible for paying all appropriate sales, use, and other taxes and duties (including without limitation sales or use tax with respect to materials purchased and/or consumed in connection with the Work) to, as well as filing appropriate returns with, the appropriate authorities. To the extent specifically included in the Contract Price, Contractor shall bill Company for and Company shall pay Contractor all such taxes and duties, but Company shall in no event be obligated for taxes and duties not specifically included in the Contract Price or for interest or penalties arising out of Contractor's failure to comply with its obligations under this Section.

b. Goods provided to Big Rivers: The Contractor shall not bill Big Rivers for Kentucky Sales Tax. A Direct Pay Authorization is maintained under Permit # 108814 as per 103 KAR 31:030.

7.25.4. Billing of Additional Work: All claims for payments of additions to the Purchase Order / Contract Price shall be shown on separate Contractor's invoices and must refer to the specific change order or written authorization issued by Company as a condition to being considered for payment.

7.25.5. Effect of Payments/Offset: No payments shall be considered as evidence of the performance of or acceptance of the Work, either in whole or in part, and all payments are subject to deduction for loss, damage, costs, or expenses for which Contractor may be liable under any Purchase Order or set-off hereunder. Company, without waiver or limitation of any rights or remedies of Company, shall be entitled from time to time to deduct from any and all amounts owing by Company to Contractor in connection with this Agreement or any other contract with Company any and all amounts owed by Contractor to Company in connection with this Agreement or any other contract with Company.

7.25.6. Evidence of Payment to Subcontractors: Contractor shall, if requested by Company, furnish Company with a certificate showing names of Contractor's Suppliers and Subcontractors hereunder, and certifying to Company that said Suppliers and Subcontractors have been paid in full.

7.26. Term and Termination

7.26.1. This Agreement shall commence upon the issuance of Purchase Order referencing this Specification, the Bidder's Proposal, and any subsequent negotiations and shall survive in full force and effect until terminated as set forth below. A termination under this Article based on certain Work shall only apply to the Purchase Order that covers such Work. Any purchase orders that do not relate to such Work shall not be affected by such a termination.

7.26.2. Termination for Contractor's Breach:

If the Work to be done under this Agreement shall be abandoned by Contractor, if this Agreement or any portion thereof shall be assigned by operation of law or otherwise without the written permission of the Company, if the Work or any portion thereof is sublet by Contractor without the written permission of Company, if Contractor is placed in bankruptcy, or if a receiver be appointed for its properties, if Contractor shall make an assignment for the benefit of creditors, if at any time the necessary progress of Work is not being maintained, or if Contractor is violating any of the conditions or terms of this Agreement, or has executed this Agreement in bad faith, Company may, without prejudice to any other rights or remedies it may have as a result thereof, notify Contractor to discontinue any or all of the Work and terminate this Agreement in whole or part. Company's foregoing right to notify Contractor and terminate this Agreement is subject to Company first providing Contractor with (i) notice and (ii) 30 days' chance to cure any such defect, failure, breach or improper performance. In the event that Section 365(a) of the Bankruptcy Code or some successor law gives Contractor as debtor-in-possession the right to either accept or reject this Agreement, then Contractor agrees to file an appropriate motion with the Bankruptcy Court to either accept or reject this Agreement within twenty (20) days of the entry of the Order for

Relief in the bankruptcy proceeding. Contractor and Company acknowledge and agree that said twenty (20) day period is reasonable under the circumstances. Contractor and Company also agree that if Company has not received notice that Contractor has filed a motion with the Bankruptcy Court to accept or reject this Agreement within said twenty (20) day period, then Company may file a motion with the Bankruptcy Court asking that this Agreement be accepted or rejected, and Contractor shall not oppose such motion.

7.26.3. Effect of Termination for Contractor's Breach:

From the effective date of such termination notice, Contractor shall vacate the site, whereupon Company shall have the right but not the obligation to take possession of the Work wherever located, and Contractor shall cooperate with Company and cause Contractor's Subcontractors to cooperate with Company so that Company can effect such possession. In obtaining replacement services, Company shall not be required to request multiple bids or obtain the lowest figures for completing the Work and may make such expenditures as shall best accomplish such completion and are reasonable given the circumstances. The expenses of completing the Work in excess of the unpaid portion of the Contract Price, together with any damages suffered by Company, shall be paid by Contractor, and Company shall have the right to set off such amounts from amounts due to Contractor.

7.26.4. Termination for Company's Convenience:

Company may terminate this Agreement or one or more purchase orders in whole or in part for its own convenience by thirty (30) days' written notice at any time. In such event, Company shall pay Contractor all direct labor and Material costs incurred on the Work that is subject to such termination prior to such notice, plus any reasonable unavoidable cancellation costs which Contractor may incur as a result of such termination, plus indirect costs or overhead on the portion of the Work completed, computed in accordance with generally accepted accounting principles less salvage value. As an alternative to salvage value reduction, Company shall have the right in its sole discretion to take possession of all or part of the Work.

7.27. Publicity

Contractor shall not issue news releases, publicize or issue advertising pertaining to the Work or this Agreement without first obtaining the written approval of Company.

7.28. Confidential Information

All information relating to the Work or the business of Company, including, but not limited to, drawings and specifications relating to the Work, and customer information, shall be held in confidence by Contractor and shall not be used by Contractor for any purpose other than for the performance of the Work or as authorized in writing by Company. In the event that the Contractor assigns the work to one or more Subcontractors, a signed confidentiality agreement between the Contractor and each Subcontractor(s) will be provided to the Company prior to the provision of any information described in the immediately preceding sentence or the performance of any Work by the Subcontractor. All drawings, specifications, or documents furnished by Company to Contractor or developed in connection with the Work shall either be destroyed or returned to Company (including any copies thereof) upon request at any time.

7.29. Miscellaneous

7.29.1. No waiver by Company of any provision herein or of a breach of any provision shall constitute a waiver of any other breach or of any other provision.

7.29.2. Headings: The headings of Articles, Sections, paragraphs, and other parts of this Agreement are for convenience only and do not define, limit, or construe the contents thereof.

7.29.3. Severability: If any provision of this Agreement shall be held invalid under law, such invalidity shall not affect any other provision or provisions hereof which are otherwise valid.

7.29.4. State Law Governing Agreement: This Agreement shall be governed by, and construed in accordance with, the laws of the Commonwealth of Kentucky, without regard to its principles of conflicts of laws.

7.29.5. Enforcement of Rights: Company shall have the right to recover from Contractor all expenses, including but not limited to fees for and expenses of inside or outside counsel hired by Company, arising out of Contractor's breach of this Agreement or any other action by Company to enforce or defend Company's rights hereunder.

7.29.6. No Third Party Beneficiaries: Except for Contractor and Company, there are no intended third party beneficiaries of this Agreement and none may rely on this Agreement in making a claim against Company.

8. NOTICES

All notices and communications respecting this Agreement shall be in writing, shall be identified by the contract number, and shall be addressed as follows (which address either party may change upon five (5) days prior notice to the other party).

To Company:	To Contractor:
Big Rivers Electric Corp.	_____
Attn: Director, Supply Chain	_____
P.O. Box 24	_____
Henderson, Kentucky 42419	_____

8.1. Any notice, request, or approval or other document required or permitted to be given under this Contract will be in writing unless otherwise provided herein and will be deemed to have been sufficiently given if delivered in person, transmitted by fax or email with return receipt and followed by a hard copy, dispatched in the U.S. mails, postage prepaid for mailing by certified or registered mail, return receipt requested, or dispatched for delivery by other courier service providing a return receipt.

9. ENGINEER'S TECHNICAL SPECIFICATION

The Engineer's technical specification from Burns and McDonnell referenced as ***Project 73827, Contract 8320, General Construction*** starts on the next page.

Big Rivers
ELECTRIC CORPORATION

Your Touchstone Energy® Cooperative

Mercury and Air Toxics Standard (MATS) Compliance Project

General Construction
Contract 8320

RFQ #GN-14-030

Table of Contents
RFQ # GN-14-030

ATTACHMENTS

Documents: 73827.00400.Bid Form.xls
73827.00400.Unit Price Breakdown.xls
73827.00420.Clarifications and Exceptions.xls

Additional reference drawings will be available via a web link identified in a separate email.

PROJECT SUMMARY

Big Rivers Electric Corporation (Owner) is installing Dry Sorbent Injection (DSI) and Activated Carbon Injection (ACI) systems for Robert D. Green Generating Station (Green Station) Units 1 and 2. The addition of the DSI and ACI systems are intended to reduce mercury (Hg) emission to levels compliant with the Mercury Air Toxic Standards (MATS). DSI systems will be used to reduce SO_3 levels as necessary to improve the Hg removal efficiency of activated carbon. The DSI system will utilize hydrated lime for the reagent. The ACI system will utilize powdered activated carbon (PAC).

This Contract sets forth the requirements for the General Construction Contractor to perform and provide the following:

A. Furnish all construction labor, supervision, equipment, tools, rigging, blocking, scaffolding, material, supplies, transportation, project management, construction management (including scheduling and cost control), and services necessary to:

   1. Receive, protect, store, haul, assemble, erect, install, and place into service Equipment and Material furnished by other contracts including, but not limited to:

      a. Dry Sorbent Injection (DSI) System

      b. Activated Carbon Injection (ACI) System

      c. Compressed air system

      d. Power control module (PCM)

      e. Structural and support steel for all equipment and piping

      f. Stair tower

      g. DCS cabinets

   2. Procure, fabricate, deliver, receive, protect, store, haul, assemble, erect, install, and place into service Equipment and Material in accordance with the requirements of this Contract. The Equipment and Materials include, but are not limited to, the following:

      a. All cables in the Cable Schedule

      b. Instrument and control cables

      c. Power feeds

      d. Ground connections

e. Lighting

f. Raceway systems

g. Pull boxes and junction boxes

h. Fire stops

i. Heat trace and insulation

B. Provide start-up, commissioning, and field testing activities.

C. Obtain the services of a testing subcontractor to perform third party electrical tests.

D. Preform grading and leveling as required to install asphalt paving.

1. DEFINITIONS

1.1. "Addenda" - written or graphic changes or interpretations of the Contract Documents issued by Owner prior to the opening of Bids.

1.2. "Administrator" shall mean the Administrator of the Rural Utilities Service of the United States of America and his or her duly authorized representative or any other person in whom or authority in which may be vested the duties and functions which the Administrator is now authorized by law to perform.

1.3. "Agreement" or "Contract" - the written agreement between Owner and Bidder covering the Work to be performed. Other Contract Documents are attached to the Contract and made a part thereof as provided therein.

1.4. "Application for Payment" - the form acceptable to Owner and Engineer which is to be used by Bidder during the course of the Work in requesting progress or final payments and which is to include such supporting documentation as is required by the Contract Documents.

1.5. "Bid" - the formal offer of the Bidder submitted on the prescribed Bid Form and all information submitted with the Bid that pertains to performance of the Work.

1.6. "Bidder" – Prior to Contract award, "Bidder" is any person, firm, or corporation submitting a Bid for the Work or their duly authorized representative. Upon Contract

award, "Bidder" is the person, firm or corporation with whom the Owner has entered into the Contract.

1.7. "Change Order" - a written document recommended by Engineer which is signed by Owner and Bidder and authorizes an addition, deletion, or revision in the Work, or an adjustment in the Contract Price or the Contract Time or other material provision issued on or after execution of the Contract.

1.8. "Company" – Big Rivers Electric Corporation, also referred to as "BREC", "Big Rivers", or "Owner".

1.9. "Contract" or "Agreement" - the written agreement between Owner and Bidder covering the Work to be performed. Other Contract Documents are attached to the Contract and made a part thereof as provided therein.

1.10. "Contract Documents" - RUS Form 198 or RUS Form 200, all documents referenced in the table of contents, exhibits, attachments, affidavits, bonds, insurance requirements and documents, releases, Specifications, drawings, and Change Orders or signed amendments issued to the Contract.

1.11. "Contract Time" - the number of days or the dates stated in the Contract Documents for the completion of the Work.

1.12. "Contractor" - is the person, firm or corporation with whom the Owner has entered into the Contract.

1.13. "Date of Contract" - the date on which the Contract is signed and executed by the Owner.

1.14. "Day" or "Days" - a calendar day of 24 hours measured from midnight to the next midnight.

1.15. "DDP" (Delivered Duties Paid) (Incoterms 2000) Point of Delivery - The Contract Price includes all costs of transporting Equipment and Materials to the named Point

of Delivery, including but not limited to any duties, permits, and insurance for the full value of the Equipment and Materials being delivered.

1.16. "Defective" - an adjective which when modifying the words Equipment and Materials, or Field Services refers to Equipment and Materials or Field Services which do not conform to the Contract Documents, or do not meet the requirements of any inspection reference standard, test, or approval referred to in the Contract Documents.

1.17. "Effective Date of the Contract" – the date of Acceptance of Contract by Owner or if approval by the Administrator is required, the date of approval by the Administrator in accordance with RUS Form 198 or RUS Form 200.

1.18. "Engineer" shall mean the Engineer employed by the Owner to provide engineering services for the project and said Engineer's duly authorized assistants and representatives. For this Project, "Engineer" means Burns & McDonnell Engineering Company, Inc. a Missouri Corporation, with offices at 9400 Ward Parkway, Kansas City, Missouri 64114.

1.19. "Equipment" - a product with operational or nonoperational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

1.20. "Field Services" - services to be furnished by Contractor at the Site as required by the Contract Documents.

1.21. "Final Acceptance" - shall mean the point after Substantial Competition when Contractor has (i) completed all punch list items; (ii) delivered to Owner all final documentation; and (iii) met all requirements associated with Liquidated Damages or paid the applicable damages.

1.22. "Force Majeure" - any condition, event or circumstance, including the examples set forth below, but only if, and to the extent (i) such condition, event or circumstance is not within the reasonable control of the Party affected, (ii) such condition, event or circumstance, despite the exercise of reasonable diligence, cannot be prevented,

avoided or removed by such Party, (iii) such condition, event or circumstance materially adversely affects the ability of the affected Party to fulfill its obligations under this Agreement, (iv) the affected Party has taken all commercially reasonable precautions, due care and commercially reasonable alternative measures in order to avoid the effect of such condition, event or circumstance on the affected Party's ability to fulfill its obligations under this Agreement and to mitigate the consequences thereof and (v) such condition, event or circumstance is not the result of any failure of such Party to perform any of its obligations under this Agreement. By way of example, such events, conditions and circumstances shall include war, rebellion, sabotage, riots, insurrection, public disorder, fires, floods, volcanic eruption, tidal wave, earthquake, quarantine, explosions or other natural catastrophes or Acts of God, and changes in applicable Laws or Regulations after the Effective Date of the Contract.

1.23. "Laws and Regulations"/ "Laws or Regulations" - laws, rules, regulations, ordinances, codes and/or orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

1.24. "Liquidated Damages" – payments which the Contractor shall make to the Owner for the value of damages experienced by the Owner to compensate for additional operational expenses or missed delivery schedules defined within the Contract.

1.25. "Materials" - products substantially shaped, cut, worked, mixed, finished, refined, or otherwise fabricated, processed, or installed to form a part of the Work.

1.26. "Notice to Proceed" - the written notice by Owner to Bidder fixing the date on which the Contract Time will commence to run and on which Bidder shall start to perform Bidder's obligation under the Contract.

1.27. "Owner" – Big River Electric Corporation, also referred to as "BREC", "Big Rivers", or "Company".

1.28. "Point of Delivery" – the place designated where the Equipment and Materials are to be delivered, being:

1.28.1. Big Rivers Electric Corporation, Green Station, 9000 HWY 2096, Robards, KY 42452.

1.29. "Parties" - Owner and Bidder, each of which is individually a "Party".

1.30. "Payment and Cancellation Schedule" - the detailed listing of activities or milestones with an associated payment percentage of the total Contract Price which accurately reflects payment for Work accomplished and cancellation percentage of the total Contract Price which reflects the payment(s) agreed to between the Parties in the event of cancellation. This schedule shall be jointly developed and agreed to by Owner and Contractor.

1.31. "Project" - the total construction of which the Work to be provided under the Contract may be the whole, or a part as indicated elsewhere in the Contract.

1.32. "Reference Drawings" - drawings not specifically prepared for this Contract, but which contain information pertinent to the Work.

1.33. "Samples" - physical examples of Equipment, Materials, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

1.34. "Shop Drawings" - all drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

1.35. "Site", "Job Site" or "Point of Delivery" - the Owner's Station where Material and Equipment is being delivered, being:

1.35.1. Big Rivers Electric Corporation, Green Station, 9000 HWY 2096, Robards, KY 42452.

1.36. "Specifications" - those portions of the Contract Documents consisting of written technical descriptions of the Work, and covering the Equipment, Materials, workmanship, performance and certain administrative details applicable thereto.

1.37. "Subcontractor" - an individual, firm, or corporation having a direct contract with Contractor to perform a portion of the Work.

1.38. "Submittals" - all Shop Drawings, product data, and Samples which are prepared by Contractor, a Subcontractor, manufacturer or Supplier, and submitted by Contractor to Owner and Engineer as a basis for approval of the use of Equipment and Materials proposed for incorporation in the Work or needed to describe proper installation, operation, and maintenance, or technical properties.

1.39. "Substantial Completion" - the event when, as determined in Owner's reasonably exercised discretion, (i) erection or installation of the Equipment and Materials furnished under the Contract has been completed by the installing Contractor and required Field Services have been furnished; (ii) all testing of the Work has been completed and all test data properly evaluated; (iii) the guarantees have been verified by Owner and Engineer and the warranty period has commenced; and (iv) Contractor has delivered to Company any operating instructions, maintenance manuals, and warranties.

1.40. "Supplier" - a manufacturer, fabricator, supplier, distributor, material man, or vendor of Bidder or Contractor.

1.41. "Work" - the goods and all services required by the Contract, and includes all labor, Materials, Equipment and services provided or to be provided by the Contractor to fulfill the Contractor's obligations herein. The Work may constitute the whole or a part of the Project.

2. OVERVIEW

2.1. The Contractor shall furnish, deliver (DDP Point of Delivery), and install all Equipment and Material in accordance with the requirements of this Contract.

2.2. Robert D. Green Generating Station consists of Unit 1 and Unit 2 which are 250 MW and 242 MW pulverized coal-fired balanced draft natural circulation, wall fired units provided by Babcock & Wilcox in 1976. Both units have two air preheaters and two electrostatic precipitators downstream of the economizers, and two wet FGD scrubbers which run at all times the units are online. The Green Station units burn a blend of bituminous coal and petroleum coke with a range of 0% - 27% petroleum coke in the blend.

2.3. If any conditions, circumstances or occurrences not covered in the Specification are encountered, or if there are any doubts as to the meaning, please contact the Rob Toerne at (270) 844-6029 or rob.toerne@bigrivers.com. Clarifications or explanations may result in an addendum to the RFQ.

2.4. The Contractor shall abide by the items in this Specification unless Big Rivers agrees in writing to any changes. Changes must be made in the form of a written request.

2.5. Big Rivers Electric Corporation reserves the right to reject any or all Bids, to waive informalities therein and to consider exceptions and clarifications therein in order to determine the lowest and best bid; to reject any or all non-conforming, non-responsive, unbalanced or conditional Bids; to reject the Bid of any Contractor that it would not be in the best interest of the Project to make an award to that Contractor, whether because the Bid is not responsive or the Contractor is unqualified or of doubtful financial ability, or fails to meet any other pertinent standard or criteria established. The Company also reserves the right to negotiate contract terms with the successful Contractor. By submitting a Bid, the Contractor agrees that such procedures will be without liability for any damage or claim brought by the Contractor because of such rejections or procedures, nor will the Contractor seek any recourse of any kind against the Company because of such rejections or procedures.

The filing of any Bid in response to this Invitation will constitute an agreement of the Contractor to these conditions.

3. PROPOSAL PREPARATION AND SUBMITTAL

3.1. A mandatory pre-bid meeting will be held on May 20, 2014 at Big Rivers Green Station starting at 8:30 AM CT.

3.2. All bids will be valid for ninety (90) days from the opening of the bid.

3.3. The Bidders must complete and submit all documents identified as submittals within this document including, but not limited to;

a. Document 00400 - BID FORM for Contract 8320 included in the Engineer's Specification
b. Document 00401 - UNIT PRICE BREAKDOWN form for Contract 8320 included in the Engineer's Specification
c. Document 00420 - Clarifications and Exceptions for Contract 8320 included in the Engineer's Specification
d. Big Rivers Contractor Safety Credentials Assessment Program
e. RUS Equal Opportunity Form 270
f. RUS Certification Relating to Lobbying
g. RUS Certification Regarding Debarment Form AD-1048
h. Big Rivers New Vendor Information Form
i. IRS Form W-9

3.4. The Bidders must submit a preliminary Payment Schedule paired with readily identifiable milestone events.

3.5. The Bidder must submit a list of any Subcontractors that might be used for this project for pre-approval. The submittal must include experience lists and reference contacts for all proposed Subcontractors.

3.6. Any deviations from or exceptions to the attached Specification, terms and conditions, or the Submittals may impact the evaluation of the Bidder's proposal. If

there are no exceptions or clarifications please so indicate on the Clarifications & Exceptions Form. Any exception taken to the Specification must be justified in writing, i.e., safety, reliability, efficiency, and increase or decrease in cost and identified on Clarifications & Exceptions Form.

3.7. Any addenda to this request for quotation (RFQ) shall be signed by the Bidder and will be returned with the proposal.

3.8. The Bidder will submit sufficient information and detail with the bid to permit full understanding and evaluation of the Equipment, Materials, and services being offered.

3.9. The proposal shall be submitted by post, courier, or hand delivered in a sealed envelope marked prominently with the RFQ number GN-14-030. **Bid Proposal must be received no later than June ~~13~~30, 2014 by 3:00 p.m. (Central Time).** Bid proposals received after this date and time will be returned and will not be considered. The bid proposal shall consist of three hard copies and one electronic copy (DVD, CD or thumb drive) and shall be submitted to the Big Rivers Supply Chain Department at the following address:

3.9.1. Big Rivers Electric Corporation
Attn: Robert F. Toerne
201 Third Street
Henderson, KY 42420

3.10. This inquiry implies no obligation on the part of Big Rivers. The Bidder offers the prices, terms, and delivery freely and without bias.

3.11. All expenses incurred by the Bidder in the development of this bid are the sole responsibility of the Bidder.

3.12. The Contractor will, within 14 days after Notice to Proceed, submit a Certificate of Insurance naming Big Rivers Electric Corporation as the holder of the certificate. The certificate will also show Big Rivers Electric Corporation and Engineer as additional insureds. Insurance coverage must meet as a minimum, the insurance requirements as specified in Section 7.21 of this document.

3.13. The Contractor will, within 10 business days after Notice to Proceed, submit performance and payment bonds (Bonds), each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of all of Bidder's obligations under the Contract Documents.

3.13.1. All Bonds shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury.

3.13.2. The Bonds shall be automatically increased in amount and extended in time without formal separate amendments to cover full and faithful performance of the Contract in the event of Change Orders, regardless of the amount of time or money involved. It is Contractor's responsibility to notify its surety of any changes affecting the general scope of the Work or change in the Contract Price or Contract Time. All Bonds signed by an agent must be accompanied by a certified copy of the agent's authority to act.

3.13.3. If at any time during the continuance of the Contract, the surety on any Bond becomes unacceptable to Owner for financial reasons, Owner has the right to require additional and sufficient sureties, which Contractor shall furnish to the satisfaction of Owner within ten (10) Days after notice to do so.

3.13.4. If the surety on any Bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of the Contract, Contractor shall within five (5) Days thereafter substitute another Bond and surety, both of which must be acceptable to Owner.

3.14. The evaluation methodology that will be used to identify the winning bid includes, but is not limited, to the following four elements: Non-Responsiveness Evaluation, Price Evaluation, Qualification/Certification Evaluation, and Technical Evaluation.

The purpose of each element and the process employed in each are described in the following sections.

3.14.1. Non-Responsiveness Evaluation: The Non-Responsiveness Evaluation is designed to identify and eliminate any proposal that has not provided the requested information in a proper format to allow an equitable evaluation to occur or that does not meet the requirements set forth in this RFQ. A bid deemed non-responsive by Big Rivers may be rejected. Bidders are subject to disqualification for such things as failure to submit the proposal on or before the designated time and date. Big Rivers Electric Corporation may, in its discretion, disqualify a bid and drop it from further consideration for failure to submit a complete proposal in the form required or failure to provide additional supporting documentation or any clarification that may be requested by Big Rivers subsequent to the submission of the proposal.

3.14.2. Price Evaluation: The Price Evaluation is designed to identify and eliminate bids which are clearly more expensive than other compliant proposals received. This will be accomplished by ranking the bids, as well as the designated options, against each other according to price. Preliminary estimates of production cost effects, operation and maintenance costs, and other pertinent costs will be made and added to each proposal for evaluation purposes. The evaluation will also include an estimate of the negative impact of deviations or exceptions, if any, to the terms and conditions in the proposed Contract or in other agreements contemplated to be entered into. Big Rivers expects the bid to contain an early payment discount structure which terms will also be part of the evaluation.

3.14.3. Qualification/Certification Evaluation: The Qualification/Certification Evaluation is designed to identify and eliminate bids that clearly demonstrate a lack of understanding or an inability to meet the intended Specification for this project. Big Rivers Electric Corporation requires all on-site contractors to complete the Contractor Certification process before any on-site work is awarded.

3.14.4. Technical Evaluation: The Technical Evaluation will consist of a comprehensive review that considers a number of price and non-price factors. The goal of the Technical Evaluation is to determine the options that best meet the needs of Big Rivers for this project and technical options which improve the facility's overall cost, reliability and availability.

4. SCHEDULE REQUIREMENTS

4.1. The time of completion of the Work is a basic consideration of the Specification. Time is of the essence of this Agreement. The proposal will be based upon completion of the Work as referenced by Section 011100, Entry 1.08 of the Engineer's Specification. Contractor's preliminary schedule and support requirements must be defined and submitted to Big Rivers and the Engineer for approval. A final, mutually agreed and approved schedule must be met.

4.2. The Contractor will provide a ~~bi-~~weekly project status update per Section 013~~2~~100 to the designated Big Rivers representative and Engineer's representation. The project status update report may be adjusted more or less often based on the Contractor's performance or Project requirements.

4.3. The Contractor will adhere to the schedule. Schedules provided with the proposal or within this Specification may be updated prior to the start of the Project. The Contractor will take any and all actions necessary to ensure scheduled completion.

4.4. The Contractor shall maintain, throughout the duration of the job, a schedule with the work progression of individual job elements. The schedule will be up-dated regularly and will be available to Big Rivers for review at any time. The schedule will be broken down to show individual job elements.

4.5. If at any time during the progress of the Work it is determined that the scheduled completion date cannot be met, Big Rivers reserves the right to take any action it deems necessary to ensure timely completion.

5. PLANT SITE REQUIREMENTS

5.1. Big Rivers is committed to procuring safe results for all Purchase Orders. The Contractor and every on-site employee must be certified through and current with Big Rivers' Contractor Safety Credentials Assessment Program (C-SCAP). Contractor will comply with all applicable OSHA, KOSHA, EPA, Big Rivers' rules or other safety practices, rules and regulations that govern work while on the Big Rivers' sites.

5.1.1. The Contractor's on-site employees will be in compliance with all C-SCAP requirements.

5.1.2. Big Rivers may stop work and/or remove the offending party from the worksite if that party fails to observe safety requirements.

5.2. The Contractor will provide all necessary supervision, labor, job management, Materials, tools, Equipment and consumables deemed necessary to ensure safe, proper and timely completion of the specified work.

5.3. The Contractor will utilize all of the information presented in this document to be fully prepared to begin work at the specified commencement date and time. The Contractor will ensure that a copy of this document has been reviewed by and is in the possession of the on-site manager.

5.4. The Contractor will ensure that all instructions and emergency warnings can be effectively and immediately communicated to all employees. Unless otherwise instructed Big Rivers requires that one (1) interpreter be provided for every eight (8) non-English speaking employees.

5.5. The Contractor will provide all necessary personnel protective equipment for each of its employees along with documentation of proper training in the use of said equipment.

5.6. The Contractor will provide for the safety and protection of existing property. Any damage to existing facilities resulting from construction operations will be reported immediately to Big Rivers thereof and promptly repaired or replaced by the Contractor.

5.7. The Contractor will protect its own employees and its Subcontractors' employees and be responsible for their work until Big Rivers' acceptance of the entire Project, and to protect Big Rivers' facilities, property, employees and third parties from damage or injury.

5.8. The Contractor will inform Big Rivers of any hazardous chemicals that will be transported or used on the plant site. Material Safety Data Sheets (MSDS) must be provided to the Owner's Site safety representative prior to use on the plant site and must be available at all times while on the plant site.

5.9. The Contractor will comply with the latest or amended version of the followings standards and codes, and with any and all other standards and codes that may be applicable:

5.9.1. National Fire Protection Association (NFPA)

5.9.2. National Electrical Code (NEC)

5.9.3. National Electrical Manufacturers Association (NEMA)

5.9.4. Electrical Apparatus Service Association (EASA)

5.9.5. International Electrical Testing Association (NETA)

5.9.6. Factory Mutual (FM)

5.10. The Contractor will notify the designated Big Rivers representative upon completion of each phase of the Work.

5.11. The Contractor will ensure that all discarded material and trash is removed from the site or placed in an approved dumpster.

~~5.11.1. Big Rivers may provide on-site dumpsters for the disposal of non-hazardous waste material. Debris must not be stacked beyond the top of the dumpster.~~

[Contradicts technical Section 015700 – 3.03.D]

5.12. The Contractor will not discharge petroleum products anywhere on the plant site. Fuel, lubrication products and any other liquid consumables stored on-site will be in an appropriate tank or container with proper labeling. Use of the proper container and the Big Rivers' approval of such containers in no way releases the Contractor from its responsibility to clean up any spills, discharges, or other releases.

5.13. The Contractor will provide for the safety and protection of existing property. Any damage to existing facilities resulting from construction operations will be reported immediately to Big Rivers and promptly repaired or replaced by the Contractor. During the project, unanticipated repairs or work may be encountered. If such needs are discovered during the project, they will be communicated to the designated Big Rivers representative by the Contractor's on-site supervisor as soon as possible.

5.13.1. The Contractor will obtain sufficient information to present a firm dollar quote for any emerging work for this project.

5.13.2. No additional work will be performed until the Contractor has been given written authorization to proceed by the Big Rivers.

5.14. The Contractor will exercise care in the protection of Materials and Equipment furnished under this Contract.

5.15. The Contractor will provide for the safety and protection of existing property. Any damage to existing facilities resulting from construction operations will be reported immediately to Big Rivers thereof and promptly repaired or replaced by the

6. PLANT SITE SUPERVISION

6.1. The Contractor will designate an on-site contact person with the authority to make decisions, correct problems and generally oversee the Contractor's equipment. In the event the contact person is absent from the job site, an alternate contact person with full authority to make decisions will be available onsite during all activities relating to this project.

6.1.1. There will be a designated Big Rivers representative on site, during day shift, to coordinate work schedules, safety issues, etc.

6.2. The Contractor will provide in writing the name and phone number (office, home, pager and mobile as applicable) of the contact person and the alternate contact person(s) prior to the start of Work hereunder and within one working day of any changes in the previously designated contact person.

6.3. To the extent possible, the on-site contact person will be the same from week to week to ensure job continuity.

6.4. The Contractor will provide an after-hours, emergency 24-hour per day contact list. The list will be prioritized as to the order that should be followed in notifying the Contractor.

7. COMMERCIAL TERMS

7.1. Submittal based Liquidated Damages will be assessed at a rate of $500 per day for the first five days and $1,000 per day upon and after six days, retroactive to the first day for each of the items referenced in Appendix 013300-A of the Engineer's Specification as being subject to Liquidated Damages.

7.2. The time of the completion of this General Construction Contract 8320 is of great importance to the Project. Should the Bidder neglect, refuse, or fail to deliver and install the ~~foundations~~ equipment as provided in and defined by this RFQ within the time herein agreed upon, after giving effect to extensions of time, if any, then, in that event and in view of the difficulty of estimating with exactness damages caused by such delay, the Owner shall have the right to deduct from and retain out of such moneys which may be then due, or which may become due and payable to the Bidder the amounts defined within this section for each and every day that such completion is delayed beyond the specified time, as liquidated damages and not as a penalty; if the amount due and to become due from the Owner to the Bidder is insufficient to pay in full any such liquidated damages, the Bidder shall pay to the Owner the amount necessary to effect such payment in full: Provided, however, that

the Owner shall promptly notify the Bidder in writing of the manner in which the amount retained, deducted or claimed as liquidated damages was computed. In no event shall Contractor be liable for delay damages if Company's ability to conduct commercial operations of its unit(s) is not harmfully reduced, impeded, delayed or otherwise adversely affected by Contractor's failure to achieve the schedule guarantees herein. Liquidated Damages will be assessed at the rate for each of the items listed below as referenced in Section 011100, Entry 1.09 of the Engineer's Specification:

7.2.1. Section 011100, Entry 1.08; Item C.8. Green Unit 2 Outage Date: Work that must be done during the unit outage shall be done within the defined outage time frame for Green Unit 2. Any cause by the contractor for the delay of returning the unit to service shall be assessed at $10,000 per day.

7.2.2. Section 011100, Entry 1.08; Item C.9~~. Green Unit 1 Outage Date: Work that must be done during the unit outage shall be done within the defined outage time frame for Green Unit 1. Any cause by the Contractor for the delay of returning the unit to service shall be assessed at $10,000 per day.~~

7.2.3. Section 011100, Entry 1.08; Item C.10. Substantial Completion: Any cause by the Contractor for the delay of meeting Substantial Completion assessed at $10,000 per day.

7.3. Retention

10% of the Contract value will be held as retention until Owner and Engineer have determined the Project to be Substantially Complete with Final Acceptance.

7.4. Warranties

7.4.1. All Materials and Equipment furnished hereunder shall be subject to the inspection, tests, and approval of the Owner and the Engineer, and the Contractor shall furnish all information required concerning the nature or source of any Materials and Equipment and provide adequate facilities for

testing and inspecting the Materials and Equipment at the plant of the Contractor.

7.4.2. Contractor warrants that:

a. the Work will conform to any applicable Specification; and any Materials and Equipment supplied in connection therewith shall be new, unused, and free from defect;

b. the Work will be suitable for the purposes specified by Company and will conform to each statement, representation, and description made by Contractor to Company;

c. the Work is not and shall not be subject to any encumbrance, lien, security interest, patent, copyright or trademark claims, infringements, or other defects in title; and

d. any labor or services performed pursuant to this Agreement shall be performed in a competent, diligent, and timely manner in accordance with the highest professionally accepted standards.

7.4.3. The Work furnished hereunder shall become the property of the Owner upon delivery, provided, however, that the Owner or the Engineer, within two years after initial operation of the Project, or within the period for which the Material and Equipment is guaranteed, whichever is longer, may reject any Materials or Equipment which does not comply with the Specifications made a part hereof or with the guarantees, if any, of the Contractor and the manufacturer. Upon any such rejection, the Contractor shall repair or replace such defective Material or Equipment within a reasonable time after notice in writing from the Owner. If any such defective Materials, Equipment, or workmanship so replaced or repaired is found to be defective within two years after the completion of the replacement or repair, the Contractor shall replace or remedy such defective Materials, Equipment, or workmanship. In the event of failure by the Contractor so to do, the Owner may make such replacement and the cost and expense thereof shall be paid by and recoverable from the Contractor.

7.4.4. Contractor shall respond in writing to any warranty claim by Company within five (5) business days of the delivery of notice of such claim to Contractor.

7.4.5. All manufacturers' guarantees of Equipment, if any, shall be transferred and assigned to the Owner upon delivery of any Equipment and before final payment is made for such Equipment.

7.4.6. The term of the Warranty is two years from the time of acceptance by the Owner and Engineer.

7.5. Materials and Supplies.

In the performance of this Contract there shall be furnished only such unmanufactured articles, Materials, and supplies as have been mined or produced in the United States or in any eligible country, and only such manufactured articles, materials, and supplies as have been manufactured in the United States or in any eligible country substantially all from articles, materials, or supplies mined, produced or manufactured, as the case may be, in the United States or in any eligible country; provided that other articles, materials, or supplies may be used in the event and to the extent that the Administrator shall expressly in writing authorize such use pursuant to the provisions of the Rural Electrification Act of 1938, being Title IV of Public Resolution No. 122, 75th Congress, approved June 21, 1938. For the purposes of this section, an "eligible country" is any country that applies with respect to the United States an agreement ensuring reciprocal access for United States products and services and suppliers to the markets of that country, as determined by the United States Trade Representative. The Bidder agrees to submit to the Owner such certificates with respect to compliance with the foregoing provision as the Administrator from time to time may require.

7.6. Conditions of Risk and Work

Unless the applicable Statement of Work expressly provides otherwise, Contractor agrees that before beginning any Work, Contractor shall carefully examine all conditions relevant to such Work and its surroundings, and, unless Contractor notifies Company in writing that it will not perform the Work under such conditions, Contractor shall assume the risk of such conditions and shall, regardless of such conditions, the expense, or difficulty of performing the Work, fully complete the Work for the stated Contract Price applicable to such Work without further recourse

to Company. Without limiting the foregoing, Contractor specifically recognizes that Company and other parties may be working concurrently at the site. Information on the site of the Work and local conditions at such site furnished by Company in Specifications, drawings, or otherwise is made without representation or warranty of any nature by Company, is not guaranteed by Company, and is furnished solely for the convenience of Contractor. All drawings and other documents, if any, required to be submitted to Company for review shall be submitted in accordance with the mutually agreed to schedule, and, if no schedule applies, such drawings or other documents shall be submitted by Contractor without unreasonable delay. No Work affected by such drawings and other documents shall be started until Contractor is authorized to do so by Company. In case of a conflict between or within instructions, Specifications, drawings, schedules, or Purchase Order(s), Company shall resolve such conflict; and Company's resolution shall be binding on Contractor.

7.7. Company Changes in Work

The scope of and conditions applicable to the Work shall be subject to changes by Company from time to time. Such changes shall only be enforceable if documented in a writing executed by Company. Except as otherwise specifically set forth in this Agreement, changes in the scope of or conditions applicable to the Work may result in adjustments in the Contract Price and/or the Work schedule in accordance with this Article. If Contractor believes that adjustment of the Contract Price or the Work schedule is justified, whether as a result of a change made pursuant to this Article or as a result of any other circumstance, then Contractor shall (a) give Company written notice of its claim within five (5) business days after receipt of notice of such change or the occurrence of such circumstances and (b) shall supply a written statement supporting Contractor's claim within ten (10) business days after receipt of notice of such change or occurrence of such circumstances, which statement shall include Contractor's detailed estimate of the effect on the Contract Price and/or the Work schedule. Contractor agrees to continue performance of the Work during the time any claim hereunder is pending. Company shall not be bound to any adjustments in the Contract Price or the Work schedule unless expressly agreed to by Company in writing. Company will not be liable for, and Contractor waives, any claims of Contractor that Contractor knew or should have known and that were not reported by Contractor in accordance with the provisions of this Article.

7.8. Force Majeure

Neither party shall be liable to the other for any damages for any failure to perform or for any delays or interruptions beyond that party's reasonable control in performing any of its obligations under this Agreement due to Force Majeure, unless the time to perform is expressly guaranteed. Contractor shall advise Company immediately of any anticipated and actual failure, delay, or interruption and the cause and estimated duration of such event. Any such failure, delay, or interruption, even though existing on the date of this Agreement or on the date of the start of the Work, shall require Contractor to within five (5) days submit a recovery plan detailing the manner in which the failure, delay, or interruption shall be remedied and the revised schedule. This Article shall apply only to the part of the Work directly affected by the particular failure, delay, or interruption, and shall not apply to the Work as a whole or any other unaffected part thereof.

7.9. Contractor Delays

Contractor agrees to cooperate with Company in scheduling the Work so that the Project and other activities at Company's site will progress with a minimum of delays. Company shall not be responsible for compensating Contractor for any costs of overtime or other premium time work unless Company has provided separate prior written authorization for additional compensation to Contractor, and, if Company provides such written authorization, such additional compensation shall be limited to Contractor's actual cost of the premium portion of wages, craft fringe benefits, and payroll burdens. Contractor shall be liable for all failures, delays, and interruptions in performing any of its obligations under this Agreement which are not (a) caused by Company and reported in accordance with Article 7.~~8~~7, (b) excused by Article 7.~~9~~8, or (c) directed by Company pursuant to Article 7.~~11~~10. Contractor shall, without adjustment to completion date or Contract Price, be obligated to make up time lost by such failures, delays, or interruptions. Company may suspend payments under this Agreement during the period of any such failure, delay, or interruption.

7.10. Company Extensions

Company shall have the right to extend schedules or suspend the Work, in whole or in part, at any time upon written notice to Contractor (except that in an emergency or

in the event that Company identifies any safety concerns, Company may require an immediate suspension upon oral or written notice to Contractor). Contractor shall, upon receipt of such notice, immediately suspend or delay the Work. Contractor shall resume any suspended Work when directed by Company. If Contractor follows the requirements of Article 7.~~8~~7, a mutually agreed equitable adjustment to the Contract Price or to the schedules for payments and performance of the remaining Work may be made to reflect Company's extension of schedules or suspension of the Work. Contractor shall provide Company all information Company shall request in connection with determining the amount of such equitable adjustment.

7.11. Right of Inspecting and Testing

Company reserves the right, but shall not be obligated, to appoint representatives to follow the progress of the Work with authority to suspend any Work not in compliance with this Agreement. The appointment or absence of an appointment, of such representatives by Company shall not have any effect on warranties. Acceptance or approval by Company's representative shall not be deemed to constitute final acceptance by Company, nor shall Company's inspection relieve Contractor of responsibility for proper performance of the Work. Inspection by Company's representative shall not be deemed to be supervision or direction by Company of Contractor, its agents, servants, or employees, but shall be only for the purpose of attempting to ensure that the Work complies with this Agreement. In the event Contractor fails to provide Company with reasonable facilities and access for inspection when advised, and if in the opinion of Company it becomes necessary to dismantle the Work for such inspection, then Contractor shall bear the expenses of such dismantling and reassembly.

7.12. Right of Auditing

Contractor shall maintain complete records relating to any cost-based (i.e., Work not covered by firm prices) components of the Work billed under this Agreement or relating to the quantity of units billed under any unit price provisions of this Agreement (all the foregoing hereinafter referred to as "Records") for a minimum of five years following the latest of performance of, delivery to Company of, or payment by Company for, such Work or units. All such Records shall be open to inspection and subject to audit and reproduction during normal working hours, by

Company or its authorized representatives to the extent necessary to adequately permit evaluation and verification of any invoices, payments, time sheets, or claims based on Contractor's actual costs incurred in the performance or delivery of Work under this Agreement. For the purpose of evaluating or verifying such actual or claimed costs, Company or its authorized representative shall have access to said Records at any time, including any time after final payment by Company to Contractor pursuant to this Agreement. All non-public information obtained in the course of such audits shall be held in confidence except pursuant to judicial and administrative order. Company or its authorized representative shall have access, during normal working hours, to all necessary Contractor facilities and shall be provided adequate and appropriate work space to conduct audits in compliance with the provisions of this Article. Company shall give Contractor reasonable notice of intended audits. The rights of Company set forth in this paragraph shall survive the termination or expiration of this Agreement.

7.13. Use of Tools and Equipment

Company, in its sole discretion, may allow Contractor to use Company's tools and equipment for the Work and related activities at designated Company locations. Contractor shall indemnify and hold harmless Company and its Affiliates, including their respective officers, directors, shareholders, agents, members and employees (each an "Indemnified Party"), from and against any and all claims, damages, losses or liabilities arising out of, relating to, or in connection with, the use of Company's tools and equipment by Contractor, its agents, servants, employees or subcontractors, and will reimburse each Indemnified Party for all expenses (including attorney's fees and expenses) as they are incurred in connection with investigating, preparing or pursuing or defending any action, claim, suit or investigation or proceeding related to, arising out of, or in connection with, the use of Company's tools and equipment by Contractor, its agents, servants, employees or subcontractors, whether or not threatened or pending and whether or not any Indemnified Party is a party. Contractor, on behalf of itself or its agents, affiliates, officers and directors, and all of their predecessors, successors, assigns, heirs, executors and administrators, hereby irrevocably release, discharge, waive, relinquish and covenant not to sue, directly, derivatively or otherwise, Company and/or its Affiliates and each of their respective directors, officers, shareholders, members, partners (general or limited), employees

and agents (including, without limitation, its financial advisors, counsel, proxy solicitors, information agents, depositories, consultants and public relations representatives) and all of their predecessors, successors, assigns, heirs, executors or administrators, and all persons acting in concert with any such person , with respect to any and all matters, actions causes of action (whether actually asserted or not), suits, damages, claims, or liabilities whatsoever, at law, equity or otherwise, arising out of, relating to, or in connection with the use of Company's tools and equipment by Contractor, its agents, servants, employees or subcontractors. Company shall in no event be liable for any claim whatsoever by or through Contractor, its employees, agents and/or subcontractors or by any third party, for any inoperability or failure of the tools and equipment to perform as designed or intended, whether such claim is based in warranty, contract, tort (including negligence), strict liability or otherwise and whether for direct, incidental, consequential, special, exemplary or other damages. Contractor shall ensure that its employees, agents, subcontractors or servants shall inspect, exercise the appropriate level of care in the use, maintenance and repair of the tools and equipment, so as to minimize the incidence of casualties and injuries occurring in connection therewith.

7.14. Applicable Laws and Safety

Contractor agrees to protect its own and its Subcontractors' employees and be responsible for their Work until Company's acceptance of the entire Project and to protect Company's facilities, property, employees, and third parties from damage or injury. Contractor shall at all times be solely responsible for complying with all applicable Laws and Regulations and facility rules, including without limitation those relating to health and safety, in connection with the Work and for obtaining (but only as approved by Company) all permits and approvals necessary to perform the Work. Without limiting the foregoing, Contractor agrees to strictly abide by and observe all standards of the Occupational Safety & Health Administration (OSHA) which are applicable to the Work and Company's Contractor/Subcontractor safety policy and any other rules and regulations of the Company. Contractor shall maintain the Work site in a safe and orderly condition at all times. Company shall have the right but not the obligation to review Contractor's compliance with safety and cleanup measures. In the event Contractor fails to keep the work area clean, Company shall have the right to perform such cleanup on behalf of, at the risk of and at the expense of

Contractor. Contractor shall require all of its Subcontractors to complete the safety and health questionnaire and checklists provided by Company and shall provide a copy of such documents to Company upon request. Contractor shall conduct, and require its Subcontractors to conduct, safety audits and job briefings during performance of the Work. In the event a Subcontractor has no procedure for conducting safety audits and job briefings, Contractor shall include the Subcontractor in its safety audits and job briefings. All safety audits shall be documented in writing by the Contractor and its Subcontractors. Contractor shall provide documentation of any and all audits identifying safety deficiencies and concerns and corrective action taken as a result of such audits to Company semi-monthly.

7.15. Hazards and Training

Contractor shall furnish trained, qualified, and experienced personnel and appropriate safety and other equipment in first-class condition, suitable for performance of the Work. Such personnel shall be skilled and properly trained to perform the Work and recognize all hazards associated with the Work. Without limiting the foregoing, Contractor shall participate in any safety orientation or other of Company's familiarization initiatives related to safety and shall strictly comply with any monitoring initiatives as determined by Company. Contractor shall accept all equipment, structures, and property of Company as found and acknowledges it has inspected the property, has determined the hazards incident to working thereon or thereabouts, and has adopted suitable precautions and methods for the protection and safety of its employees and the property.

7.16. Drug and Alcohol

No person will perform any of the Work while under the influence of drugs or alcohol. No alcohol may be consumed within four (4) hours of the start of any person's performance of the Work or anytime during the workday. A person will be deemed under the influence of alcohol if a level of .02 percent blood alcohol or greater is found. In addition to the requirements of the drug testing program, as set forth in Company's rules and regulations, all persons who will perform any of the Work will be subject to drug and alcohol testing under either of the following circumstances: (i) where the person's performance either contributed to an accident or cannot be completely discounted as a contributing factor to an accident which

involves off-site medical treatment of any person; and (ii) where Company determines in its sole discretion that there is reasonable cause to believe such person is using drugs or alcohol or may otherwise be unfit for duty. Such persons will not be permitted to perform any Work until the test results are established. Contractor shall be solely responsible for administering and conducting drug and alcohol testing, as set forth herein, at Contractor's sole expense. As applicable and in addition to any other requirements under this Agreement, Contractor shall develop and strictly comply with any and all drug testing requirements as required by applicable Laws or Regulations.

7.17. Status of Contractor

Contractor, in performing the Work, shall not act as an agent or employee of Company, but shall be and act as an independent contractor and shall be free to perform the Work by such methods and in such manner as Contractor may choose, doing everything necessary to perform such Work properly and safely and having supervision over and responsibility for the safety and actions of its employees and the suitability of its equipment. Contractor's employees and Subcontractors shall not be deemed to be employees of Company. Contractor agrees that if any portion of Contractor's Work is subcontracted, all such Subcontractors shall be bound by and observe the conditions of this Agreement to the same extent as required of Contractor.

7.18. Equal Employment Opportunity

To the extent applicable, Contractor shall comply with all of the following provisions, which are incorporated herein by reference: (i) Equal Opportunity regulations set forth in 41 CFR § 60-1.4(a) and (c), prohibiting employment discrimination against any employee or applicant because of race, color, religion, sex, or national origin; (ii) Vietnam Era Veterans Readjustment Assistance Act regulations set forth in 41 CFR § 60-250.4 relating to the employment and advancement of disabled veterans and Vietnam era veterans; (iii) Rehabilitation Act regulations set forth in 41 CFR § 60-741.4 relating to the employment and advancement of qualified disabled employees and applicants for employment; (iv) the clause known as "Utilization of Small Business Concerns and Small Business Concerns Owned and Controlled by Socially and Economically Disadvantaged

Individuals" set forth in 15 USC § 637(d)(3); and (v) the subcontracting plan requirement set forth in 15 USC § 637(d).

7.19. Indemnity

Contractor shall indemnify and hold harmless the Company and Engineer and their agents and employees from and against all claims, costs, losses, and damages (including reasonable attorney's fees and court costs) arising from and to the extent of the violation of law, negligence, acts, errors, omissions, or intentional misconduct of Contractor or any firm, entity, or other persons for whose acts or omissions the Contractor is responsible, including any Subcontractors. Company shall indemnify and hold harmless Contractor and its directors, officers, employees, and agents from and against all claims, costs, losses, and damages (including reasonable attorney's fees and court costs) arising from and to the extent of the violation of law, negligence, acts, errors, omissions, or intentional misconduct of Company.

7.20. Environmental Control:

As required under the OSHA Hazard Communication Standard (29 CFR 1910.1200) and certain other applicable Laws or Regulations, Contractor or its Subcontractors shall provide Material Safety Data Sheets ("MSDS") covering any hazardous substances and materials furnished under or otherwise associated with the Work under this Agreement. Contractor and its Subcontractors shall provide Company with either copies of the applicable MSDS or copies of a document certifying that no MSDS are required under any applicable Laws or Regulations in effect at the worksite. No asbestos or lead containing materials shall be incorporated into any Work performed by Contractor or otherwise left on the Work site without the prior written approval of Company. Contractor and its Subcontractors shall be solely responsible for determining if any chemical or material furnished, used, applied, or stored or Work performed under this Agreement is subject to any applicable Laws or Regulations.

7.20.1. Contractor and its Subcontractors shall label hazardous substances and materials and train their employees in the safe usage and handling of such substances and materials as required under any applicable Laws or Regulations.

7.20.2. Contractor and its Subcontractors shall be solely responsible for the management of any petroleum or hazardous substances and materials brought onto the Work site and shall prevent the release of petroleum or hazardous substances and materials into the environment. All petroleum or hazardous substances and materials shall be handled and stored according to Contractor's written Spill Prevention Control and Countermeasures Plan or Best Management Practices Plan as defined under the provisions of the Clean Water Act, as amended, if either such Plan must be maintained pursuant to applicable Laws or Regulations. Contractor shall provide secondary containment for the storage of petroleum or hazardous substances and materials. The prompt and proper clean-up of any spills, leaks, or other releases of petroleum or hazardous substances and materials resulting from the performance of the Work under this Agreement and the proper disposal of any residues shall be Contractor's sole responsibility, but Contractor shall give Company immediate notice of any such spills, leaks, or other releases. Contractor shall be solely responsible for the storage, removal, and disposal of any excess or unused quantities of chemicals and materials which Contractor causes to be brought to the Work site.

7.20.3. Unless Company and Contractor expressly agree otherwise in writing, Contractor and its Subcontractors shall be solely responsible for any wastes generated in the course of the Work, and Contractor shall handle, store, and dispose of such wastes in accordance with any Applicable Laws.

7.21. Contractor's Insurance Obligation: Contractor shall provide and maintain, and shall require any Subcontractor to provide and maintain, the following insurance which shall be primary (and, except with regard to Workers' Compensation), naming Company and Engineer as additional insureds and waiving rights of subrogation against Company, Engineer and Company's insurance carrier(s), and shall submit evidence of such coverage to Company prior to the start of the Work. Contractor's liability shall not be limited to its insurance coverage.

7.21.1. Contractor shall furnish certificates of insurance, in the name of the Big Rivers Electric Corporation, evidencing insurance coverage of the following types of minimum amounts:

a. Workman's compensation and employer's liability insurance covering all employees who perform any of the obligations under the Contract or Purchase Order, in the amounts required by law. If any employer or employee is not subject to the workers compensation laws of the governing state, then insurance shall be obtained voluntarily to provide coverage to the same extent as though the employer or employee were subject to such laws.

b. Comprehensive general liability insurance covering all operation under the Contract or Purchase Order: bodily injury - $1,000,000 each occurrence and aggregate; property damage - $1,000,000 each occurrence and aggregate. A combined single limit of $1,000,000 for bodily injury and property damage liability is acceptable. The insurance may be in a policy or policies of insurance. A primary policy and an excess policy including the umbrella or catastrophe form is acceptable. Coverage should include contractual liability, broad form property damage liability, Owner's and Contractor's protective (independent contractor's) liability, products and completed operations hazard, explosion, collapse, and underground property damage hazard.

c. Automotive liability insurance on all motor vehicles used in conjunction with the Contract or Purchase Order, whether owned, nonowned, or hired; bodily injury - $1,000,000 each person and $1,000,000 each occurrence; property damage $1,000,000 each occurrence. A combined single limit of $1,000,000 for bodily injury and property damage liability is acceptable. The insurance may be in a policy or policies of insurance. A primary policy and an excess policy including the umbrella or catastrophe form is acceptable.

d. Certificates evidencing the insurance coverage's must be furnished before the commencement of Work. If any work to be performed under this Contract or Purchase Order is sublet, the Contractor will be required to furnish proof of insurance from all Subcontractors evidencing equal to or better coverage.

7.21.2. The above policies to be provided by Contractor shall be written by insurance companies which are both licensed to do business in the state where the Work will be performed and either satisfactory to Company or having a Best Rating of not less than A-. These policies shall not be materially changed or canceled except with thirty (30) days written notice to Company from Contractor and the insurance carrier. Evidence of coverage, notification of cancellation or other changes shall be mailed to: Attn: Manager, Supply Chain, Big Rivers Electric Corp., P.O. Box 24, Henderson, KY 42419.

7.21.3. Company reserves the right to request and receive a summary of coverage of any of the above policies or endorsements; however, Company shall not be obligated to review any of Contractor's certificates of insurance, insurance policies, or endorsements, or to advise Contractor of any deficiencies in such documents. Any receipt of such documents or their review by Company shall not relieve Contractor from or be deemed a waiver of Company's rights to insist on strict fulfillment of Contractor's obligations under this Agreement.

7.21.4. Contractor shall provide notice of any accidents or claims at the Work site to Company's Manager, Risk Management at Big Rivers Electric Corporation, P.O. Box 24, Henderson, KY 42419 and Company's site safety representative.

7.22. Intellectual Rights and Patents

Contractor shall pay all royalties and license fees which may be payable on account of the Work or any part thereof. In case any part of the Work is held in any suit to constitute infringement and its use is enjoined, Contractor within a reasonable time shall, at the election of Company and in addition to Contractor's obligations under Article 7.19, either (a) secure for Company the perpetual right to continue the use of such part of the Work by procuring for Company a royalty-free license or such other

permission as will enable Contractor to secure the suspension of any injunction, or (b) replace at Contractor's own expense such part of the Work with a non-infringing part or modify it so that it becomes non-infringing (in either case with changes in functionality that are acceptable to Company).

7.23. Release of Liens

Contractor hereby releases for itself and its successors in interest, and for all Subcontractors and their successors in interest, any and all claim or right of mechanics or any other type lien upon Company's or any other party's property, the Work, or any part thereof as a result of performing the Work. Contractor shall execute and deliver to Company such documents as may be required by applicable Laws or Regulations to make this release effective and shall give all required notices to Subcontractors with respect to ensuring the effectiveness of the foregoing release against those parties. Contractor shall secure the removal of any lien that Contractor has agreed to release in this Article within five (5) working days of receipt of written notice from Company to remove such lien. If not timely removed, Company may remove the lien and charge all costs and expenses to Contractor, including without limitation costs of bonding off such lien.

7.24. Assignment of Agreement; Subcontracting

Contractor shall not, by operation of law or otherwise, assign and/or subcontract any part of the Work or this Agreement without Company's written approval. Such approval, if given by Company, shall not relieve Contractor from full responsibility for the fulfillment of any and all obligations under this Agreement. Under any and all circumstances, any permitted assignee of Contractor, whether or not such assignee shall be a division, subsidiary and/or affiliate entity of Contractor, shall also be fully bound by the terms of this Agreement and, furthermore, upon request by Company, each of Contractor and its permitted assignee shall provide sufficient financial information, as determined by Company in its sole discretion, necessary to validate such assignee's credit worthiness and ability to perform under this Agreement.

7.25. Invoices and Effects of Payments

7.25.1. Invoices: In accordance with the Payment and Cancellation Schedule, Contractor shall submit an invoice to Company that complies with this Article. Payments shall be made within thirty (30) days of Company's receipt of Contractor's proper invoice, and, in the event that Company's payment is overdue, Contractor shall promptly provide Company with a notice that such payment is overdue. Contractor's invoices shall designate the Company location which is the responsible party. Such invoices shall reference the Contract / Purchase Order number and shall also show labor, material, taxes paid (including without limitation sales and use taxes, duties, fees, and other assessments imposed by governmental authorities), freight, and all other charges (including without limitation equipment rental) as separate items. All invoices shall be submitted with supporting documentation and in acceptable form and quality to Company's authorized representative. Should Company dispute any invoice for any reason, payment on such invoice shall be made within thirty (30) days of the dispute resolution. Payment of the invoice shall not release Contractor from any of its obligations hereunder, including but not limited to its warranty and indemnity obligations. Invoices shall not be delivered with goods, unless expressly authorized by the Company, but all correspondence and packages related to this Agreement shall reference the Purchase Order / Contract number assigned by Company.

7.25.2. Surcharges: All charges must be pre-approved and referenced within the Purchase Order or Contract. Unapproved charges will not be accepted and will cause the invoice to be rejected and returned. This includes, but is not limited to, surcharges, packing charges, core charges, deposits, and/or any other added costs.

7.25.3. Sales and Use Taxes

a. Projects: If Company provides Contractor with an exemption certificate demonstrating an exemption from sales or use taxes in Kentucky, then Contractor shall not withhold or pay Kentucky sales or use taxes to the

extent such exemption certificate applies to the Work (such exemption does not and shall not apply to any materials consumed by Contractor in performing the Work). If Company does not provide Contractor with an exemption certificate demonstrating an exemption from sales or use taxes in Kentucky, Contractor shall be solely responsible for paying all appropriate sales, use, and other taxes and duties (including without limitation sales or use tax with respect to materials purchased and/or consumed in connection with the Work) to, as well as filing appropriate returns with, the appropriate authorities. To the extent specifically included in the Contract Price, Contractor shall bill Company for and Company shall pay Contractor all such taxes and duties, but Company shall in no event be obligated for taxes and duties not specifically included in the Contract Price or for interest or penalties arising out of Contractor's failure to comply with its obligations under this Section.

b. Goods provided to Big Rivers: The Contractor shall not bill Big Rivers for Kentucky Sales Tax. A Direct Pay Authorization is maintained under Permit # 108814 as per 103 KAR 31:030.

7.25.4. Billing of Additional Work: All claims for payments of additions to the Purchase Order / Contract Price shall be shown on separate Contractor's invoices and must refer to the specific change order or written authorization issued by Company as a condition to being considered for payment.

7.25.5. Effect of Payments/Offset: No payments shall be considered as evidence of the performance of or acceptance of the Work, either in whole or in part, and all payments are subject to deduction for loss, damage, costs, or expenses for which Contractor may be liable under any Purchase Order or set-off hereunder. Company, without waiver or limitation of any rights or remedies of Company, shall be entitled from time to time to deduct from any and all amounts owing by Company to Contractor in connection with this Agreement or any other contract with Company any and all amounts owed by Contractor to Company in connection with this Agreement or any other contract with Company.

7.25.6. Evidence of Payment to Subcontractors: Contractor shall, if requested by Company, furnish Company with a certificate showing names of Contractor's Suppliers and Subcontractors hereunder, and certifying to Company that said Suppliers and Subcontractors have been paid in full.

7.26. Term and Termination

7.26.1. This Agreement shall commence upon the issuance of Purchase Order referencing this Specification, the Bidder's Proposal, and any subsequent negotiations and shall survive in full force and effect until terminated as set forth below. A termination under this Article based on certain Work shall only apply to the Purchase Order that covers such Work. Any purchase orders that do not relate to such Work shall not be affected by such a termination.

7.26.2. Termination for Contractor's Breach:

If the Work to be done under this Agreement shall be abandoned by Contractor, if this Agreement or any portion thereof shall be assigned by operation of law or otherwise without the written permission of the Company, if the Work or any portion thereof is sublet by Contractor without the written permission of Company, if Contractor is placed in bankruptcy, or if a receiver be appointed for its properties, if Contractor shall make an assignment for the benefit of creditors, if at any time the necessary progress of Work is not being maintained, or if Contractor is violating any of the conditions or terms of this Agreement, or has executed this Agreement in bad faith, Company may, without prejudice to any other rights or remedies it may have as a result thereof, notify Contractor to discontinue any or all of the Work and terminate this Agreement in whole or part. Company's foregoing right to notify Contractor and terminate this Agreement is subject to Company first providing Contractor with (i) notice and (ii) 30 days' chance to cure any such defect, failure, breach or improper performance. In the event that Section 365(a) of the Bankruptcy Code or some successor law gives Contractor as debtor-in-possession the right to either accept or reject this Agreement, then Contractor agrees to file an appropriate motion with the Bankruptcy Court to either accept or reject this Agreement within twenty (20) days of the entry of the Order for

Relief in the bankruptcy proceeding. Contractor and Company acknowledge and agree that said twenty (20) day period is reasonable under the circumstances. Contractor and Company also agree that if Company has not received notice that Contractor has filed a motion with the Bankruptcy Court to accept or reject this Agreement within said twenty (20) day period, then Company may file a motion with the Bankruptcy Court asking that this Agreement be accepted or rejected, and Contractor shall not oppose such motion.

7.26.3. Effect of Termination for Contractor's Breach:

From the effective date of such termination notice, Contractor shall vacate the site, whereupon Company shall have the right but not the obligation to take possession of the Work wherever located, and Contractor shall cooperate with Company and cause Contractor's Subcontractors to cooperate with Company so that Company can effect such possession. In obtaining replacement services, Company shall not be required to request multiple bids or obtain the lowest figures for completing the Work and may make such expenditures as shall best accomplish such completion and are reasonable given the circumstances. The expenses of completing the Work in excess of the unpaid portion of the Contract Price, together with any damages suffered by Company, shall be paid by Contractor, and Company shall have the right to set off such amounts from amounts due to Contractor.

7.26.4. Termination for Company's Convenience:

Company may terminate this Agreement or one or more purchase orders in whole or in part for its own convenience by thirty (30) days' written notice at any time. In such event, Company shall pay Contractor all direct labor and Material costs incurred on the Work that is subject to such termination prior to such notice, plus any reasonable unavoidable cancellation costs which Contractor may incur as a result of such termination, plus indirect costs or overhead on the portion of the Work completed, computed in accordance with generally accepted accounting principles less salvage value. As an alternative to salvage value reduction, Company shall have the right in its sole discretion to take possession of all or part of the Work.

7.27. Publicity

Contractor shall not issue news releases, publicize or issue advertising pertaining to the Work or this Agreement without first obtaining the written approval of Company.

7.28. Confidential Information

All information relating to the Work or the business of Company, including, but not limited to, drawings and specifications relating to the Work, and customer information, shall be held in confidence by Contractor and shall not be used by Contractor for any purpose other than for the performance of the Work or as authorized in writing by Company. In the event that the Contractor assigns the work to one or more Subcontractors, a signed confidentiality agreement between the Contractor and each Subcontractor(s) will be provided to the Company prior to the provision of any information described in the immediately preceding sentence or the performance of any Work by the Subcontractor. All drawings, specifications, or documents furnished by Company to Contractor or developed in connection with the Work shall either be destroyed or returned to Company (including any copies thereof) upon request at any time.

7.29. Miscellaneous

7.29.1. No waiver by Company of any provision herein or of a breach of any provision shall constitute a waiver of any other breach or of any other provision.

7.29.2. Headings: The headings of Articles, Sections, paragraphs, and other parts of this Agreement are for convenience only and do not define, limit, or construe the contents thereof.

7.29.3. Severability: If any provision of this Agreement shall be held invalid under law, such invalidity shall not affect any other provision or provisions hereof which are otherwise valid.

7.29.4. State Law Governing Agreement: This Agreement shall be governed by, and construed in accordance with, the laws of the Commonwealth of Kentucky, without regard to its principles of conflicts of laws.

7.29.5. Enforcement of Rights: Company shall have the right to recover from Contractor all expenses, including but not limited to fees for and expenses of inside or outside counsel hired by Company, arising out of Contractor's breach of this Agreement or any other action by Company to enforce or defend Company's rights hereunder.

7.29.6. No Third Party Beneficiaries: Except for Contractor and Company, there are no intended third party beneficiaries of this Agreement and none may rely on this Agreement in making a claim against Company.

8. NOTICES

All notices and communications respecting this Agreement shall be in writing, shall be identified by the contract number, and shall be addressed as follows (which address either party may change upon five (5) days prior notice to the other party).

To Company:	To Contractor:
Big Rivers Electric Corp.	_____
Attn: Director, Supply Chain	_____
P.O. Box 24	_____
Henderson, Kentucky 42419	_____

8.1. Any notice, request, or approval or other document required or permitted to be given under this Contract will be in writing unless otherwise provided herein and will be deemed to have been sufficiently given if delivered in person, transmitted by fax or email with return receipt and followed by a hard copy, dispatched in the U.S. mails, postage prepaid for mailing by certified or registered mail, return receipt requested, or dispatched for delivery by other courier service providing a return receipt.

9. ENGINEER'S TECHNICAL SPECIFICATION

The Engineer's technical specification from Burns and McDonnell referenced as ***Project 73827, Contract 8320, General Construction*** starts on the next page.

Big Rivers
ELECTRIC CORPORATION

Your Touchstone Energy® Cooperative

PURCHASE ORDER

PURCHASE ORDER NO	REVISION	PAGE
226689	0	1

SHIP TO:
R. D. Green Station
9000 HWY 2096
Robards,KY 42452

BILL TO:
201 Third Street
Henderson,KY 42420

VENDOR: **A AND D CONSTRUCTORS INC**
707 SCHRADER AVE
EVANSVILLE, IN 47712

ITEM	PART NUMBER/DESCRIPTION	DELIVERY DT	QTY	UNIT	UNIT PRICE	EXTENSION

VENDOR NO 56772	DELIVER TO	DATE OF ORDER/BUYER 30-JUL-14 Toerne, Robert Frank	REVISED DATE/BUYER Toerne, Robert Frank
PAYMENT TERMS 30 NET DAYS		BUYER TELEPHONE/FAX 270-844-6029 888-268-6219	F.O.B DESTINATION
FREIGHT TERMS PREPAID/ADD		SHIP VIA	VENDOR CONTACT/TELEPHONE (812) 428-3708

Special Instructions: This Purchase Order No. must appear on all invoices, packing lists, cartons and correspondences related to this order

Terms: Negotiated Terms on File.

ITEM	PART NUMBER/DESCRIPTION	DELIVERY DT	QTY	UNIT	UNIT PRICE	EXTENSION
1.1	PROVIDE GENERAL CONSTRUCTION SERVICES FOR GREEN STATION MATS PROJECT PER CONFORMED RFQ SPECIFICATION GN-14-030 AND CONFORMED TECHNICAL SPECIFICATION 8320FI	31-MAR-15	4822849	EACH	$ 1.00	$ 4,822,849.00
2.1	PROVIDE OUT-OF-SCOPE SERVICES, MATERIALS, AND SUPPLIES FOR WORK PRE-APPROVED BY BREC'S VICE PRESIDENT OF ENVIROMENTAL SERVICES AND CONSTRUCTION ON A TIME AND MATERIALS / NOT TO EXCEED BASIS	31-MAR-15	250000	EACH	$ 1.00	$ 250,000.00

TOTAL $ 5,072,849.00

Big Rivers
ELECTRIC CORPORATION

Your Touchstone Energy® Cooperative

Equipment and Material

Mercury and Air Toxics Standard (MATS) Compliance Project

Project #BR13156

Table of Contents

Project #BR13156

PROJECT SUMMARY

Big Rivers Electric Corporation (Owner) is installing Dry Sorbent Injection (DSI) and Activated Carbon Injection (ACI) systems for Robert D. Green Generating Station (Green Station) Units 1 and 2. The addition of the DSI and ACI systems are intended to reduce mercury (Hg) emission to levels compliant with the Mercury Air Toxic Standards (MATS). DSI systems will be used to reduce SO_3 levels as necessary to improve the Hg removal efficiency of activated carbon. The DSI system will utilize hydrated lime for the reagent. The ACI system will utilize powdered activated carbon (PAC).

1. DEFINITIONS

1.1. "Addenda" - written or graphic changes or interpretations of the Contract Documents issued by Owner prior to the opening of Bids.

1.2. "Administrator" shall mean the Administrator of the Rural Utilities Service of the United States of America and his or her duly authorized representative or any other person in whom or authority in which may be vested the duties and functions which the Administrator is now authorized by law to perform.

1.3. "Agreement" or "Contract" - the written agreement between Owner and Bidder covering the Work to be performed. Other Contract Documents are attached to the Contract and made a part thereof as provided therein.

1.4. "Application for Payment" - the form acceptable to Owner and Engineer and Contractor which is to be used by Bidder during the course of the Work in requesting progress or final payments and which is to include such supporting documentation as is required by the Contract Documents.

1.5. "Bid" - the formal offer of the Bidder submitted on the prescribed Bid Form and all information submitted with the Bid that pertains to performance of the Work.

1.6. "Bidder" – Prior to Contract award, "Bidder" is any person, firm, or corporation submitting a Bid for the Work or their duly authorized representative. Upon Contract

award, "Bidder" is the person, firm or corporation with whom the Owner has entered into the Contract.

1.7. "Change Order" - a written document recommended by Engineer which is signed by Owner and Bidder and authorizes an addition, deletion, or revision in the Work, or an adjustment in the Contract Price or the Contract Time or other material provision issued on or after execution of the Contract.

1.8. "Company" – Big Rivers Electric Corporation, also referred to as "BREC", "Big Rivers", or "Owner".

1.9. "Contract" or "Agreement" - the written agreement between Owner and Bidder covering the Work to be performed. Other Contract Documents are attached to the Contract and made a part thereof as provided therein.

1.10. "Contract Documents" - RUS Form 198 or RUS Form 200, all documents referenced in the table of contents, exhibits, attachments, affidavits, bonds, insurance requirements and documents, releases, Specifications, drawings, and Change Orders or signed amendments issued to the Contract. The Parties agree to the following Order of Priority (in descending order): (a) Change Orders; (b) Project #BR13156; (c) Exhibit A (conformed); (d) Exhibits (B) through (K).

1.11. "Contract Time" - the number of days or the dates stated in the Contract Documents for the completion of the Work.

1.12. "Contractor" - is the person, firm or corporation with whom the Owner has entered into the Contract.

1.13. "Date of Contract" - the date on which the Contract is signed and executed by the Owner and Contractor.

1.14. "Day" or "Days" - a calendar day of 24 hours measured from midnight to the next midnight.

1.15. "DDP" (Delivered Duties Paid) (Incoterms 2000) Point of Delivery - The Contract Price includes all costs of transporting Equipment and Materials to the named Point of Delivery, including but not limited to any duties, permits, and insurance for the full value of the Equipment and Materials being delivered.

1.16. "Defective" - an adjective which when modifying the words Equipment and Materials, or Field Services refers to Equipment and Materials or Field Services which do not conform to the Contract Documents, or do not meet the requirements of any inspection reference standard, test, or approval referred to in the Contract Documents.

1.17. "Effective Date of the Contract" – the date of Acceptance of Contract by Owner and Contractor or if approval by the Administrator is required, the date of approval by the Administrator in accordance with RUS Form 198 or RUS Form 200.

1.18. "Engineer" shall mean the Engineer employed by the Owner to provide engineering services for the project and said Engineer's duly authorized assistants and representatives. For this Project, "Engineer" means Burns & McDonnell Engineering Company, Inc. a Missouri Corporation, with offices at 9400 Ward Parkway, Kansas City, Missouri 64114.

1.19. "Equipment" - a product with operational or nonoperational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

1.20. "Field Services" - services to be furnished by Contractor at the Site as required by the Contract Documents.

1.21. "Final Acceptance" - shall mean the point after Substantial Competition when Contractor has (i) completed all punch list items as mutually agreed by Owner and Contractor acting in a commercially reasonable manner; (ii) delivered to Owner all final documentation; (iii) met all Performance Guarantees with associated liquidated damages or paid the applicable damages; and (iv) met all "Make Right" Performance Guarantees.

1.22. "Laws and Regulations"/ "Laws or Regulations" - laws, rules, regulations, ordinances, codes and/or orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

1.23. "Liquidated Damages" – payments which the Contractor shall make to the Owner for the value of damages experienced by the Owner to compensate for additional operational expenses or missed delivery schedules defined within the Contract.

1.24. "Major Subcontractors" in this Agreement shall mean any supplier and subcontractor of Contractor whose subcontract price exceeds $100,000.

1.25. "Materials" - products substantially shaped, cut, worked, mixed, finished, refined, or otherwise fabricated, processed, or installed to form a part of the Work.

1.26. "Notice to Proceed" - the mutually agreed upon written notice by Owner to Bidder fixing the date on which the Contract Time will commence to run and on which Bidder shall start to perform Bidder's obligation under the Contract.

1.27. "Owner" – Big River Electric Corporation, also referred to as "BREC", "Big Rivers", or "Company".

1.28. "Point of Delivery" – the place designated where the Equipment and Materials are to be delivered, being:

1.28.1. Big Rivers Electric Corporation, Green Station, 9000 HWY 2096, Robards, KY 42452.

1.29. "Parties" - Owner and Bidder, each of which is individually a "Party".

1.30. "Payment and Cancellation Schedule" - the detailed listing of activities or milestones with an associated payment percentage of the total Contract Price which accurately reflects payment for Work accomplished and cancellation percentage of the total Contract Price which reflects the payment(s) agreed to between the Parties in the event of cancellation. This schedule shall be jointly developed and agreed to by Owner and Contractor.

1.31. "Project" - the total construction of which the Work to be provided under the Contract may be the whole, or a part as indicated elsewhere in the Contract.

1.32. "Reference Drawings" - drawings not specifically prepared for this Contract, but which contain information pertinent to the Work.

1.33. "Samples" - physical examples of Equipment, Materials, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

1.34. "Shop Drawings" - all drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

1.35. "Site", "Job Site" or "Point of Delivery" - the Owner's Station where Equipment is being delivered, being:

1.35.1. Big Rivers Electric Corporation, Green Station, 9000 HWY 2096, Robards, KY 42452.

1.36. "Specifications" - those portions of the Contract Documents consisting of written technical descriptions of the Work, and covering the Equipment, Materials, workmanship, performance and certain administrative details applicable thereto.

1.37. "Subcontractor" - an individual, firm, or corporation having a direct contract with Contractor to perform a portion of the Work.

1.38. "Submittals" - all Shop Drawings, product data, and Samples which are prepared by Contractor, a Subcontractor, manufacturer or Supplier, and submitted by Contractor to Owner and Engineer as a basis for approval of the use of Equipment and Materials proposed for incorporation in the Work or needed to describe proper installation, operation, and maintenance, or technical properties.

1.39. "Substantial Completion" - the event when, (i) erection or installation of the Equipment and Materials furnished under the Contract has been completed by the Owner's installing contractor; (ii) required Contractor field services have been furnished (as mutually agreed by Owner and Contractor acting in a commercially reasonable manner), (iii) the Equipment and Materials are operating safely for the purpose of commissioning and startup (as mutually agreed by Owner and Contractor acting in a commercially reasonable manner), (iv) all performance testing of the Work has been completed by Owner and all test data properly evaluated by Owner or they have been deemed accepted, (v) the Emissions Guarantees have been verified by the Performance Tests or they have been deemed accepted, and (vi) Contractor has delivered to Company all operating instructions, maintenance manuals, and warranties.

1.40. "Supplier" - a manufacturer, fabricator, supplier, distributor, material man, or vendor of Bidder or Contractor.

1.41. "Work" - the goods and all services required by the Contract, and includes all labor, Materials, Equipment and services provided or to be provided by the Contractor to fulfill the Contractor's obligations herein. The Work may constitute the whole or a part of the Project.

1.42. "Force Majeure" - any condition, event or circumstance, including the examples set forth below, but only if, and to the extent (i) such condition, event or circumstance is not within the reasonable control of the Party affected, (ii) such condition, event or circumstance, despite the exercise of commercially reasonable diligence, cannot be prevented, avoided or removed by such Party, (iii) such condition, event or circumstance materially adversely affects the ability of the affected Party to fulfill its obligations under this Agreement, (iv) the affected Party has taken all commercially reasonable precautions, due care and commercially reasonable alternative measures in order to avoid the effect of such condition, event or circumstance on the affected Party's ability to fulfill its obligations under this Agreement and to mitigate the consequences thereof and (v) such condition, event or circumstance is not the result of any failure of such Party to perform any of its obligations under this Agreement. By way of example, such events, conditions and circumstances shall include, but not

be limited to war, rebellion, sabotage, riots, insurrection, public disorder, fires, floods, volcanic eruption, tidal wave, earthquake, quarantine, explosions or other natural catastrophes or Acts of God, lightning, acts of terrorism, theft on site, acts of a public enemy, governmental act or omission, labor disturbance, labor shortages, action or industry-wide or national strike, the failure of any subcontractor or supplier to furnish labor, services, materials or equipment due to an event of Force Majeure and changes in applicable Laws or Regulations after the Effective Date of the Contract.

2. OVERVIEW

2.1. The Contractor shall design, manufacture and deliver (DDP Point of Delivery) all Equipment and Material which are detailed in the Scope of Work and in accordance with the requirements of this Contract. The Equipment and Materials include, but is not limited to, the following:

a. Activated Carbon Injection (ACI) systems
b. Dry Sorbent Injection (DSI) systems
c. All materials and equipment integral with ACI and DSI systems
d. Oil free compressed air systems
e. All instrumentation and control devices as required to monitor and control all process equipment supplied under this Contract.
f. Power control module (PCM) building to support electrical equipment, control equipment, and miscellaneous piping, valves and instrumentation.
g. Stair towers with access platforms and catwalks as necessary to access each silo's roof and equipment areas.
h. Structural and support steel for all equipment including supporting columns and beams, hanger rods, platforms, galleries, grating, stairs and handrails.
i. All steel required to modify the existing structural steel and related connections as required to support the piping, cable tray, and electrical conduits from the pipe rack to the points of injection.
j. Physical flow modeling and computational fluid dynamic modeling of the ACI and DSI Systems.

k. Performance Guarantee Test Procedures, mutually agreed upon with Owner.

2.2. Robert D. Green Generating Station consists of Unit 1 and Unit 2 which are 250 MW and 242 MW pulverized coal-fired balanced draft natural circulation, wall fired units provided by Babcock & Wilcox in 1976. Both units have two air preheaters and two electrostatic precipitators downstream of the economizers, and two wet FGD scrubbers which run at all times the units are online. Green burns a blend of bituminous coal and petroleum coke with a range of 0% - 27% petroleum coke in the blend. Fuel range and analyses are provided in Appendix 011101-A of the Engineer's Specification.

2.3. If any conditions, circumstances or occurrences not covered in the Specification are encountered, or if there are any doubts as to the meaning, please contact the Rob Toerne at (270) 844-6029 or rob.toerne@bigrivers.com. Clarifications or explanations may result in an addendum to the RFQ.

2.4. The Company recognizes this Agreement as a contract for the supply of materials and equipment however certain entries of this document contain specific requirements that apply to the on-site presence of the Contractor's representatives, Subcontractor's representatives, or Supplier's representatives.

2.5. The Contractor shall abide by the items in this Specification unless Big Rivers agrees in writing to any changes. Changes must be made in the form of a written request.

2.6. Big Rivers Electric Corporation reserves the right to reject any or all Bids, to waive informalities therein and to consider exceptions and clarifications therein in order to determine the lowest and best bid; to reject any or all non-conforming, non-responsive, unbalanced or conditional Bids; to reject the Bid of any Contractor that it would not be in the best interest of the Project to make an award to that Contractor, whether because the Bid is not responsive or the Contractor is unqualified or of doubtful financial ability, or fails to meet any other pertinent standard or criteria established. The Company also reserves the right to negotiate contract terms with the successful Contractor. By submitting a Bid, the Contractor agrees that such

procedures will be without liability for any damage or claim brought by the Contractor because of such rejections or procedures, nor will the Contractor seek any recourse of any kind against the Company because of such rejections or procedures. The filing of any Bid in response to this Invitation will constitute an agreement of the Contractor to these conditions.

2.7. Owner and Contractor agree that where provisions in this Project #BR135156 conflict in whole or in part with provisions in the other Contract Documents, the provisions in this Project #BR135156 shall take precedence. Specifically, Owner and Contractor agree that the following sections in Exhibit C are expressly overridden by provisions in this Project #BR135156 and that such sections in Exhibit C shall have no effect or validity: Contract Article 4 Due Diligence; Contract Article 6 The Time for Delivery of the Equipment; Proposal Article I, Section 4 Due Diligence; Proposal Article II, Section 1 Delivery (last paragraph); Proposal Article II, Section 2 Defective Materials and Workmanship; Proposal Article III Payment; Proposal Article IV, Section 1(d); Proposal Article IV, Section 1(e); Article IV, Section 2 and Proposal Article V Remedies. The Parties agree that Company is seeking approval of the language in this Section 2.7 from the RUS Administrator. If the language is not approved by the RUS Administrator, then the Parties will address such action in a mutually agreeable manner.

3. PROPOSAL PREPARATION AND SUBMITTAL

3.1. A mandatory pre-bid meeting will be held on September 4, 2013 at Big Rivers Green Station starting at 8:00 AM CT.

3.2. All bids will be valid for ninety (90) days from the opening of the bid.

3.3. The Bidders must complete and submit all documents identified as submittals within this document including, but not limited to;

a. Division 49 of the Engineer's Specification
b. RUS Form 198
c. RUS Equal Opportunity Form 270
d. RUS Certification Relating to Lobbying
e. RUS Certification Regarding Debarment Form AD-1048

not relieve Contractor from or be deemed a waiver of Company's rights to insist on strict fulfillment of Contractor's obligations under this Agreement.

7.27.4. Contractor shall provide notice of any accidents or claims at the Work site to Company's Manager, Risk Management at Big Rivers Electric Corporation, P.O. Box 24, Henderson, KY 42419 and Company's site safety representative.

7.28. Intellectual Rights and Patents

7.28.1. Contractor shall pay all royalties and license fees which may be payable on account of the Work or any part thereof. In case any part of the Work is held in any suit to constitute infringement and its use is enjoined, Contractor within a reasonable time shall, at the election of Contractor and in addition to Contractor's obligations under Article 7.34, either (a) secure for Company the perpetual right to continue the use of such part of the Work by procuring for Company a royalty-free license or such other permission as will enable Contractor to secure the suspension of any injunction, or (b) replace at Contractor's own expense such part of the Work with a non-infringing part or modify it so that it becomes non-infringing (in either case with changes in functionality that are acceptable to Company). Contractor's patent indemnity obligations are conditioned upon Contractor being given prompt written notice of such claim (if and when notice is received by Owner) and full opportunity and full cooperation of Owner to defend such claim and to minimize damages and shall not apply to the extent that any Equipment are made to Owner's design specifications.

7.28.2. Contractor hereby grants Company a royalty-free, non-revocable, non-transferable license to all Contractor Deliverables provided by Contractor to Company under this Contract, including the right to use, copy or duplicate same, solely for the purposes of operation, installation, maintenance and training on this Project. Company agrees to obtain the prior written consent of Seller before conveying any Contractor Deliverables, which is marked proprietary or confidential by Contractor or its subcontractors to any third party.

7.29. Release of Liens

Provided it has been paid in accordance with this Agreement, Contractor hereby releases for itself and its successors in interest, and for all Subcontractors and their successors in interest, any and all claim or right of mechanics or any other type lien upon Company's or any other party's property, the Work, or any part thereof as a result of performing the Work. Contractor shall execute and deliver to Company such documents as may be required by applicable Laws or Regulations to make this release effective and shall give all required notices to Subcontractors with respect to ensuring the effectiveness of the foregoing release against those parties. Contractor shall secure the removal of or bond off any lien that Contractor has agreed to release in this Article within five (5) working days of receipt of written notice from Company to remove such lien. If not bonded off, Company may remove the lien and charge all costs and expenses to Contractor, including without limitation costs of bonding off such lien.

7.30. Assignment of Agreement; Subcontracting

Neither Party shall, by operation of law or otherwise, assign any part of the Work or this Agreement without the other Party's written approval. Such approval, if given by the other Party, shall not relieve the assignor from full responsibility for the fulfillment of any and all obligations under this Agreement. Under any and all circumstances, any permitted assignee of the assignor, whether or not such assignee shall be a division, subsidiary and/or affiliate entity of the assignor, shall also be fully bound by the terms of this Agreement and, furthermore, upon request by the other Party, each of the assignor and its permitted assignee shall provide sufficient financial information, as determined by the other Party in its sole discretion, necessary to validate such assignee's credit worthiness and ability to perform under this Agreement.

7.31. Invoices and Effects of Payments

7.31.1. Invoices: In accordance with the Payment and Cancellation Schedule, Contractor shall submit an invoice to Company that complies with this Article. Payments shall be made within thirty (30) days of Company's receipt of

Contractor's proper invoice, and, in the event that Company's payment is overdue, Contractor shall promptly provide Company with a notice that such payment is overdue. Contractor's invoices shall designate the Company location which is the responsible party. Such invoices shall reference the Contract / Purchase Order number and shall also show labor, material, taxes paid (including without limitation sales and use taxes, duties, fees, and other assessments imposed by governmental authorities), freight, and all other charges (including without limitation equipment rental) as separate items. All invoices shall be submitted with supporting documentation and in acceptable form and quality to Company's authorized representative. Should Company dispute any invoice for any reason, payment on such invoice shall be made within thirty (30) days of the dispute resolution. Payment of the invoice shall not release Contractor from any of its obligations hereunder, including but not limited to its warranty and indemnity obligations. Invoices shall not be delivered with goods, unless expressly authorized by the Company, but all correspondence and packages related to this Agreement shall reference the Purchase Order / Contract number assigned by Company.

7.31.2. All charges must be pre-approved and referenced within the Purchase Order, Contract, or change orders. This includes, but is not limited to, surcharges, packing charges, core charges, deposits, and/or any other added costs.

7.31.3. Sales and Use Taxes

a. Projects: If Company provides Contractor with an exemption certificate demonstrating an exemption from sales or use taxes in Kentucky, then Contractor shall not withhold or pay Kentucky sales or use taxes to the extent such exemption certificate applies to the Work (such exemption does not and shall not apply to any materials consumed by Contractor in performing the Work). If Company does not provide Contractor with an exemption certificate demonstrating an exemption from sales or use taxes in Kentucky, Contractor shall be solely responsible for paying all appropriate sales, use, and other taxes and duties (including without

limitation sales or use tax with respect to materials purchased and/or consumed in connection with the Work) to, as well as filing appropriate returns with, the appropriate authorities. To the extent specifically included in the Contract Price, Contractor shall bill Company for and Company shall pay Contractor all such taxes and duties, but Company shall in no event be obligated for taxes and duties not specifically included in the Contract Price or for interest or penalties arising out of Contractor's failure to comply with its obligations under this Section.

b. Goods provided to Big Rivers: The Contractor shall not bill Big Rivers for Kentucky Sales Tax. A Direct Pay Authorization is maintained under Permit # 108814 as per 103 KAR 31:030

7.31.4. Billing of Additional Work: All claims for payments of additions to the Purchase Order / Contract Price shall be shown on separate Contractor's invoices and must refer to the specific change order or written authorization issued by Company as a condition to being considered for payment.

7.31.5. Effect of Payments/Offset: No payments shall be considered as evidence of the performance of or acceptance of the Work, either in whole or in part, and all payments are subject to withholding for loss, damage, costs, or expenses for which Contractor may be liable under this Agreement. Company, without waiver or limitation of any rights or remedies of Company, shall be entitled from time to time to deduct from any and all amounts owing by Company to Contractor in connection with this Agreement or any other contract with Company any and all amounts owed by Contractor to Company in connection with this Agreement.

7.31.6. Evidence of Payment to Major Subcontractors: Contractor shall, if requested by Company, furnish Company with a certificate showing names of Contractor's Major Suppliers and Subcontractors hereunder, and certifying to Company that said Major Suppliers and Subcontractors have been paid in accordance with their respective subcontracts

7.32. Term and Termination

7.32.1. This Agreement shall commence upon the issuance of Purchase Order referencing this Specification, the Bidder's Proposal, and any subsequent negotiations and shall survive in full force and effect until terminated as set forth below. A termination under this Article based on certain Work shall only apply to the Purchase Order that covers such Work. Any purchase orders that do not relate to such Work shall not be affected by such a termination.

7.32.2. Termination for Contractor's Breach:
If the Work to be done under this Agreement shall be abandoned by Contractor, if this Agreement or any portion thereof shall be assigned by operation of law or otherwise without the written permission of the Company, if any significant Work is sublet by Contractor to third parties not on the Owner's approved vendor lists after execution of the Agreement without the written permission of Company, if Contractor is placed in bankruptcy, or if a receiver be appointed for its properties, if Contractor shall make an assignment for the benefit of creditors, if at any time Contractor has abandoned any part of the Work or if Contractor is violating any of the material conditions or terms of this Agreement, or has executed this Agreement in bad faith, Company may, without prejudice to any other rights or remedies it may have as a result thereof, notify Contractor to discontinue any or all of the Work and terminate this Agreement in whole or part. Company's foregoing right to notify Contractor and terminate this Agreement is subject to Company first providing Contractor with (i) notice and (ii) 30 days' chance to commence a cure of any such defect, failure, breach or improper performance, which the Contractor shall diligently pursue to completion. In the event that Section 365(a) of the Bankruptcy Code or some successor law gives Contractor as debtor-in-possession the right to either accept or reject this Agreement, then Contractor agrees to file an appropriate motion with the Bankruptcy Court to either accept or reject this Agreement within twenty (20) days of the entry of the Order for Relief in the bankruptcy proceeding. Contractor and Company acknowledge and agree that said twenty (20) day period is reasonable under the

circumstances. Contractor and Company also agree that if Company has not received notice that Contractor has filed a motion with the Bankruptcy Court to accept or reject this Agreement within said twenty (20) day period, then Company may file a motion with the Bankruptcy Court asking that this Agreement be accepted or rejected, and Contractor shall not oppose such motion.

7.32.3. Effect of Termination for Contractor's Breach:

From the effective date of such termination, Contractor shall vacate the site, whereupon Company shall have the right but not the obligation to take possession of the Work wherever located, and Contractor shall cooperate with Company and cause Contractor's Subcontractors to cooperate with Company so that Company can effect such possession. In obtaining replacement services, Company shall not be required to request multiple bids or obtain the lowest figures for completing the Work and may make such expenditures as shall best accomplish such completion and are reasonable given the circumstances. The reasonable, direct, and verifiable expenses of completing the Work in excess of the unpaid portion of the Contract Price shall be paid by Contractor, and Company shall have the right to set off such amounts from amounts due to Contractor.

7.32.4. Termination for Company's Convenience:

Company may terminate this Agreement and Purchase Order in whole or in part for its own convenience by thirty (30) days' written notice at any time. In such event, Company shall pay Contractor all direct labor and material costs incurred on the Work that is subject to such termination prior to such notice, plus any reasonable unavoidable cancellation costs which Contractor may incur as a result of such termination, plus indirect costs or overhead on the portion of the Work completed or in progress, computed in accordance with generally accepted accounting principles less salvage value. As an alternative to salvage value reduction, Company shall have the right in its sole discretion to take possession of all or part of the Work. The agreed markup on Contractor's compensation will be on the basis of the cost of the work plus markup of 12%.

7.33. Publicity

Contractor shall not issue news releases, publicize or issue advertising pertaining to the Work or this Agreement without first obtaining the written approval of Company.

7.34. Confidential Information

The Parties have entered into a mutual confidentiality agreement.

7.35. Miscellaneous

7.35.1. No waiver by either Party of any provision herein or of a breach of any provision shall constitute a waiver of any other breach or of any other provision.

7.35.2. Headings: The headings of Articles, Sections, paragraphs, and other parts of this Agreement are for convenience only and do not define, limit, or construe the contents thereof.

7.35.3. Severability: If any provision of this Agreement shall be held invalid under law, such invalidity shall not affect any other provision or provisions hereof which are otherwise valid.

7.35.4. State Law Governing Agreement: This Agreement shall be governed by, and construed in accordance with, the laws of the Commonwealth of Kentucky, without regard to its principles of conflicts of laws.

7.35.5. Enforcement of Rights: The prevailing party in a dispute resolution proceeding shall have the right to recover from the other party all reasonably incurred expenses of outside counsel hired by the prevailing party, arising out of the other party's breach of this Agreement or any other action to enforce or defend the prevailing party's rights hereunder.

7.35.6. No Third Party Beneficiaries: Except for Contractor and Company, there are no intended third party beneficiaries of this Agreement and none may rely on this Agreement in making a claim against either Party.

8. NOTICES

All notices and communications respecting this Agreement shall be in writing, shall be identified by the contract number, and shall be addressed as follows (which address either party may change upon five (5) days prior notice to the other party).

To Company:	To Contractor:
Big Rivers Electric Corp.	_____
Attn: Director, Supply Chain	_____
P.O. Box 24	_____
Henderson, Kentucky 42419	_____

8.1. Any notice, request, or approval or other document required or permitted to be given under this Contract will be in writing unless otherwise provided herein and will be deemed to have been sufficiently given if delivered in person, transmitted by fax followed by a hard copy, dispatched in the U.S. mails, postage prepaid for mailing by certified or registered mail, return receipt requested, or dispatched for delivery by other courier service providing a return receipt.

9. LIMITATION OF LIABILITY

Contractor's liability on all claims of any kind (excluding death or bodily injury), whether based on contract, indemnity, tort, strict liability or otherwise, for all losses or damages arising out of, connected with, or resulting from this order, or from the performance or breach thereof, or from any equipment or services covered by or furnished under this order or any extension or expansion thereof, shall in no case exceed the Contract Price. Excluding each Party's obligation to indemnify the other Party for third party claims of death or bodily injury under Article 7.25, in no event, whether based on contract, indemnity, warranty, tort (including negligence), strict liability or otherwise, shall either Party, its employees, subcontractors and suppliers be liable for special, incidental, indirect, exemplary or consequential damages, loss of use of the equipment or any associated equipment, cost of capital, cost of purchased or replacement power, cost of substitute equipment, facilities or services, loss of anticipated profit or revenue, downtime costs, or claims of customers of the other Party for such damages. This Limitation of Liability shall prevail over any conflicting or inconsistent provision contained in any item or document which comprises the Agreement.

10. DELIVERY, TITLE, AND RISK OF LOSS

Title to the equipment delivered or placed into storage will pass to Company upon delivery except that Contractor shall retain a security interest in any equipment not paid for in full. The risk of loss or damage to the equipment shall pass to Company upon delivery. When the equipment is ready for delivery and delivery is delayed or postponed by Company for any cause not within control of the Contractor, then Contractor shall arrange for storage of the equipment and Company shall assume the risk of loss or damage and shall be responsible for any charges in connection with storage and reconditioning which, at that time, shall be considered the date of delivery. Other than as provided in this Article 10, the date of delivery shall be regarded as the date when Equipment has reached the defined FOB destination.

BIG RIVERS ELECTRIC CORPORATION
Green Station MATS Compliance Project – Unit No. 1 and 2
Contract No. 1340 – Mercury Control Equipment
Burns & McDonnell Project No. 73827

DOCUMENT 00005 - INDEX AND CERTIFICATION PAGE

TECHNICAL SPECIFICATIONS

CERTIFICATION(S)

STATE OF KENTUCKY
STANLEY C. LAWSON
26539
LICENSED
PROFESSIONAL ENGINEER

20-DEC-2013
DIV 1, 5, 9, 13

STATE OF KENTUCKY
BRENT D. OXANDALE
27172
LICENSED
PROFESSIONAL ENGINEER

12-20-13
Div 26 only

STATE OF KENTUCKY
MICHAEL J. ROUSH II
29249
LICENSED
PROFESSIONAL ENGINEER

12-20-2013
DIV. 48 only.

STATE OF KENTUCKY
KRISTIN L. GLIKBARG
29371
LICENSED
PROFESSIONAL ENGINEER

DIV 1, 48, 49
20 DEC-2013

STATE OF KENTUCKY
DONALD LUECK[illegible]
26466
LICENSED
PROFESSIONAL ENGINEER

DIV 40
20 DEC-2013

Big Rivers Electric Corporation
MATS Compliance Projects
MATS Equipment Contract

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DIVISION 1 - GENERAL REQUIREMENTS

SECTION 011101 - SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section summarizes the Work covered in detail in the complete Contract Documents.

1.02 CONTRACT INFORMATION:

A. Owner: Big Rivers Electric Corporation (BREC) is contracting for the Work described in the Contract Documents.
   1. Contract Identification: Contract 1340 – Mercury Control Equipment
   2. Points of Delivery:
      a. BREC – Robert D. Green Generating Station:
         9000 Highway 2096
         Robards, KY 42452

B. Engineer: The Contract Documents were prepared by Burns & McDonnell Engineering Company, Inc., 9400 Ward Parkway, Kansas City, Missouri 64114

1.03 PROJECT DESCRIPTION:

A. Description of Project:
   1. Big Rivers Electric Corporation (BREC) is installing Dry Sorbent Injection (DSI) and Activated Carbon Injection (ACI) systems for Robert D. Green Generating Station (Green) Units 1 and 2. The addition of the DSI and ACI systems are intended to reduce mercury (Hg) emission to levels compliant with the Mercury Air Toxic Standards (MATS). DSI systems will be used to reduce SO_3 levels as necessary to improve the Hg removal efficiency of activated carbon.
   2. The DSI system will utilize hydrated lime for the reagent, and the ACI system will utilize powdered activated carbon (PAC).
   3. A performance based equipment contract, Distributed Control System (DCS) contract, and construction contract will be utilized to complete the BREC MATS compliance project.

B. Description of Plant:
   1. Robert D. Green Generating Station consists of Unit 1 and Unit 2 which are 250 MW and 242 MW pulverized coal-fired balanced draft natural circulation, wall fired units provided by Babcock & Wilcox in 1976. Both units have two air preheaters and two Electro Static Precipitators (ESP)s downstream of the economizers, and two wet Flue Gas Desulferizer (FGD) scrubbers which run at all times the units are online. Green burns a blend of bituminous coal and petcoke with a range of 0% - 27% petcoke in the blend. Fuel range and analyses are provided in Appendix 011101-A.

1.04 UNIT OPERATING AND DESIGN PARAMETERS:

A. This Article includes the basic Site/Project information and certain design criteria applicable to the Project. This information is general in nature and may be additionally defined within the technical Specifications. When additionally defined or specified within the technical Specifications, the technical Specification criteria shall control. In the event that additional specific information regarding the Site is required, Contractor shall contact Engineer.

B. Building Code of Record: All Work shall be in accordance with the Kentucky Building Code – 2007 including all appendices, amendments, and reference standard.
   1. Wind Design: Per Kentucky Building Code – 2007 to include the following:
      a. 90 MPH Basic Ground Wind Speed at 33 feet above ground (3-second gust)
      b. Wind Importance Factor $I_W = 1.15$
      c. Exposure C
      d. No wind shielding shall be taken into account
      e. Design to include Topographic Kzt and Directionality Kd Factors as applicable per Code.
      f. Structures and equipment to be permanently located indoors shall be design for no less than a 5 psf 'wind' load.
   2. Snow Design: Per Kentucky Building Code – 2007 to include the following:
      a. Ground snow load = 15 psf
      b. Snow Importance Factor $I_S = 1.1$
      c. Design to include Exposure C_e and Thermal C_t Factors as applicable per Code.
      d. Design to include drifting increases when applicable due to adjacent structures.
      e. Include rain-on-snow load increase for 'roof' areas sloped less than 1/2 inch per foot.
   3. Seismic Design: Per Kentucky Building Code – 2007 to include the following:
      a. Seismic Importance Factor $I_E = 1.25$
      b. Mapped Spectral Accelerations
         (a) Short Period $S_S = 0.851$g, $S_{S,0} = 0.606$g
         (b) 1-second Period $S_1 = 0.240$g, $S_{1,0} = 0.187$g
      c. The soil properties at the Project Site are classified as Site Class D (to be verified by Geotechnical investigation).
      d. Structures and Equipment shall be considered as Occupancy Category III.
   4. Ice Loads: Per Kentucky Building Code – 2007 to include the following:
      a. Nominal Ice Thickness t = 0.75 in.
      b. Concurrent Wind Speed $V_c = 30$ mph

C. All Materials for the Project shall comply with the OSHA Regulations and Standards 29CFR1910. If conflicts between Kentucky Building – 2007 and OSHA occur, Kentucky Building Code – 2007 to control. All Work performed on Site shall comply with OSHA Regulations and Standards.

D. All Work and Materials shall be in compliance with local, county, state, federal regulations, codes, standards, laws, and ordinances.

E. Site Conditions:
   1. Elevation:
      a. Approximately ~~391~~412 ft above mean sea level (MSL).
   2. Climatology:
      a. Extreme Temperatures:
         (a) Maximum Dry Bulb: 108 °F
         (b) Minimum Dry Bulb: -23 °F
      b. Design Conditions: (ASHRAE)
         (a) Summer (1% coincident): 90.9 °Fdb/76.2 °Fwb
         (b) Winter (99%): 15 °F
         (c) Design Relative Humidity 89%
      c. Plant Site Frost Depth: Per Kentucky Building Code – 2007, a minimum depth of 24 in. or erecting on solid rock. Actual minimum depth to be determined by the Geotechnical investigation.

d. Precipitation:
   (a) Average Annual Rainfall: 45.5 inches
   (b) Design Storm (24 hour): (US Department of Commerce/US Weather Bureau - Technical Paper 40).

Duration	10-year Return Period	25-year Return Period	100-year Return Period
24 hour	4.3 inches	5.2 inches	6.1 inches

F. Noise control: All equipment shall be designed to comply with near-field noise requirements of 85 dbA measured 3 feet horizontally from the base of the equipment and 5 feet above floor level or personnel platform. The only exceptions to this requirement are the material handling blowers which may be provided with sound enclosures to meet the noise requirements.

G. The Equipment furnished under this Contract shall be designed for outdoor installation, except for Equipment located in enclosed areas, which may be designed for indoor service.

H. Asbestos material is strictly prohibited for the Equipment furnished under this Contract.

1.05 WORK COVERED BY CONTRACT DOCUMENTS:

A. Design, manufacture and deliver (DDP Point of Delivery) all Equipment and Material in accordance with the requirements of this Contract. The Equipment and Materials include, but is not limited to, the following:

1. One Activated Carbon Injection (ACI) system per unit, complete with shop fabricated activated carbon silos sized for 5-days storage, bin vent filters, pressure relief valves, level indicators, silo fluidizing air system, silo fill lines, two (2) x 100% weigh bins and screw feeders, two (2) x 100% positive displacement conveying systems per unit, transport piping, manifolds, injection lances, and other accessories to form a complete system for each unit.
2. One Dry Sorbent Injection (DSI) system per unit, complete with 14' diameter shop fabricated hydrated lime silos sized for 5-days storage, bin vent filters, pressure relief valves, level indicators, silo fluidizing air system, silo fill lines, two (2) x 100% weigh bins and screw feeders, two (2) x 100% positive displacement conveying systems, transport piping, manifolds, injection lances, and other accessories to form a complete system for each unit.
3. Option bid #1: One DSI system per unit including 20' diameter field erected silos to be field erected by others that are sized for 5-days storage, bin vent filters, silo fill lines, two (2) x 100% weigh bins and screw feeders, two (2) x 100% positive displacement conveying systems, transport piping, manifolds, injection lances, and other accessories to form a complete system for each unit.
4. Option bid #2: One DSI system per unit designed for use of hydrated lime and trona as a reagent. Option shall include any additional Equipment and Materials necessary to allow for the use of either reagent.
5. One compressed air system for Contractor's air usage requirements. System shall be complete with two (2) x 100% oil free compressors, baseplate, inlet filters, intercooler, aftercooler, two (2) x 100% capacity skid-mounted twin-tower regenerative dessicant dryers, separator automatic drain valves, one (1) air receiver tank per silo, interconnecting piping, and control systems.

6. All Materials and Equipment integral with ACI and DSI systems including, but not limited to, ductwork connections / supports, internal ductwork flow correction devices, piping, valves, injection lances, fittings, instrumentation, and pipe supports required for a complete system.
7. Owner will provide one 480V switchgear feed as a power source to each unit. This Contract shall distribute this power source as required for a fully functioning system. This Contract shall provide all electrical equipment required for distribution of power to all Equipment supplied under this Contract. Raceway and cabling outside of PCM buildings and silos will be provided by others. Electrical power will be from the existing Owner power supplies specified below:
   a. One (1) 480V breaker feed from each of the following existing 480V switchgear:
      (a) For Green Unit 1: 480V Unit Substation Bus 1A3
      (b) For Green Unit 2: 480V Unit Substation Bus 2A3
8. All instrumentation and control devices as required to monitor and control all process equipment supplied under this Contract.
9. One (1) power control module (PCM) building to support electrical equipment, control equipment, and miscellaneous piping, valves and instrumentation for both units. PCM building shall include all structural support and framing, insulated siding and roofing, access doors, HVAC, and lighting and receptacles. PCM building shall be fully fabricated to the greatest extent possible prior to shipment to Site.
10. The PCM shall have separate motor control center (MCC) line-ups for each unit. All motors will be fed from an MCC as follows:
    a. Motor operated valves shall be fed from a 480V breaker in the MCC
    b. Silo HVAC vent fans and motor operated louvers will be fed from MCC breakers. Contractor shall provide local starters.
    c. All other process load motors will be fed from MCC starters.
11. Weatherproof enclosures, if required by Contractor's design, for the ACI and DSI handling equipment. Enclosures shall include all structural support and framing, insulated siding and roofing, access doors, HVAC, and lighting and receptacles. Monorails and hoists shall be included to facilitate removal of blowers and blower motors. Enclosure shall be shop-fabricated to the greatest extent possible with equiment factory installed prior to shipment to Site. Weatherproof enclosure shall be designed as specified in SECTION 133425.
12. One (1) stair tower located between activated carbon silos and hydrated lime silos for both units with access platforms and catwalks as necessary to access each silo's roof and equipment areas.
13. Design and furnish the stair tower to provide lateral support for an elevator (by others).
14. Structural and support steel for all equipment including supporting columns and beams, hanger rods, platforms, galleries, grating, stairs and handrails. The steel design shall take into account all required cable trays, conduits, piping and miscellaneous structures necessary to support balance of plant piping, conduit, and cable tray on main pipe bridges. The pipe rack steel design shall be designed to support 200 lb/lft. of additional balance of plant piping and cable provided by Others. Contractor shall furnish all access gallery platforms and support steel required for the ACI and DSI systems. Contractor shall include adequate space and support structure for supporting all balance of plant piping, conduit, and cable tray, and shall coordinate the design of the structural steel with Owner and Engineer to facilitate the structural support of these balance of plant systems. The Owner does not intend to relocate below grade obstructions in the vicinity of the pipe rack. The Contractor shall locate all pipe rack support columns such that new foundations (provided by others) will not interfere with existing below grade obstructions

or access road. The Contractor shall submit the pipe rack support column layout to the Engineer for approval prior to design of the pipe rack. See Exhibit EX-001 for Typical Pipe Rack Bent Detail. Contractor shall provide conduit support steel from the new pipe rack to the PCM.

15. It is the Contractor's responsibility to determine and define the actual pipe route corridor from the pipe rack to the points of injections. Generalized routing suggestions are indicated in the Piping Corridor Drawings, however, confirmation of this routing and implementaion of the support system is the Contractor's responsibility. Final pipe routing and support system layout is subject to Engineer and Owner approval.
16. All steel required to modify the existing structural steel and related connections as required to support the piping, cable tray, and electrical conduits from the pipe rack to the points of injection. Modifications shall include, but not be limited to, the design and furnishing the reinforcing of the existing steel and connections as required. Contractor will take no responsibility for the condition of the existing structure.
17. Physical flow modeling and computational fluid dynamic modeling of the ACI and DSI Systems.
18. Performance Guarantee Test Procedures, mutually agreed upon with Owner. Testing will be by others.
19. All required submittals and operating and maintenance manuals as specified in SECTION 013301.
20. Special tools for erection and maintenance.
21. Building Permit:
    a. Contractor to provide submittal documents to include building Plans, Sections, Elevations, and Detail Drawings sealed by an Architect or Engineer Registered in the State of Kentucky. The Contractor's submittal documents will be issued by the Owner to the State of Kentucky for a building permit.
    b. Contractor shall make any necessary revisions to their design as required by the State of Kentucky to satisfy building permit requirements.

B. Boundaries of Work: The following is a general description of the boundaries of work applying to the design, supply and delivery of Work covered by the Contract Documents:
   1. Electrical Work:
      a. Contractor shall supply all equipment to distribute power to skids and equipment provided by this Contract.
      b. Contractor shall supply lighting and receptacles for all silos.
      c. Instrumentation: Contractor's control and instrumentation interface shall be at the field device or skid terminal box.
   2. Control System:
      a. Distributed Control System (DCS): Owner will integrate Contractor's recommended system control logic within its existing DCS. Contractor's control logic will be integrated consistent with Owner's existing logic templates and HMI screens.
   3. Continuous Emissions Monitoring System (CEMS):
      a. Stack mercury (Hg) monitors will be provided by Owner and integrated into existing control system.
   4. Civil / Structural:
      a. Contractor's structural steel interfaces shall be at the bottom of the baseplate. Foundations will be provided by others.

C. Procure and deliver (DDP Points of Delivery) spare parts, special tools, lubricants, and consumables as specified in Paragraph 1.11 of this Section.

D. Perform Manufacturer's Field Services at the Site for erection, commissioning and startup. Field services shall include witnessing performance testing.

E. Training:

1. General: Provide a complete list of each Manufacturer's standard training classes, including scheduled dates and prices, for training of engineers, maintenance personnel, and operations personnel.
   a. Include a detailed description of the objectives, knowledge, prerequisites, and content of each course.
   b. Include instruction on all supplied Equipment, software, software configuration and programming, hardware configuration, maintenance procedures, and troubleshooting procedures, as applicable.
   c. Include text books and training materials as applicable for each class participant.
   d. Contractor shall provide with the Proposal a list of recommended courses and participants. The list shall contain sufficient descriptions of each course objective so that the Owner may determine its value. The Contractor shall also provide the schedule and costs of these training programs.
   e. The cost of each course shall be stated in the proposal such that the Owner may pick or choose any or all courses and the number of participants in any combination.
   f. Training manuals and pertinent documentation shall be provided for each of the course participants at the time the course is conducted. Upon completion of each course, the Material shall be retained by the course participant.
2. Specific: Provide on-Site Project-specific classes for training Owner's personnel on the operation of all Equipment and major systems provided. Training personnel shall be certified by the supplier or manufacturer of the specific product or system as having the necessary knowledge and experience to perform the training. On-Site training room will be provided by Owner. The training shall include, as a minimum, the following:
   a. Operator Training:
      (a) Provide Project specific classes for training operator personnel in the operation and use of the system. The training session shall be of sufficient content and duration to provide basic understanding of each system in general and specific instruction on the Site-specific implementation. Include Equipment startup, shutdown, normal operation, operation at reduced loads, alarms, corrective actions, and functional descriptions of the supplied systems and Equipment.
      (b) Operator training shall include four ~~3~~2-day sessions of on-Site Project specific class room training. Each session shall be conducted during a different time period as part of an overall Project training program. Provide all materials, hardware, and software required to train 8 operators during each class. If Contractor's recommended training program is not suited for 3-day classes, Contractor to propose a recommended duration.
   b. Maintenance / Engineering Training:
      (a) Provide Project specific classes for training maintenance and engineering personnel. The training session shall be of sufficient content and duration to provide basic understanding of the systems and Equipment provided and specific instruction on the Site-specific implementation. Contractor shall provide all necessary materials required for hands-on training of Owner's staff.
      Provide four 1-day on-Site training sessions . Each session shall be conducted during a different time period as part of an overall Project

training program. 10 to 12 people will be in each training session. If Contractor's recommended training program is not suited for 1-day class, Contractor to propose a recommended duration.

(b) Mechanical:
1) Each mechanical system's overview on principle of operation, using as-built Process and Instrumentation Diagrams and Equipment operating manuals.
2) Regular maintenance intervals and procedures of mechanical Equipment.
3) Troubleshooting most common problems associated with each system.
4) Overview of Equipment overhaul procedures and disassemblies to constitute safe and cost-effective use of personnel and resources.

(c) Electrical:
1) Each electrical system's overview on principle of operation, using as-built electrical design documentation and Equipment operating manuals.
2) Regular maintenance intervals and procedures of electrical Equipment.
3) Troubleshooting most common problems associated with each system.

(d) Instrument and Controls (I&C) training shall include the following:
1) System Overview: review of general logics and operational overview.
2) Calibration of instruments.
3) Maintenance of instruments.

c. The Site-specific training will occur on the plant Site. The Owner will provide space at the Site for the training.
d. Owner may videotape all on-Site training sessions for future use.
e. The operation and maintenance manuals shall be the basis of the training.
f. Provide a training agenda, schedule, and course outline.

1.06 WORK BY OTHERS:

A. Other contracts:
1. Contract 8320 – Construction Services. This contract will receive, store, provide erection material, erect, and start-up all Equipment and Materials furnished by Contract 1340. This contract will also construct, furnish and / or install foundations, underground utilities, insulation, lagging, jacketing, raceway, cabling, and heat tracing. This contract will be responsible for installing power feeds between the plant and the PCM as well as from between the PCM and the silos and skids.
2. Contract 6110 – Distributed Control System (DCS). This contract will provide software and hardware modification to the existing DCS system to support the addition of all Equipment furnished by Contract 1340.

B. Work by Owner:
1. Owner will contract with others for loop checks and to test the Work.
2. Owner will provide operating labor for supporting initial operation and performance testing.

1.07 WORK SEQUENCE:

A. General: Sequence of Work shall be determined by Contractor subject to meeting the following delivery dates:
   1. Deliveries shall not commence prior to 4 June 2014.
   2. Deliveries shall be completed no later than the following:
      a. Structural and miscellaneous steel, handrail, grating, stairs, etc: 13 June 2014
      b. DSI Silos: 27 June 2014
      c. ACI Silos: 27 June 2014
      d. ACI / DSI Equipment: 4 July 2014
      e. PCM Building and other Enclosures: 18 Jul 2014
      f. Piping, Piping Specials, and Instrumentation: 18 Jul 2014
      g. All other Equipment and Materials not Included Above: 1 Aug 2014

B. Other Dates of Interest:
   1. Erection complete and system ready for startup: 28 Nov 2014
   2. Performance Test: 10 Jan 2015
   3. Start Reliability Demonstration (~~180~~120 days): 17 Jan 2015
   4. Anticipated Substantial Completion: 14 Feb 2015
   5. Outage dates: TBD

1.08 MEASUREMENT AND PAYMENT:

A. Lump Sum Contracts: All Work indicated and specified in the Contract Documents shall be included in the Lump Sum Contract Price.

B. Change Orders and Payment Procedures: Stated in RUS FORMS.

1.09 COPIES OF DOCUMENTS:

A. Furnished Copies: Contractor will be furnished, at no cost, two original sets of Contract Documents including full-size Contract Drawings. Contractor will also be furnished one electronic PDF file of the Contract Documents.

1.10 PROJECT RECORD DOCUMENTS:

A. General: In addition to documentation required by the Contract Documents, maintain at the Contractor's facilities (and at installation Site) one record copy of:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other Modifications to the Contract.
   5. Approved Shop Drawings, product data, and Samples.

B. Recording:
   1. Label each document "PROJECT RECORD" in neat, large, printed letters.
   2. Record information concurrently with fabrication or Field Services progress.
   3. Record Drawings: Legibly mark to record actual construction:
      a. Where Submittals are used for mark-up, record a cross-reference at corresponding location on Drawings.
      b. Field changes of dimension and detail.
      c. Changes made by Change Order or other Modifications. Note related Change Order numbers where applicable.
      d. Details not on original Contract Drawings.

4. Record Specifications and Addenda: Legibly mark each Section to record:
   a. Manufacturer, trade name, catalog number, and Supplier of each product and item of Equipment actually furnished, particularly optional and substitute items.
   b. Changes made by Addendum, Change Order, or other modifications.
   c. Related Submittals.
5. Record Product Data: Maintain one copy of each product data Submittal, and mark-up significant variations in actual Work in comparison with submitted information.
   a. Include both variations in product as delivered to Point of Delivery, and variations from manufacturer's instructions and recommendations for installation.
   b. Give particular attention to concealed products and portions of the Work which cannot otherwise be readily observed. Note related Change Orders and mark-up of record drawings and specifications.

1.11 SPARE PARTS, SPECIAL TOOLS, LUBRICANTS AND CONSUMABLES:

A. Contractor shall furnish spare parts, special tools, tools required for metric sized fasteners and hardware, lubricants, and other consumables required for complete installation and commissioning. These shall be delivered to Site with the Equipment and Materials being supplied under this Contract.

B. Contractor shall furnish a list of Manufacturer Recommended Two-Year Operational Spare Parts that Owner, at it's discretion, may elect to purchase and a separate list of installation and commissioning Spare Parts.

C. Each spare parts list shall include description of spare, quantity, manufacturer part number, lead times, unit price, and extended price. Unit price for spare parts shall be valid for two years from the Agreement date.

D. Any spare parts supplied by Owner and used during erection and startup or during the warranty period shall be replaced within the warranty period at no charge to Owner. The Contractor shall not use any of these spare parts without written permission of Owner.

E. Special tools which are required to maintain, inspect, disassemble, or operate the Equipment supplied by the Contractor shall be furnished by Contractor and will be turned over to Owner upon Substantial Completion. Examples include but are not limited to:
   1. Non-standard wrenches including off set wrenches, special slings and chokers, electrical breaker lifting and racking mechanisms, rotor stands, specialized electronic test Equipment, and the like.
   2. If a tool is a required specialty tool, and the Supplier supplying the Equipment provides the tool directly with the Equipment or offers it as an assessory to assist in the installation, inspection, operation, repair, or disassembly, then it shall be considered by the Contractor as a Contractor-supplied part.

F. Furnish tool inventory manual to document tools. Manual shall include individual photograph of each tool, description of tool, and description of tools use.

PART 2 - PRODUCTS - NOT APPLICABLE.

PART 3 - EXECUTION - NOT APPLICABLE.

END OF SECTION 011101

APPENDIX 011101-A – DESIGN CRITERIA AND PARAMETERS

1.01 SUMMARY:

A. This Section summarizes the design criteria and parameters specific to the ACI and DSI systems for Big Rivers Electric Corporation's Green Generating Station Units 1 and 2. The Contractor shall use these criteria to develop the detailed design necessary to furnish equipment and materials in accordance with the technical specifications included herein and to meet the performance guarantees.

1.02 DESIGN CRITERIA:

A. General:

1. These criteria set the minimum standards acceptable. They are not intended to limit the Contractor to a single design approach. The technical specifications set the standards of quality for equipment and materials included in the Contractor's design.
2. The anticipated life that is required for the ACI and DSI systems is 30 years. The ACI and DSI systems shall be capable of continuous operation for their anticipated lives with minimum scheduled downtime for inspections and maintenance. The systems will be operated as load following within a wide load range and with rapid load changes. The ACI and DSI systems shall be designed to maintain specified mercury levels on a 30-day rolling average.
3. The materials specified in the technical sections are the minimum requirements. Contractor shall furnish higher-grade materials where required to allow for service life consistent with the anticipated 30-year life of the plants.
4. The design of the ACI and DSI systems furnished by this Contract shall not limit operation of the existing units. The design conditions specified herein take into consideration that actual boiler operation may not match design operating points due to: variations in fuel analysis, boiler/turbine operation at higher than anticipated output, variations in excess air, variations in air heater leakage, and variations in flue gas temperature. The equipment furnished shall satisfy the required performance guarantees while operating with any range of fuel, any variation in unit load, and any variation in boiler operation specified herein for each unit.
5. The system shall be suitable for operation at all gas flows within the design range of gas flows specified herein.
6. Contractor shall ensure the design of the DSI system does not impact the existing O_2 probes located in the ductwork downstream of the economizer.

B. Design of the ACI and DSI systems shall be based on the following parameters. Systems shall be capable of meeting Hg emission requirements over the entire design range given below for each unit. Performance guarantees shall be based on the performance conditions given below for each unit:

Design Site Operating Conditions:

Parameter	Green Unit 1	Green Unit 2
Gross Output at Performance, MW	250	242
Gross Output at Low Load, MW	160	160
Gross Plant Heat Rate, Btu/kWh	10,640	10,990
Heat Input at Performance, mmBtu/hr	2,660	2,660
Heat Input at Low Load, mmBtu/hr	1,702	1,758
Boiler Excess Air at Performance, %	18	18
Boiler Excess Air at Low Load, %	17	17
Economizer Outlet Flue Gas Temperature, °F	740	740
Economizer Outlet Flue Gas Static Pressure, in. wg	-2.00	-2.00
Air Preheater Leakage, %	18 - 25	18 - 25
Air Preheater Outlet Flue Gas Temperature, °F	300	300
Air Preheater Outlet Flue Gas Static Pressure, in. H_2O	-9.00	-9.00
Precipitator Outlet Flue Gas Temperature, °F	300	300
Precipitator Outlet Flue Gas Static Pressure, in. H_2O	-12.00	-12.00
ID Fan Outlet Flue Gas Temperature, °F	300	300
ID Fan Outlet Flue Gas Static Pressure, in. H_2O	6	6
Site Elevation (ft)	~~391~~412	~~391~~412
Average Ambient Temperature, °F	56	56
Ambient Humidity, lb H2O/lb dry air	0.013	0.013

Design Range of Flue Gas Conditions:

Area	Parameter	Green Unit 1	Green Unit 2
Economizer Outlet	Temperature (°F)	650 - 760	650 - 760
	Static Pressure (in.H_2O)	(-1) - (-3)	(-1) - (-3)
	Specific Volume of Flue Gas (ft^3/lb)	30.2081	30.2081
	Flue Gas Flow Rate (lb/hr)	1,458,238 - 2,956,761	1,506,206 - 2,956,294
	Flue Gas Flow Rate (acfm)	734,177 - 1,488,636	758,327 - 1,488,400
Air Heater Outlet	Temperature (°F)	300 - 350	300 - 350
	Static Pressure (in.H_2O)	(-8) – (-10)	(-8) – (-10)
	Specific Volume of Flue Gas (ft^3/lb)	19.5940	19.5940
	Flue Gas Flow Rate (lb/hr)	1,710,992 - 3,672,642	1,767,274 - 3,672,062
	Flue Gas Flow Rate (acfm)	558,753 - 1,199,362	577,133 - 1,199,173
Precipitator Outlet	Temperature (°F)	300 - 350	300 - 350
	Static Pressure (in.H_2O)	(-10) - (-14)	(-10) - (-14)
	Specific Volume of Flue Gas (ft^3/lb)	19.7451	19.7451
	Flue Gas Flow Rate (lb/hr)	1,710,998 - 3,672,649	1,767,280 - 3,672,070
	Flue Gas Flow Rate (acfm)	563,064 - 1,208,614	581,585 - 1,208,423
ID Fan Outlet	Temperature (°F)	300 - 350	300 - 350
	Static Pressure (in.H_2O)	4 - 8	4 - 8
	Specific Volume of Flue Gas (ft^3/lb)	18.8720	18.8720
	Flue Gas Flow Rate (lb/hr)	1,710,998 - 3,672,649	1,767,280 - 3,672,070
	Flue Gas Flow Rate (acfm)	538,166 - 1,155,171	555,869 - 1,154,988

Performance Flue Gas Conditions:

Area	Parameter	Green Unit 1	Green Unit 2
Economizer Outlet	Temperature (°F)	740	740
	Static Pressure (in.H_2O)	-2.00	-2.00
	Specific Volume of Flue Gas (ft^3/lb)	30.2081	30.2081
	Flue Gas Flow Rate (lb/hr)	2,588,251	2,587,842
	Flue Gas Flow Rate (acfm)	1,303,102	1,302,897
Air Heater Outlet	Temperature (°F)	300	300
	Static Pressure (in.H_2O)	-9.00	-9.00
	Specific Volume of Flue Gas (ft^3/lb)	19.5940	19.5940
	Flue Gas Flow Rate (lb/hr)	3,214,462	3,213,955
	Flue Gas Flow Rate (acfm)	1,049,736	1,049,571
Precipitator Outlet	Temperature (°F)	300	300
	Static Pressure (in.H_2O)	-12.00	-12.00
	Specific Volume of Flue Gas (ft^3/lb)	19.7451	19.7451
	Flue Gas Flow Rate (lb/hr)	3,214,469	3,213,962
	Flue Gas Flow Rate (acfm)	1,057,834	1,057,667
ID Fan Outlet	Temperature (°F)	300	300
	Static Pressure (in.H_2O)	6	6
	Specific Volume of Flue Gas (ft^3/lb)	18.8720	18.8720
	Flue Gas Flow Rate (lb/hr)	3,214,469	3,213,962
	Flue Gas Flow Rate (acfm)	1,011,058	1,010,898

Baseline Emissions:

Parameter	Green Unit 1	Green Unit 2
Baseline Design Uncontrolled Mercury, Economizer Outlet (lbs/TBtu)	4.43 – 12.23	4.43 – 12.23
Baseline Performance Uncontrolled Mercury, Economizer Outlet (lbs/TBtu)	9.80	9.80
Baseline Design Uncontrolled SO_3, Economizer Outlet (ppmv, dry)	10 - 40	10 - 40
Design Uncontrolled SO_3 with Extra Catalyst Layer, Economizer Outlet (ppmv, dry)	N/A	N/A
Design Uncontrolled SO_3 with New SCR, Economizer Outlet (ppmv, dry)	10 - 90	10 - 90
Baseline Performance Uncontrolled SO_3, Air Heater Inlet (ppmv, dry)	32	32
Baseline Uncontrolled PM, Economizer Outlet (lbs/mmBtu)	10.86	10.86
Baseline Controlled PM, Stack (lbs/mmBtu)	0.0046	0.0040

Note: Design range shall allow for future installation of new SCRs. Each SCR will have three catalyst layers with an SO_2 to SO_3 oxidation rate of 0.5% ~~pre~~ per layer.

C. Contractor shall incorporate the recommendations and conclusions from the flow model in the final design of the system at no extra cost to the Owner.

1.03 DESIGN PARAMETERS:

A. Design Fuel (Coal):

1. Design Range of Coal Constituents:

Ultimate Analysis		
	Coal	**Petcoke**
Moisture, total %	8.29 - 16.86	6.20 - 8.70
Ash %	7.57 - 14.94	0.27 - 0.44
Volatile Matter %	35.05 - 37.26	10.70 - 11.03
Fixed Carbon %	40.19 - 42.81	80.27 - 82.50
Sulfur %	3.39 - 4.30	5.02 - 5.76
Gross Calorific Value, BTU/lb	10,500 - 11,267	14,400
Carbon %	58.79 - 64.48	80.54 - 82.56
Hydrogen %	4.10 - 4.42	3.12 - 3.14
Nitrogen %	1.07 - 1.31	1.48 - 1.49
Oxygen %	6.27 - 8.25	0.06 - 0.81
Chlorine, Cl %	0.04 - 0.13	0.03 - 0.07
Analysis of Ash		
Silicon Dioxide %	40.34 - 47.96	
Aluminum Oxide %	19.44 - 20.52	
Titanium Dioxide %	0.84 - 1.01	
Iron Oxide %	18.53 - 26.87	
Calcium Oxide %	2.65 - 4.94	
Magnesium Oxide %	0.92 - 1.28	
Potassium Oxide %	1.97 - 2.99	
Sodium Oxide %	0.54 - 1.98	
Sulfur Trioxide %	2.35 - 3.74	
Phosphorus Pentoxide %	0.15 - 0.41	
Strontium Oxide %	0.03 - 0.05	
Barium Oxide %	0.05 - 0.19	
Manganese Oxide %	0.05 - 0.07	
Trace Elements in Fuel- Dry Basis (ppm)		
Arsenic, As	4 - 25	1
Beryllium, Be	1.2 - 2.4	0.2
Cadmium, Cd	0.2 - 1.5	0.2
Chromium, Cr	16 - 35	1 - 2
Copper, Cu	8 - 20	1
Lead, Pb	4 - 10	2
Manganese, Mn	27 - 48	1 - 2
Mercury, Hg	0.06 - 0.14	0.02
Nickel, Ni	13 - 23	210 - 260
Vanadium, V	32 - 125	710 - 760
Zinc, Zn	23 - 56	2 - 3

Note: For as fired fuel, design shall include as high as 27% petcoke blend.

2. Performance Fuel:

Ultimate Analysis	
	Green Station
Moisture, total %	11.0
Ash %	14.5
Volatile Matter %	34
Fixed Carbon %	40.5
Sulfur %	3.7
Gross Calorific Value, BTU/lb	10,900
Carbon %	60.52
Hydrogen %	3.90
Nitrogen %	1.06
Oxygen %	5.20
Chlorine, Cl %	0.12
Analysis of Ash	
Silicon Dioxide %	40.34
Aluminum Oxide %	19.55
Titanium Dioxide %	0.84
Iron Oxide %	26.87
Calcium Oxide %	4.94
Magnesium Oxide %	0.92
Potassium Oxide %	2.10
Sodium Oxide %	0.54
Sulfur Trioxide %	3.60
Phosphorus Pentoxide %	0.15
Strontium Oxide %	0.03
Barium Oxide %	0.05
Manganese Oxide %	0.07
Trace Elements in Fuel- Dry Basis (ppm)	
Arsenic, As	25
Beryllium, Be	1.7
Cadmium, Cd	0.4
Chromium, Cr	16
Copper, Cu	16
Lead, Pb	8
Manganese, Mn	36
Mercury, Hg	0.12
Nickel, Ni	18
Vanadium, V	75
Zinc, Zn	31

B. Reagent:
   1. Reagent provided for use in the DSI systems shall be Hydrated Lime.
      a. Size: 83% - 87% passing 325 US Standard Seive
      b. Typical Total $Ca(OH)_2$ Available: 92.5% (Range: 90-99%)
      c. Typical Total MgO: 1.1% (Range 0.4-1.9%)
      d. Typical Free Moisture: 0.75% (Range: 0.3-1.2%)
      e. Bulk Density: 25 – 33 lb/cubic feet.
      f. Density for silo sizing: 25 lb/cubic feet.
      g. Density for structural design: 60 lb/cubic feet.
      h. Angle of repose: 25°
   2. Option Bid: Reagant provided for use in the DSI systems shall allow for both Hydrated Lime as specified above and Trona as specified below.
      a. Size: 35 micron maximum.
      b. Trona Purity: 95% minimum sodium sesquicarbonate.
      c. Free Moisture: 0.06% maximum.
      d. Bulk Density: 60 – 78 lb/cubic feet.
      e. Density for silo sizing: 50 lb/cubic feet.
      f. Density for structural design: 90 lb/cubic feet.
   3. Reagent provided for use in the ACI systems shall be Powdered Activated Carbon (PAC).
      a. PAC information shall be per carbon supplier.
      b. ~~Contractor shall specify the specific carbon supplier and product line for which~~ Contract Performance Guarantees are based on the use of any commercial halogenated carbon supplier, meeting the below minimum specifications:~~.~~
         (1) Activated Carbon produced from coal or lignite, maximum of 8% volatile matter, dry basis, ignition temperature >= 350 C.
         (2) Maximum of 8% moisture.
         (3) Greater than 95% passing 325 mesh.
         (4) Virgin material, not regenerated.
         (5) Brominated ~~and~~/or demonstrated sulfur tolerant.
         (6) Supplier to be an established producer with demonstrated experience base in mercury control by ACI on coal fired boilers.
         (7) Suppliers ADA, Norit, Calgon, Albemarle or equal.

C. Compressed Air: Contractor shall furnish a new compressed air system to meet all compressed and instrument air requirements within the scope of this project.

D. Structural Design Loads:
   1. Structural steel:
      a. Structural steel shall be designed in accordance with the specifications of the American Institute of Steel Construction and using the Steel Construction Manual, Thirteenth Edition.
      b. Materials:
         (1) W-shapes and tees cut from W-shapes: ASTM A992 Grade 50 or ASTM A572 Grade 50.
         (2) Angles: ASTM A36.
         (3) Channels: ASTM A36.
         (4) Steel plate and bars: ASTM A36.
         (5) Square and rectangular tubes: ASTM A500, Grade B.
         (6) High-strength bolts: ASTM A325 or ASTM A490.

c. Structural Steel Connections: Slip critical type connections for "Oversize and Short-Slotted holes" using 3/4-inch diameter bolts or larger or bearing type connections as determined by the Contractor.

2. Equipment Loading: Structures that support rotating, reciprocating or vibrating machinery shall be designed for static loading plus 50% minimum for impact. Maximum oscillation of supporting members for specific operating conditions shall be in accordance with manufacturer's recommendations, but not to exceed 3/32-inch.
3. Dead Loads: Include weight of all structural and architectural elements, service equipment, piping and all other permanent stationary construction that becomes a part of the structure, including conduit, wiring, piping, and other equipment which will be a part of the completed system.
   a. Dead Load shall include 10 psf for insulation and lagging for gravity conditions and 5 psf for uplift conditions where required
4. Live Loads: As specified in this SECTION and as required to support the equipment specified or furnished by Contractor. Minimum live loads shall be as follows:
   a. Grating platforms and walkways: 100 psf plus maintenance loads.
   b. Stairs: 125 psf
   c. Wind Loads: per SECTION 011101 – Summary of Work
   d. Seismic Loads: per SECTION 011101 – Summary of Work
   e. Snow Loads: per SECTION 011101 – Summary of Work
5. Electrical corridor shall be designed for loads of 800 pounds per linear foot. Location of electrical corridor shall be mutually agreed upon after award.
   Load Combinations: Load combinations shall conform to the applicable building codes. Combinations which produce the most unfavorable effect in the structural member being considered shall be included in the design. Effects of one or more loads not acting shall be investigated. The most unfavorable effects from both wind and earthquake loads shall be investigated, where appropriate, but they need not be assumed to act simultaneously.
6. The Contractor shall furnish load data for each column or interface point to foundations for each load condition. The load data shall be broken down into components due to each individual load applied to the structure; i.e. dead load, live load, seismic, wind, snow, thermal expansion, internal pressure, ash, etc., at each column baseplate or connection point. In addition, supply both the maximum and minimum vertical values and the horizontal forces for each loading condition, which must be considered simultaneously. Direction or sensibility of each load shall be graphically defined. The load data shall be presented in such a manner as to clearly show which loads occur simultaneously at the various columns or support locations. Loads submitted shall be service loads only, without a safety factor or overstress factor applied. These drawings shall in addition include size of column base plates, anchor bolt requirements such as quantity, spacing, diameter, projection length, sleeve requirements, shear key dimensions, and any other data required for foundation design.
7. All structural design drawings custom prepared and essentially only for this Project shall be sealed/stamped by a licensed professional engineer in the State of Kentucky. Said sealing/stamping is the responsibility of Contractor. Drawings of products, Materials, and Equipment that are of standard structural designs by the manufacturer, fabricator, subcontractor, or Contractor need not contain the seal/stamp of a licensed professional engineer.

1.04 PERSONNEL AND MAINTENANCE ACCESS REQUIREMENTS:

A. Personnel Access Requirements:

1. General:
   a. Head room shall be a minimum of 7'-0" clear including adequate allowance for installation of piping, conduit, and lighting fixtures.
   b. Operating platforms and access walkways shall be not be less than 4'-0" in width.
   c. Stairs shall not be less than 4'-0" in width.
   d. Avoid dead ends in platforms. Furnish emergency escape ladders from any platform for which dead ends cannot be avoided in compliance with Kentucky Building Code – 2007.
   e. Access platforms shall be furnished at elevations where equipment needing regular maintenance is located.
   f. For all enclosures, in addition to clearances required for maintenance and removal, there shall be a minimum clearance of 5 feet between equipment and structural wall member and between any two separate pieces of equipment.
   g. Arrange structural steel columns such that when the steel girts, and metal panel walls are applied to the outside face of the columns all platforms, stairs, walkways, and unit auxiliaries, drives, piping, and other items are totally enclosed with sufficient walkway space between wall and all parts of the units where access is required. No projections or cutouts will be permitted in the metal panel walls except as required for cable trays, pipes, conduits, and doors. Furnish framing for access to all enclosure roofs.
   h. Piping over walkways will have a minimum clearance of 7 feet and 10 feet over maintenance aisles. Piping, piping racks, or pipe bridge over roadways and unit access will have clearance of at least 23 feet.
2. Class 1: Regularly attended areas shall have access operating platforms which are fully accessible by stairs. No ladder or ships ladders for access will be permitted. Areas include: silo rooftops, silo dischargers, weigh bins, screw feeders, blowers, all lubrication points, bearings, instruments, control drives, control valves, valve operators, level indicators, main platform levels, walkways, and stairs.
3. Class 2: Maintenance access areas such as access to dust collector bags, access doors, hopper access doors, instrument connections and other areas requiring access only monthly or annually shall have access platforms of adequate size to permit two people to work, 12 square foot minimum, with stair access and walkways for reaching the platforms in accordance with the following. Where stair access is not practical, caged ladder access can be furnished.
   a. Maintenance access walkways shall be not less than 4'-0" in width.
   b. Stairs and caged ladders shall be as specified herein.
   c. Head room shall be a minimum of 7'-0" clear. Inlcude adequate allowance for installation of piping, conduit, and lighting fixtures.
4. Class 3: Maintenance access areas where access is required for painting, reinsulation, and replacement of components with a service life of 10 years or more, shall be met by providing facilities to enable Owner to erect patent scaffolding, temporary ladders, platforms, and safety nets to safely perform the work involved.

B. Maintenance access requirements:
   1. Furnish service platforms for all Equipment furnished by this Contract, regardless of whether Equipment is located on steel or concrete foundations furnished by this Contract or by others.
   2. Rotating Machinery and Mechanical Equipment:

a. Pieces over 200 pounds shall be furnished with cranes or monorails and trolleys with hoists to permit the equipment to be removed and lowered to grade in a single lift.
b. Furnish eyebolts or lifting lugs on equipment for use with monorails and cranes. Indicate weights and center of gravity locations for equipment.

1.05 HVAC:

A. Design Standards:
1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) "Guide" latest edition.

B. Equipment and Construction Standards:
1. Air Moving and Conditioning Association, Inc.
2. Sheet Metal and Air Conditioning Contractors National Association, Inc.
a. "HVAC Duct Construction Standards."
b. "Rectangular Industrial Duct Construction."
c. "Round Industrial Duct Construction."

C. Indoor Design Conditions and System Types:
1. Control Room and Electrical Equipment Areas:
a. Temperature: 70 °F Minimum, 77 °F Maximum
b. Relative Humidity: 40% Minimum, 60% Maximum
c. Maintain positive pressure in the space with respect to the outdoor environment.
d. System Type: 100 percent redundant HVAC (Heating, ventilation and air conditioning) system. Electric heating only.
2. Silo Skirted Areas
a. Indoor maximum temperature is the greater of the following resultant temperatures: ambient temperature plus 10 °F or the equipment temperature limit.
b. Indoor minimum temperature is 50 °F.
c. System Type: Heating and Ventilation.
3. Mechanical Equipment Enclosures
a. Indoor maximum temperature is the greater of the following resultant temperatures: ambient temperature plus 10 °F or the equipment temperature limit.
b. System Type: Ventilation only.

PART 2 - PRODUCTS - NOT APPLICABLE.

PART 3 - EXECUTION:

3.01 PERFORMANCE GUARANTEES:

A. Performance guarantees are listed in Section 492000.

B. The guaranteed Hg emission rate for each ACI system at a maximum, shall be 1.0 lb/TBtu while operating in all ranges specified and burning any fuel within range specified. Range of inlet Hg loading for efficiency guarantee shall be as defined in 1.02.B of this Section. This guarantee is subject to the "Make Good" provisions of Section 7.5 of the MATS Framework (Project BR13156) provided that Contractor shall not be required to change or adjust the storage volumes for both the DSI and ACI systems provided.

C. ~~The guaranteed PM emission rate for each unit at a maximum, shall be 0.030 lb/mmBtu while operating in ranges specified and burning any fuel within range specified in 1.03.A of this Section.~~ The Contractor shall guarantee that the ESP inlet root mean squared (RMS) velocity distribution shall be no greater than the baseline ESP inlet RMS velocity distribution based on

CFD model analysis. Baseline distribution will be determined using the project CFD model analysis with model runs of the existing geometry prior to the installation of new mixing and flow distribution devices. The velocity distribution will be measured on the downstream side of the existing inlet perforated plate.

D. Contractor shall guarantee bin vent emissions at a maximum of 0.005 grains/dry standard cubic foot for each silo as part of this Contract.
E. Contractor shall guarantee activated carbon consumption in units of lb/mmacf at the performance inlet Hg loading as well as the design range specified in 1.02.B of this Section.
F. Contractor shall guarantee hydrated lime consumption in units of lb/mmacf at the performance inlet SO_3 loading as well as the design range specified in 1.02.B of this Section.
G. Contractor shall guarantee trona consumption in units of lb/mmacf at the performance inlet SO_3 loading as well as the design range specified in 1.02.B of this Section.
H. The Contractor shall guarantee the total power consumption for Equipment furnished by this contract which is normally operating, on a unit by unit basis. Power consumption for the compressed air system shall be provided separately. Power consumption will be measured during the final performance tests. The measurements will be made under normal operation and no special cleaning, adjustments or other preparations will be allowed.
I. Contractor shall guarantee the total connected load for all motors and equipment furnished.
J. The Contractor shall warranty the minimum bin vent filter bag life.
K. Contractor shall guarantee that the sound pressure levels specified in SECTION 011101 for individual equipment (complete assembly including driven equipment, drives and drive motors) will not be exceeded.
L. Unit operating conditions will vary due to variations in fuel content, gas temperature, etc. Contractor shall submit correction curves showing effect of gas volume flow, SO_3 content, mercury content, and gas temperature on system Hg removal performance. The correction curves will be used to establish the expected range of hydrated lime, trona and PAC injection rates at reasonable combinations of operating conditions within the design range. In order to provide for this intended use, the Contractor's correction curves shall provide a clear system for determining the combined effect of variations in these individual operating conditions on the value of the hydrated lime, trona and PAC injection rates. The correction curves shall be drawn on graph paper with sufficient grid lines to clearly determine the effect of changes in the operating variables on the hydrated lime, trona and PAC injection rates. At no time shall any combination of these variables cause the systems to fail to meet required Hg emission rates.

3.02 SYSTEM PERFORMANCE AND ACCEPTANCE TESTS:

A. Performance and acceptance tests will be performed by the Owner as specified below and at such time as mutually agreed upon by Owner and Contractor, all equipment and systems furnished under the Contract appear to be operating in a reliable and satisfactory manner.
B. Performance tests will be conducted for determination of meeting system guaranteed performance as specified in this SECTION.
C. Performance tests will be run as near as practical to the performance conditions specified in this SECTION. The results will be compared to the guaranteed values listed in SECTION 019001, with appropriate adjustments applied based on Contractor's correction curves.
D. Contractor shall furnish performance test procedures and correction curves for Owner's approval and use with bid. For test procedures not specified, the Owner and Contractor shall mutually agree on the test procedures prior to the tests.
E. Contractor shall witness ACI and DSI system and equipment tests and attend pretest meetings at its own expense.

F. The Contractor shall conduct preliminary tests, at its own expense, to assure Owner equipment and systems will perform as specified and that final performance tests should be conducted.

G. Final tests for System performance will be conducted in accordance with the test procedures described in the Code of Federal Regulations, Title 40 – Protection of Environment, Chapter I – Environmental Protection Agency, Subchapter G-Air Programs, Part 60 – Standards of Performance for New Stationary Sources, Appendix A, Methods 1 through 5, Method 8A, and Method 30B.

H. Lime consumption shall be measured using hydrated lime loss-in-weight feeders and carbon consumption shall be measured using PAC loss-in-weight feeders. The feeders shall be calibrated prior to testing to the mutual satisfaction of Owner and Contractor.

I. Emissions of total and filterable particulate ~~and H_2SO_4~~ will be tested ~~using test ports in the precipitator systems outlet ductwork~~at the stack. ~~Inlet H_2SO_4 will also be tested using test ports in the air preheater system inlet ductwork.~~

J. Controlled SO_3 shall be tested at the air preheater outlet. Uncontrolled SO_3 shall be tested using test ports in the air preheater system inlet ductwork.

K. Uncontrolled mercury emissions shall be determined either by coal sampling at the weigh feeder to the mill or by testing at the air preheater system inlet using the Ontario Hydro method (ASTM D6784-02) Inlet testing shall include speciation testing.

L. Controlled mercury emissions shall be determined by testing ~~downstream of the precipitator outlet~~ at the stack using EPA Method 30B.

M. Performance guarantees for mercury, PM, and SO_3 emissions shall be based on an average of three (3) test runs.

N. Reagant Consumption shall be measured simultaneously with emissions guarantee tests. Consumption guarantees shall be based on an average of the three (3) test runs.

O. Total power consumption for equipment within the Contractor's Scope of Work will be determined through the use of recording watt-hour meters. The watt-hour meters used will be connected at the power supply inputs to the Contractor's equipment. Watt-hour meters will be accurate to within 0.3 percent. Watt-hour meters will be supplied by Owner. Power consumption tests will be conducted over a period of at least 24 hours to measure average power consumption for the Contractor's equipment when the boiler unit and DSI/ACI system are operating normally at full load. Total power consumption requirement for the equipment in the Contractor's scope of supply does not include nonprocess loads such as lighting, HVAC, welding/ power receptacles, etc.

3.03 RELIABILITY DEMONSTRATION:

A. Contractor shall guarantee that the ACI/DSI systems shall have a reliability of at least 99.0 percent over a ~~180~~120-day period. Only Equipment and Material furnished by the Contractor will be considered in the accounting of unavailability.

B. The ~~180~~120 days period shall commence following the successful completion of Performance testing. The spare equipment can be used during the test period as a replacement for failed equipment. Owner will perform normal maintenance on the auxiliaries located outside the ACI/DSI systems in a manner that will not adversely affect system performance.

C. Owner will operate the ACI and DSI systems within the design ranges specified above and in accordance with Contractor's operating and maintenance instructions. The required reagent, water, electrical power, and other such provisions required during the reliability demonstration period will be provided by the Owner.

D. During this period, the ACI/DSI systems shall meet the guaranteed Hg emissions rate on a 30-day weighted rolling average as determined by Owner's outlet CEM system or by long term EPA Method 30B testing at the stack.

E. During the reliability demonstration period, all costs for operation and normal maintenance will be borne by the Owner. All material costs for non-routine repair work and equipment removal, modification, and replacement shall be by Contractor.

F. During the demonstration period, the number of hours of forced ACI and DSI system outages or ACI and DSI system capacity reductions attributable to the ACI/DSI system equipment furnished by the Contractor shall be identified as hours of unavailability. Periods during which the ACI/DSI system is incapable of maintaining its guaranteed Hg emission limit due to malfunction of systems or Equipment and Material furnished by the Contractor shall also be counted as hours of unavailability.

G. At the conclusion of the demonstration period the ACI/DSI system reliability shall be calculated as follows:

% Reliability = (1- (total unavailability hours / ~~4,320~~2,880)) x 100

H. Adverse impacts to Reliability caused by Owner or third party shall not be counted against this guarantee to the extent of such impact.

END OF APPENDIX 011101-A

APPENDIX 011101-B

1.01 APPROVED SUPPLIERS LIST:

The following is a list of equipment suppliers that is acceptable to Owner. Additional suppliers can be proposed by Contractor for Owner review and approval. Contractor and Owner will collaborate through the procurement and supplier selection process.

A. Shop Fabricated Storage Silos, Bin Dischargers, Weigh Hoppers, and Associated Equipment:
   1. Pittsburgh Tank Co.
   2. Arrow Tanks
   3. Modern Welding
   4. Palmer
   5. Imperial Industries
   6. Tank Connections
   7. Titan Contracting
   8. Phoenix Fabricators
   9. US Tanks
   10. CST
   11. Weigh Hopper and Surge Hopper – IAC Captive Vendor
   12. Accessories:
      1. Screw Feeders: SCC Corp., Continental Screw Conveyor, Thomas Conveyor, KWS Manufacturing, Acrison, Metal Fab, IAC
      2. Load Cells: Rice Lakes

B. Silo Discharger:
   1. Carman
   2. Carrier/Vibranetics
   3. Kinergy
   4. Vibra-screw
   5. Metal Fab

C. Compressed Air System:
   1. Air Compressors:
      1. Atlas-Copco
      2. Ingersoll-Rand
      3. Gardner Denver

   2. Aftercooler:
      1. Engineer Approved

   3. Air Dryers:
      1. Ingersoll-Rand
      2. Pneumatic Products
      3. Atlas Copco.
      4. Sullair
      5. Gardner Denver

4. Speed Increasing Gears:
   1. Philadelphia Gear
   2. Falk

5. Compressor Main Drive Couplings:
   1. Sier-Bath

6. Intake Filter Silencer:
   1. Burgess Industries
   2. Dollinger
   3. Universal

7. Blowoff Valve:
   1. Fisher "Whisper Trim"

8. Blowoff Silencer:
   1. Burgess-Manning

9. Expansion Joints:
   1. Flexonics
   2. Pathway

10. Moisture or Drain Traps:
    1. Armstrong Model 71

D. Positive Displacement Conveying Air Blowers:
   1. M.D.
   2. Roots
   3. Sutorbilt
   4. Smoot
   5. Tuthill

E. Dehumidification Systems:
   1. Governair Corporation.
   2. Kathabar Inc.
   3. Munters; Cargocair Division

F. Rotary Airlock Feeders
   1. Delta
   2. FLSmidth
   3. Smoot
   4. Myers

G. Cutoff Gates:
   1. FLSmidth
   2. Stock
   3. PEBCO
   4. Delta
   5. Dezurick

H. Diverter Valves:
   1. Delta
   2. FLSmidth

I. Couplings:
   1. Dresser
   2. Morse
   3. Gruvlok
   4. Morris

J. Pulse Jet Bag-Type Dust Collectors:
   1. American Air Filter Co.
   2. Flex-Kleen
   3. Johnson-March
   4. United States Filter Corp./Mikro Pul.
   5. IAC

K. Power Control Modules (PCM)
   1. Powell Industries, Inc.
   2. Pederson Power Products
   3. Lectrus
   4. M & M Coastal
   5. Protect Controls, Inc. (PCI)

L. Cables
   1. Okonite
   2. Rockbestos
   3. Pirelli
   4. Kerite
   5. Southwire
   6. Rome Tamaqua

M. Cable Ties
   1. AMP Special Industries AMP-TY
   2. Dennison Manufacturing Company BAR-LOK
   3. Panduit Corporation PAN-TY
   4. Thomas & Betts TY-RAP
   5. Minnesota Mining and Manufacturing 3M Brand

N. PVC Coated Conduit
   1. Plasti-Bond
   2. Thomas and Betts

O. Intercommunication and Public Address System:
   1. Gai-Tronics Corporation.

P. Alternating Current Electric Motors – Low Voltage
   1. General Electric Co.
   2. Siemens Energy and Automation, Inc.
   3. U.S. Electrical Motors
   4. Marathon
   5. Baldor
   6. Teco Westinghouse

Q. Variable Frequency Drives (480 and 120 VAC)
   1. Allen-Bradley Power Flex

R. Low-Voltage Motor Starters and Contactors:
   1. General Electric E150, F225, or J600 Line
   2. Cutler-Hammer FB, KB, or LB
   3. Siemens

S. Low-Voltage Air Circuit Breakers:
   1. General Electric Company
   2. Siemens

T. Low-Voltage Disconnect Switches:
   1. 480V
      1. Siemens HF 362S with Class H, J, K, R fuses type VBII
   2. Below 480V
      1. General Electric Company - Type QMR
      2. Cutler-Hammer – Type DH
      3. Allen-Bradley
      4. Square D

U. Local Control Stations:
   1. Allen-Bradley
   2. Square D

V. Panelboards and Switchboards:
   1. Siemens
   2. General Electric Company.

W. Transformers:
   1. Siemens
   2. General Electric Company.

X. Receptacle Outlets – Outdoor:
   1. Appleton FSK-1VDR
   2. Hubbell HBL 5362I
   3. Bryant BRY 5362I

Y. Terminal Blocks:
   1. General Electric Type CR2960SY139
   2. Phoenix Contact Type UK 5-HESILA 250 (fuse disconnect)
   3. States Slide Link

Z. Light Sensitive Control Devices (Photocells):
   1. Fisher-Pierce, Div. of Sigma Instruments, Inc. (Fisher-Pierce).
   2. Precision Multiple Controls, Inc.
   3. Tork, Inc.

AA. Light Switches:
   1. Bryant Electric Inc., Div. of Hubbell Corp. (Bryant).
   2. Leviton Manufacturing Co. Inc. (Leviton).
   3. Harvey Hubbell Inc. (Harvey Hubbell).
   4. Pass & Seymour Inc.
   5. Cooper Wiring Devices, Div. of Cooper Ind. (Cooper).

BB. Light Fixures:
   1. As specified for PCM
   2. Thomas & Betts Pendant Mount – Cat. # DHP17C040-TGL-P2E
   3. Thomas & Betts Stanchion Mount – Cat # DHP17C040-TGL-S4E

CC. 480-Volt Motor Control Centers:
   1. Siemens

DD. Flow Measurement:
   1. Differential Pressure Transmitter
      1. Honeywell Smart Transmitters – ST 3000 Series

   2. Flow Thermal Dispersion:
      1. Sierra 780S

EE. Level Measurement (Dry Product):
   1. Point Level
      1. Bindicators (Turning Fork) with remote electronics

   2. Silo Continous Level:
      1. VegaPuls 68 / Precision Pulse Digital TD765

FF. Process Switches:
   1. Limit Switches:
      1. Namco Snap-Lock EA-Series

   2. Zero Speed Switches:
      1. Pyott-Boone Electronics Slip/Sequence Control 110/220VAC Model 405A Sensor 500-0538-001

GG. Temperature Measurement
1. Thermocouples:
1. Type E - Thermo/Probes Inc.

2. Gauges:
1. Swagelock PGI Series

HH. Pressure Measurement
1. Transmitters
1. Honeywell Smart Transmitters – ST 3000 Series

2. Gauges:
1. Swagelok PGI series

II. Tubing, tube fittings and supports shall be Swagelok no equal.

JJ. Instrument Blowback Valves
1. Swagelok

KK. Instrument Shutoff Valves:
1. Air Isolation:
1. Apollo, Series 70-100
2. Nibco, Series 580 and 585

2. Process Fluid Isolation:
1. Swagelok

LL. Instrument Manifold Valves:
1. Swagelok

MM. Instrument Blowdown Valves:
1. Swagelok

NN. Instrument Stands:
1. O'Brien, Saddlepak
2. Swagelok

OO. Heat traced tube bundles:
1. O'Brien Corp., compatible with Vipak, A Series
2. Thermon, compatible with ThermoCase

PP. Heated Instrument Enclosures:
1. O'Brien Corp., Vipak, A Series
2. Thermon, ThermoCase

QQ. Instrument Air Accessories:
1. Balston
2. Deltech
3. Swagelok

RR. Pneumatic Positioners:
1. Fisher – FIELDVUE
2. ABB TZID

SS. Workstation Consol
1. PanelMatic

TT. HVAC Units:
1. For PCM Building
    1. Marc Climate
    2. Specific Systems
2. Trane
3. York
4. Carrier

UU. Steel Fabricators:
1. AFCO
2. Dave Steel
3. Merrill
4. Cives
5. Steel Fabricators of Monroe
6. Allstate Tower
7. Structural Steel Services, Inc.

VV. Pipe Hangers and Supports:
1. Anvil International, Inc.
2. Bergen Pipe Supports
3. Lisega, Inc.
4. Piping Technology and Products, Inc.
5. Rilco (General Service Pipe Supports only)

WW. Valves
1. Carbon Steel and Alloy Steel Gate, Globe, Angle, and Check Valves shall be manufactured by the following:
    1. 2-1/2 inches and larger:
        (1) Class 150 to Class 400: Anchor/Darling, Atwood-Morrill, Crane, Dewrance, Newco, Nibco, Pacific, Powell, Edward-Vogt, Stockham, Velan, or Walworth.
        (2) Class 600 to Class 2500: Anchor/Darling, Atwood-Morrill, Crane, Dewrance, Newco, Pacific, Powell, Edward-Vogt, R-P&C, Velan, or Walworth.
    2. 2 Inches and Smaller:
        (1) Class 600: Hancock, Newco, Edward-Vogt, R-P&C, Smith, Velan, or Waeco.
        (2) Class 1500 to Class 2500: Anchor/Darling, Conval, Hancock, Edward-Vogt, R-P&C, Velan, Waeco, or Yarway.

2. Class 150 Stainless Steel Gate, Globe, Angle, and Swing Check Valves shall be manufactured by the following:
   1. 2-1/2 inches and larger: Anchor/Darling, Crane, Jenkins, Newco, Pacific, Powell, Stockham, Velan, or Walworth.
   2. 2 inches and smaller: Crane, Jenkins, Newco, Pacific, Powell, Stockham, Velan, or Walworth.

3. Class 125 and Class 250: Cast Iron Gate, Globe, Angle, and Swing Check Valves shall be manufactured by the following:
   1. 2-1/2 inches and larger: Crane, Jenkins, Newco, Nibco, Powell, or Walworth.

4. Class 150 and Class 200 Bronze Gate, Globe, Angle, and Lift Check Valves shall be manufactured by the following:
   1. 2 inches and smaller: Crane, Jenkins, Newco, Nibco, Powell, Stockham, or Walworth.

5. Class 150 to Class 600 Carbon Steel Lubricated Plug Valves shall be manufactured by the following:
   1. 2-1/2 inches and larger: Nordstrom, Walworth, or Worcester.
   2. 2 inches and smaller: Nordstrom, Walworth, or Worcester.

6. Class 150 to Class 600 Carbon Steel Nonlubricated Plug Valves shall be manufactured by the following:
   1. 2-1/2 inches and larger: Aloycoseal, Durco, Stockham, or Tufline.
   2. 2 inches and smaller: Aloycoseal, Durco, Stockham, or Tufline.

7. Class 150 Eccentric Plug Valve shall be manufactured by the following:
   1. 3 inches and larger (soft rubber-lined cast iron): Clow, Dezurik, or Dresser.
   2. 2-1/2 inches and smaller (Alloy 20): Dezurik.

8. 2-Inch and Smaller Ball Valves shall be manufactured by the following:
   1. Class 150 and Class 300 carbon steel, metal seat: Jamesbury, Nibco, Velan, WKM (Cooper-Cameron), or Worcester.
   2. Class 150 and Class 300 carbon steel, soft seat: Hills-McCanna, ITT, Jamesbury, KTM (OMNI), Newco, Nibco, Powell, Smith, Stockham, Velan, WKM (Cooper-Cameron), or Worcester.
   3. Class 150 brass or bronze: Hills-McCanna, Jamesbury, KTM (OMNI), Newco, Nibco, Powell, Smith, Stockham, WKM (Cooper-Cameron), or Worcester.
   4. Class 150 stainless steel: Jamesbury, ITT, Nibco, Powell, Stockham, Velan, or Worcester.

9. Class 150 Cast Iron Butterfly Valves shall be manufactured by the following:
   1. 2-1/2 inches and larger: Centerline, Crane, Dezurik, Dresser, Jamesbury, Keystone, Henry Pratt, Norris, Powell, Stockham, Weco, Nibco, Clow, or Ultraflow.

10. Class 150 Rubber-Lined Cast Iron Butterfly Valves shall be manufactured by the following:
    1. 2 inches and larger: Keystone or Nibco.

11. Class 150 and Class 300 Carbon Steel High Performance Butterfly Valves shall be manufactured by the following:
    1. 2 inches and larger: Posi-Seal, Dezurik, Flowseal, Jamesbury, Contromatics (Litton), Crane, Durco, Centerline, Fisher, Dynalok (ITT), Norris, WKM (Cooper-Cameron), Pliaxseal, or Clow.

12. Class 150 Fiberglass Reinforced Vinyvester Lined Carbon Steel Knife Gate Valves shall be manufactured by the following:
    1. 2 inches and larger: Clarkson or ITT.

13. Class 150 Soft Rubber-Lined Cast Iron Weir Type Diaphragm Valves shall be manufactured by the following:
    1. 2 inches and larger: ITT or Saunders.

14. Class 150 Rubber Sleeve Cast Iron Pinch Valves shall be manufactured by the following:
    1. 2 inches and larger: Dezurik, Fisher, Red Valve, or FlowCon.

15. 2-1/2-Inch and Larger Carbon Steel Three-Way Valves shall be manufactured by the following:
    1. Class 150 and Class 300: Atwood-Morrill, Gimpel, or Schutte & Koerting.
    2. Class 600 to Class 2500: Anchor/Darling, Atwood-Morrill, Gimpel, or Schutte & Koerting.

16. 2-1/2-Inch and Larger Carbon Steel Stop Check Valves shall be manufactured by the following:
    1. Class 150 to Class 300: Atwood & Morrill, Crane, Pacific, Powell, Velan, or Walworth.
    2. Class 600 to Class 2500: Anchor/Darling, Atwood & Morrill, Crane, Powell, Edward-Vogt, or Walworth.

17. 2-1/2-Inch and Larger Steel Power-Assisted Check Valves shall be manufactured by the following:
    1. Class 150 to Class 600: Anchor/Darling, Atwood & Morrill, Gimpel, or Schutte & Koerting.
    2. Class 900: Atwood & Morrill or Gimpel.

XX. Control Valves:
    1. Copes-Vulcan, Inc.
    2. Emerson Process Management – Fisher Controls
    3. Valtek International

YY. Electric Control Drives – Open/Close:
    1. Limitorque

ZZ. Electric Control Drives – Modulating:
    1. Beck
    2. Limitorque

AAA. Y-Type Strainers:
1. Zurn
2. Armstrong
3. Leslie
4. McAlear
5. Yarway
6. Mueller
7. Tate Andale

BBB. Air Coalescing Filters:
1. Hankison Aerolescer filters

CCC. Expansion Joings (Rubber):
1. Holz Rubber Co. (Spanflex)
2. Mercer Rubber Co. (Styles 700 and 1000)
3. Belmont Packing and Rubber Co. (Style 5100 Belfex)
4. Garlock Inc. (Garflex Style 8100)
5. Unaflex (Styles 140, 150, and 200)

DDD. Expansion Joints (Metal) Stainless Bellows:
1. Marquette Coppersmithing Co., Inc. - Marflex - Omega.
2. Adsco-Corruflex.
3. Flexonics.
4. Pathway.
5. Atlantic.
6. Sola-Flex.
7. Ametek.

EEE. Flexible Metal Hoses:
1. Flexonics By UOP.
2. Anaconda Metal Hose Co.
3. Atlantic Metal Hose Co.
4. Marquette Coppersmithing Co.
5. Metraflex.

FFF. Flexible Rubber Hoses:
1. Goodyear (Diversipipe)
2. B.F. Goodrich (Convertapipe)
3. Gates (Adaptapipe)

GGG. Truck Hoses:
1. Hose:
    1. Gates Rubber Company, Type 24SB Wagon Master.
    2. Goodyear Industrial Hose.

2. Hose Couplers:
    1. Dover Corporation, OPW Division (Coupler: 633-C and Plug: 634-A).
    2. Ever-Tite Coupling Co.

HHH. Flange Restricting Orifices:
1. Taylor Forge Division-Gulf Western
2. Grinnell

III. Orifice Flanges:
1. Taylor Forge Division-Gulf Western
2. Grinnell

JJJ. Water Hose Bibs:
1. Coupling:
    1. Chicago Pneumatic Universal Hose Coupling.
    2. Febco Hose Bib Vacuum Breaker (Model 730).

2. Valve:
    1. Crane (Model 117 Hose Angle Globe Valve).

KKK. Air Cocks
1. Coupling:
    1. Chicago Pneumatic Universal Hose Coupling
    2. Chicago Pneumatic Quick Change Hose Coupling (Model C 91857Y)
2. Cock Valve:
    1. Crane (Model 930 TF)
    2. Jamesbury (Model CDA844)

LLL. Safety and Relief Valves (Pressure):
1. Consolidated
2. Farris
3. Crosby

MMM. Safety and Relief Valves (Vacuum):
1. Shand and Jurs
2. Varec

NNN. Pressure-Regulating Valves:
1. Fisher Governor Company

OOO. Portable Heated Eyewash Stations:
1. Haws (Model 7461: eyewash).
2. Bradley (Model S19-921HR: portable heated eyewash)
3. Haws (Model 7500EB: portable heated eyewash)

PPP. Grating:
1. Tru-Weld Grating, Inc.
2. Amico-Klemp Corporation
3. IKG-Borden
4. Approved Equal

QQQ. Metal Doors, Frames and Associated Equipment:
1. Overly Manufacturing Company
2. Pioneer Fireproof Door Company
3. Trussbilt

RRR. Overhead Coiling Doors and Associated Equipment:
1. The Cookson Company
2. Cornell Iron Works Inc.
3. Mahon Door Corp.
4. Overhead Door Corporation
5. Pacific Rolling Door Co.
6. Raynor Garage Doors
7. Southwestern Steel Rolling Door Co.
8. Wayne-Dalton Corp.
9. Windsor Door; A United Dominion Company

SSS. Finish Hardware:
1. Locks and Latches:
    1. Best Lock Corporation

2. Door Closers:
    1. LCN Closers Div., Schlage Lock

3. Butts and Hinges:
    1. Hager Hinge Co.
4. Door Stops:
    1. Glynn-Johnson
    2. Ives; H.B. Ives
    3. Sargent Mfg. Div.; Essex Industries
    4. Corbin Hardware, Black & Decker
    5. Russwin Hardware, Black & Decker

5. Kick Plates, Armour Plates, Door Pulls, Push Plates, and Bars:
    1. Hiawather, J.L. Industries
    2. Cipco Corp.
    3. Quality Hardware Mfg. Co.

6. Automatic Flush Bolts and Coordinators:
    1. Glynn-Johnson

7. Thresholds and Weatherstripping:
    1. National Guard

8. Exit Devices:
    1. Von Duprin

9. Astragal:
    1. Flat Steel, UL-listed for labeled doors.
    2. Spring type, aluminum for nonlabeled doors

TTT. Coatings:
1. Ameron Protective Coatings Systems Group, Ameron Corp.
2. Carboline Company, Inc.
3. Ceilcote USA, Inc.
4. Devoe Coating Company, Division of ICI.
5. ITW Devcon Futura Coatings, Inc.
6. International Protective Coatings
7. Keeler & Long, Inc., Division of PPG Industries, Inc.
8. Pittsburgh Paints, PPG Industries Inc.
9. Rust-oleum
10. Sherwin-Williams
11. Tnemec Company, Inc.

UUU. Cranes and Hoists:
1. Abell-Howe
2. Anchor Crane & Hoist
3. Coffing
4. Kone-Landel
5. Lift-Tech
6. Orely Meyer
7. P&H
8. Robbins & Meyers
9. Shepard Niles
10. ACCO Wright
11. Yale

VVV. Motors, Cranes and Hoists:
1. General Electric

WWW. Gearbox / Gear Reducers:
1. Cleveland Gear Co.
2. Falk Corp.
3. Foote-Jones
4. Horburgh & Scott
5. Lufkin
6. Philadelphia Gear

XXX. Control Valves:
1. Copes Vulcan
2. Fisher Control
3. Masonelian
4. Valtek International

YYY. CFD Modeling Subcontractors:
1. REI (Reaction Engineering International)
2. FlowTack
3. Adapco
4. Air Flow Sciences
5. Nels
6. Babcock Power Environmental

ZZZ. Physical Flow Modeling Subcontractors:
1. Nels
2. Alden Labs
3. Air Flow Sciences
4. Balke-Duerr

END OF APPENDIX 011101-B

SECTION 012304 - ALTERNATES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section specifies administrative and procedural requirements for Alternates.

B. Definition: An Alternate is an amount proposed by Contractors and stated on the Proposal Form for certain Work activities defined in the Bidding Requirements that may be added to or deducted from Base Bid amount if Owner decides to accept a corresponding change in either the Materials, Equipment, systems, the amount of Work to be completed on the Project, or Field Services described in the Contract Documents.

C. Coordination: Coordinate related Work and modify or adjust related components of the Work as necessary to ensure that Work affected by each accepted Alternate is complete and can be fully integrated into the Project. Costs listed for each Alternate shall include costs of related coordination, modification, or adjustment.

D. Notification: Immediately following the award of the Contract, prepare and distribute to each party involved, notification of the status of each Alternate. Indicate whether Alternates have been accepted, rejected, or deferred for consideration at a later date. Include a complete description of negotiated modifications to Alternates.

E. Schedule: A "Schedule of Alternates" is included at the end of this Section. Specification Sections and/or Drawings referenced in the Schedule contain requirements for Equipment, Materials, and methods necessary to achieve the Work described under each Alternate.

1. Each Alternate is defined by abbreviated language, recognizing that Drawings and Specifications document the requirements.
2. Include as part of each Alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not mentioned as part of the Alternate.

PART 2 - PRODUCTS – Not Applicable.

PART 3 - EXECUTION

3.01 SCHEDULE OF ALTERNATES:

A. Alternate No. 1: All Hydrated lime silos shall be furnished as shipped loose panels of welded-steel design for field erection by others. Silos shall be 20' in diameter. Contractor shall supply all steel panels and other accessories as required for installation.

B. Alternate No. 2: All dry sorbent injection trains shall be designed to handle both Trona and Hydrated Lime.

END OF SECTION 012304

SECTION 013210 - PROJECT MEETINGS, SCHEDULES, AND REPORTS

PART 1 - GENERAL

1.01 SUMMARY:

A. Project Meetings:
   1. Preliminary Conference.
   2. Engineering Coordination Meetings.

B. Schedules and Reports:
   1. Initial Coordination Submittals.
   2. Work Progress Schedule.
   3. Work Progress Reports.
   4. Delivery Schedule.

C. Related Work Specified Elsewhere:
   1. SECTION 013301 - SUBMITTALS.
   2. SECTION 016001 – EQUIPMENT AND MATERIALS.

1.02 PROJECT MEETINGS:

A. Preliminary Conference:
   1. Engineer will conduct a meeting within 10 days after the Effective Date of Procurement Agreement, to review items stated in the agenda and to establish a working understanding between the parties as to their relationships during performance of the Work. The conference shall be attended by:
      a. Contractor.
      b. Representatives of principal Subcontractors and Suppliers.
      c. Engineer.
      d. Owner's representative(s).
   2. Meeting Agenda:
      a. Projected fabrication/construction schedules.
      b. Project coordination.
      c. Procedures and processing of:
         (1) Substitutions.
         (2) Submittals.
         (3) Change Orders.
         (4) Applications for Payment.
      d. Procedures for testing.
   3. Location of Meeting: Project Site or teleconference.
   4. Reporting: Engineer will prepare and distribute minutes of the meeting to each party represented.

B. Engineering Coordination Meetings:
   1. Engineer will schedule and conduct a meeting at least monthly for coordination during Contractor's equipment engineering and design phase of the Work. Meetings shall be attended by:
      a. Contractor representative(s) including engineering personnel.
      b. Representatives of principal Subcontractors and Suppliers.
      c. Engineer representative(s) including lead engineers.
      d. Owner's representative(s).
   2. Meeting Agenda:

a. Review of action items.
b. Facility design interfaces.
c. Equipment and Material procurement status.
d. Engineering/fabrication/manufacturing schedules.
e. Requests for information (RFIs).

3. Location of Meetings: Teleconference
4. Reporting: Engineer will prepare and distribute minutes of the meetings to each party represented.

1.03 SCHEDULES AND REPORTS:

A. Initial Coordination Submittals: Within the time period(s) defined in Appendix 013301-A, Contractor shall submit to Engineer for review and acceptance:
1. A preliminary Work progress schedule.
2. A preliminary schedule of Submittals, as stated in SECTION 013301.
3. Certification of insurance.

B. Work Progress Schedule:
1. After submittal of preliminary Work progress schedule, submit to Engineer a detailed Work progress schedule within the time period(s) defined in Appendix 013301-A. Base the schedule on the preliminary Work progress schedule and incorporate review comments and other feedback.
2. The schedule shall show the Work in a graphic format suitable for displaying scheduled and actual progress.
a. Prepare schedules as a horizontal bar chart with separate bar for each major portion of the Work or operation.
b. The schedule shall also show the Work broken down into major phases and key items with the dates Work is expected to begin and be completed. Sequence of listings shall be in the chronological order of the start of each item of Work.
c. Scale and spacing shall allow space for notations and revisions.
d. Sheet size: Minimum 11 x 17 inches.
3. Provide sub-schedules to define critical portions of entire schedules.
4. Coordinate Work progress schedule with Work progress reports and delivery schedule.
5. Engineer will review and comment on Work progress schedule and, upon agreement between Engineer and Contractor on necessary changes:
a. Contractor shall print and distribute copies of the accepted schedule to Owner, Engineer, Suppliers, and other parties required to comply with scheduled dates.
6. Contractor shall not change the accepted Work progress schedule without prior concurrence of Engineer.
7. Submit to Engineer an updated schedule at least once monthly. Schedule shall show actual progress and any proposed changes in the schedule of remaining Work.

C. Work Progress Reports:
1. Submit monthly a report on actual Work progress. More frequent reports may be required should the Work fall behind the accepted schedule.
2. Work progress reports shall consist of marked copies of prints made from the accepted Work progress schedule, and a narrative report which shall include but not be limited to the following:
a. A description of current and anticipated delaying factors, if any.
b. Impact of possible delaying factors.
c. Proposed corrective actions.

3. A Work progress report shall accompany each application for partial payment. Work reported complete but not readily apparent to Engineer must be substantiated with supporting data.
4. Should operations fall behind accepted schedule to an extent that completion of Work within the Contract Time appears doubtful, Contractor shall, at no change in Contract Price, take corrective action to get back on schedule.

D. Delivery Schedule:
1. Within 30 days after the Effective Date of Procurement Agreement, Owner and Contractor shall agree on a delivery schedule for all Equipment and Materials to be furnished for which the delivery time is not named in the Bid or specified.
2. Actual delivery dates shall be subject to the ability of Owner or installing contractor to receive and care for the delivered items.
3. Contractor shall notify Engineer at least two weeks in advance of any delivery date, and shall not make any shipments without written approval of Engineer.
4. No delivery will be approved until proper Submittals pertaining to storage and installation have been received and accepted.
5. Any items delivered without written approval may be returned to the point of origin, or unloaded and stored at a place and in a manner determined by Owner, and Contractor will be charged with any additional expense resulting therefrom.
6. If written order by Owner delays any shipment for more than 30 days after the time set forth in the Contract Documents or the agreed delivery schedule, Owner will pay Contractor for storage at a rate to be mutually agreed upon at that time. Time of storage will be figured from 30 days after the later of the dates defined above to receipt of Contractor's certified statement of the actual shipping date.

PART 2 - PRODUCTS - Not Applicable.

PART 3 - EXECUTION - Not Applicable.

END OF SECTION 013210

SECTION 013301 - SUBMITTALS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes definitions, descriptions, transmittal, and review of Submittals.

B. Related Work Specified Elsewhere:

1. SECTION 013210 – PROJECT MEETINGS, SCHEDULES, AND REPORTS.
2. SECTION 017801 – CONTRACT CLOSEOUT.

1.02 GENERAL INFORMATION:

A. Definitions:

1. Shop Drawings, product data, and Samples are technical Submittals prepared by Contractor, Subcontractor, manufacturer, or Supplier and submitted by Contractor to Engineer as a basis for approval of the use of Equipment and Materials proposed for incorporation in the Work or needed to describe installation, operation, maintenance, or technical properties, as specified in each Division of the Specifications.
   a. 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.
   b. Product data includes standard printed information on materials, products, and systems; not custom-prepared for this Project, other than the designation of selections from available choices.
   c. Samples include both fabricated and unfabricated 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. Mockups are a special form of Samples which are too large to be handled in the specified manner for transmittal of Sample Submittals.
   d. Descriptions of some submittal requirements are defined in APPENDIX 013301-B.
2. Informational Submittals are those technical reports, administrative Submittals, certificates and guarantees not defined as Shop Drawings, product data, or Samples.
   a. Technical reports include laboratory reports, tests, technical procedures, technical records, and Contractor's design analysis.
   b. Administrative Submittals are those nontechnical Submittals required by the Contract Documents or deemed necessary for administrative records. These Submittals include maintenance agreements, Bonds, Project photographs, physical work records, statements of applicability, copies of industry standards, Project record data, schedules, security/protection/safety data, and similar type Submittals.
   c. 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.
3. Refer to ARTICLES 1.03 and 1.04 of this Part for detailed lists of Submittals and specific requirements.

B. Quality Requirements:

1. Submittals such as drawings and data submitted to Engineer shall be of suitable quality for legibility and reproduction purposes. Every line, character, and letter shall be clearly legible. Drawings such as reproducibles shall be useable for further reproduction to yield legible hard copy.

2. Documents submitted to Engineer that do not conform to specified requirements shall be subject to rejection by Engineer, and upon request, Contractor shall resubmit conforming documents. If conforming Submittals cannot be obtained, such documents shall be retraced, redrawn, or photographically restored as may be necessary to meet such requirements. Contractor's or its Subcontractor's failure to initially satisfy the legibility quality requirements will not relieve Contractor or its Subcontractors from meeting the required schedule for Submittals.

C. Language and Dimensions:
   1. All words and dimensional units shall be in the English language.
   2. Metric dimensional unit equivalents may be stated in addition to English units. However, English units of measurement shall prevail.
   3. All words shall be in the English language.

D. Submittal Completeness:
   1. Submittals shall be complete with respect to dimensions, design criteria, materials of construction, and other information specified to enable Engineer to review the information effectively.
   2. Where standard drawings are furnished which cover a number of variations of the general class of Equipment, each drawing shall be annotated to indicate exactly which parts of the drawing apply to the Equipment being furnished. Use hatch marks to indicate variations which do not apply to the Submittal. The use of "highlighting markers" will not be an acceptable means of annotating Submittals. Such annotation shall also include proper identification of the Submittal permanently attached to the drawing.
   3. Reproduction or copies of Contract Drawings or portions thereof will not be accepted as complete fabrication or erection drawings, but will be acceptable when used by Contractor as a drawing upon which to indicate information on erection or to identify detail drawing references. Whenever the Contract Drawings are revised to show that additional Contractor's information, Engineer's title block shall be replaced with Contractor's title block, and Engineer's professional seal shall be removed from the drawing. Contractor shall revise these erection drawings for subsequent Engineer revisions to the Contract Drawings.

E. Form of Submittals:
   1. Submittals and other Project documents shall be transmitted in electronic format as specified.
      a. Selected Submittals may be provided in paper ("hardcopy") copies with advance approval of Engineer, and using procedures specified herein.
      b. Equipment instruction books and operating manuals shall be provided in paper copies in addition to specified electronic format.
   2. Electronic Format using Engineer's Document Management System:
      a. Scanned Submittals and documents are not acceptable. Transmit Submittal and Project documents in:
         (1) Adobe *PDF files created directly from native electronic format, or
         (2) Engineer-approved equal.
         (3) Electronic Submittals in .tif format are permitted only with specific Engineer approval.
      b. Each drawing shall be submitted with an electronic filename that is equivalent to the drawing number, and any resubmitted drawing shall use the same filename as the original file name each time.

c. Contractor Submittals shall be accompanied with a completed transmittal letter. Submittals that are not accompanied with an approved transmittal letter will not be accepted and will be returned to Contractor.
d. All Contractor transmittal letters submitted to Engineer shall be in the form supplied and shall contain as a minimum the following information:
(1) Contractor's Name.
(2) Engineer's Project number.
(3) Engineer's Contract number.
(4) Filename.
(5) Description of the information contained in the specific Submittal.
(6) Revision number.
(7) Submittal type.
(8) Date of Submittal.
e. Nonconforming Submittals are subject to rejection by Engineer.
f. For any given Submittal, the file name and format shall be consistent for initial submission and subsequent revisions of the same. Use consistent naming convention throughout.
g. Provide "as-constructed" Submittals, record documents, Equipment instruction books and operating manuals, and other documents on CD-ROM in AutoCAD version 8.0 format as required and approved by Owner.

3. Engineer's review comments will be provided electronically in Adobe *PDF format.
4. Digital delivery media for transmittal of electronic documents and Submittals shall be through Engineer's Document Management (DM) Project website in accordance with the procedures specified herein, as addressed below. More information will be provided in the preliminary conference for this Contract. See Appendix 013301-D for more information.
a. DM guidelines and procedures:
(1) Contractor shall complete the DM transmittal letter spreadsheet (provided by Engineer after award), package Submittals in one ZIP file, and upload transmittal to the DM website.
(2) Contractor shall collect and download reviewed Submittals after notification from Engineer that the reviewed Submittals have been posted to the DM website.
(3) A confirmation email is automatically distributed to Contractor after a successful upload to the DM website. If a confirmation email is not received by Contractor, a potential error has occurred; and Contractor shall contact Engineer.

1.03 TECHNICAL SUBMITTALS:

A. Items shall include but not be limited to, the following:
1. Manufacturer's specifications.
2. Catalogs, or parts thereof, of manufactured Equipment.
3. Shop fabrication and erection drawings.
4. General outline drawings of Equipment showing overall dimensions, location of major components, weights, and location of required building openings and floor plates.
5. Detailed Equipment installation drawings, showing foundation details, anchor bolt sizes and locations, base plate sizes, location of Owner's connections, and all clearances required for erection, operation, and disassembly for maintenance.

6. Schematic diagrams for electrical items, showing external connections, terminal block numbers, internal wiring diagrams, and one-line diagrams.
7. HVAC analysis and design notes that shall include HVAC calculations and design criteria.
8. Bills of material and spare parts list.
9. Instruction books and operating manuals.
10. Material lists or schedules.
11. Performance tests on Equipment by manufacturers.
12. Samples and color charts.
13. All drawings, catalogs, or parts thereof, manufacturer's specifications and data, samples, instructions, and other information specified or necessary:
    a. For Engineer to determine that Equipment and Materials conform with the design concept and comply with intent of the Contract Documents.
    b. For proper erection, installation, operation, and maintenance of Equipment and Materials which Engineer will review for general content but not for basic details.
    c. For Engineer to determine what supports, anchorages, structural details, connections, and services are required for Equipment and Materials, and effects on contiguous or related structures, Equipment, and Materials.

B. Structural Submittal Requirements:
1. This submittal applies to structural Submittal requirements where supporting foundation or structure will be provided by others. Contractor shall provide and submit all information necessary to facilitate structural design, support, and attachment of Equipment and Materials provided by this Contract. Submit information in an orderly and timely manner to meet the overall Project Schedule. Structural Submittal requirements shall include and/or take into account the following:
    a. The applicable building code for design. Where applicable, Contractor shall design to any State or Local Building Codes.
    b. Identify and provide individual component reaction loads applied to supporting structure to include: dead, live, operating, empty, hydrostatic, wind, seismic, snow, and snow drifting, thermal, friction, impact, pressure, thrust, vacuum, vibration, start-up, unbalanced, flooded, belt pull, or others.
        (1) Provide relative to each support location the magnitude of each component reaction load, and clearly indicate the direction of the reaction load based on the applied load.
        (2) For all reaction loads that are reversible due to a reversible applied load, such as wind, clearly indicate magnitude and direction of reaction load based on each possible applied reversible applied load magnitude and direction.
    c. Identify and provide recommended loading combinations based on Contractor's expertise and experience with the Equipment and Materials being furnished.
        (1) Identify and tabulate all expected and reasonable concurrent loading combinations.
        (2) Combine individual component reaction loads that are reasonably expected to act concurrently during start-up, upset conditions, normal operations, and/or during wind/seismic events and to produce the most adverse effect in the Equipment or on the support structure/foundation being considered. Also, investigate the effect of one or more loads not occuring.
        (3) Prepare load data in a manner (drawing, table, and/or spreadsheet) that clearly indicates resulting combined loads occuring simultaneously at each

support point for each loading combination. Direction or sensibility of each load shall be graphically indicated and defined.

d. Provide applicable service and strength loads for individual components.
   (1) Indicate service and strength loading combinations without additional safety or overstress factors, unless otherwise specifically recommended.
   (2) Provide data indicating individual component loads and combined loadings to form a logical, understandable overall loading format.
   (3) Submitted loading combinations shall be the same used by Contractor in design of the structure and/or Equpment.
   (4) Unless otherwise recommended by Contractor, the loading combinations, strength factors, and coefficients shall be based on the Project building code (or other Engineer-approved code). Use care not to intermingle service and strength loads.
   (5) Provide the numeric magnitude of the combined loading and the algebraic equation pertaining to each loading combination.

e. Anchor Bolt Sizing for Major Equipment and Materials:
   (1) Determine based on ASTM F1554 anchor bolts using Grade 36 material and nuts conforming to ASTM A563.
      (a) Allowable service load bolt stresses: 20 ksi in tension and 10 ksi in shear.
      (b) For substantial shear loads, use shear bars shop-welded to Equipment and Materials to transfer shear loads to concrete foundations. Only minor shear loads shall be transferred to concrete foundations via anchor bolts.
   (2) Anchor bolts diameter by Contractor for concrete foundations will be cast in place bolts furnished and installed by others.

f. Anchor for Minor Equipment and Materials:
   (1) May be provided by post-installed drill-in or epoxy type anchors for concrete or ASTM A307 bolted assemblies for steel supports.
   (2) Size, select, and identify on drawings the anchor manufacturer and anchor type. Provide required embedment depth and select appropriate material requirements for installation on concrete foundations, all in compliance with Project building code.
   (3) Anchors specified by Contractor will be furnished and installed by others for either concrete foundation or steel support structure mounting.
   (4) Welded mounting steel support may be used when approved by Engineer. All welding interface information shall be as indicated on Submittal drawings. All welding work shall be in compliance with AWS standards.

g. For concrete supporting structures, base the design of Equipment bearing plates and base plates on concrete attaining a minimum 4000 psi 28-day strength. All concrete-supported major Equipment and Materials shall facilitate a nominal thickness of 1-1/2 inches of leveling grout furnished and placed by others.

h. For all Equipment and Materials, provide detailed mounting and support information to include the following:
   (1) General:
      (a) Location of Equipment and Materials with respect to designated column rows, plant coordinate system, and plant north arrow.
      (b) Elevations of Equipment and Materials with respect to the plant elevation.

(c) Clearance requirements applicable to concrete or steel supporting structures.

(d) Elevation to the top of mounting surface applicable to top of concrete or steel interface elevation.

(e) Submit excerpts from instruction and operation manuals with loading data for use by others in design of supports, taking into account manufacturer's requirements and recommendations applicable to support details required for proper installation.

(2) For concrete mounted: Anchor bolt locations with respect to Equipment centerlines, anchor bolt diameter, projection, thread length, need for more than one nut, grout thickness, grout type and strength, anchor bolt sleeves if recommended, anchor bolt tolerances, locations and arrangement of shear keys, location and details of any other embedments, required installed anchor bolt torques in ft-pounds (foundation engineer will not compute anchor bolt torques), and similar data.

(3) For steel mounted: Connection bolt locations, diameter, grip, overall length, need for more than one nut, need for slotted holes (if slotted holes are required, they shall preferably be in Equipment), material requirements, required bolt torques, and related items.

i. For vibrating or rotating machinery, provide information and manufacturer's recommendations required for both static and dynamic analysis of the supporting structure for the Equipment system (motors, fluid couplings,and related items), to include the following:

(1) Dynamic loads, including unbalance forces, and short circuit load where applicable.

(2) Clear representation (drawing or narrative) to identify which loads occur simultaneously for all conditions of operation to include: not running, normal operation, upset operating conditions, wind or seismic conditions, and the like.

(3) Allowable amplitudes.

(4) Shaft elevation.

(5) Support locations and all required mounting details as specified herein.

(6) Range of machine speeds and operating speed.

(7) Center of gravity.

(8) Isolation data.

(9) Mass moment of inertia of the total machine about the center of gravity.

(10) Weight of machine rotor components, other major components, and center of gravity for each.

(11) Motor torques for normal operating, start-up, and locked rotor conditions.

(12) Locations of rotor bearings.

(13) Any pier or concrete longitudinal dimensions.

(14) Clearances and space required for maintenance and inspections.

(15) Lifting plan for maintenance to include hoist recommendations, recommended hoisting equipment, and removal access space.

(16) Recommended support criteria and manufacturer's foundation recommendations.

(17) Required foundation bolt torques in foot-pounds. Engineer will not compute bolt torques.

j. Furnish other drawings, details, data, and explanations providing additional information as requested by Engineer.

k. Composite Drawings:

(1) Furnish one comprehensive composite drawing for each piece of Equipment which requires a foundation, pad, or support to be provided by others.

(2) Provide one comprehensive composite drawing indicating requirements of the assembled components for major Equipment systems that consist of several individual components (ie, motor, coupling, pump, related items).

C. Schedule of Submittals:

1. Prepare for Engineer's concurrence a schedule for submission of all Submittals specified or necessary for Engineer's approval of the use of Equipment and Materials proposed for incorporation in the Work or needed for proper installation, operation, or maintenance. Submit the schedule with the Work progress schedule. Schedule submission of all Submittals to permit review, fabrication, and delivery in time so as to not cause delay in the Work of Contractor or its Subcontractors or any other contractors as described herein.

2. In establishing schedule for Submittals, allow ~~20~~10 days in Engineer's office for reviewing original Submittals and ~~15~~10 days in Engineer's office for reviewing resubmittals.

3. Submittals requiring revisions shall be resubmitted within 15 days after receipt of Engineer's review notations.

4. The schedule shall indicate anticipated dates of original submission for each item and Engineer's approval thereof, and shall be based upon at least one resubmission of each item.

5. Schedule all Submittals (Shop Drawings, product data, and Samples), not listed in Appendix 013301-A, that are required prior to fabrication or manufacture for submission as necessary to meet Contract delivery requirements as specified in RUS FORMS. Contractor shall allow Engineer time to review these submittals as detailed in Paragraph 1.03C.2. of this SECTION 013301.

6. Resubmit Submittals the number of times required for Engineer's "Submittal Approved." However, any need for resubmittals in excess of the number set forth in the accepted schedule, or any other delay in obtaining approval of Submittals, will not be grounds for extension of the Contract Time provided Engineer completes his reviews within the times specified.

7. Where a Submittal is required by the Specifications or the accepted Submittal Schedule, Contractor shall not commence production of any part of the Equipment and Materials affected thereby until such Submittal has been reviewed and approved by Engineer.

D. Transmittal of Submittals:

1. All Submittals (Shop Drawings, product data, and Samples) for Equipment and Materials furnished by Contractor, Subcontractors, manufacturers, and Suppliers shall be submitted to Engineer by Contractor.

2. Transmit all Submittals to Engineer for approval as follows:

a. Submittal Information Block:

(1) Affix to all paper copies whether Submittal is prepared by Contractor, Subcontractor, or Supplier. Use transparent decal type Submittal Information Blocks for Shop Drawings and use gummed paper type for product data and Sample Submittals. All Submittal Information Blocks needed for this Contract will be furnished to Contractor at no charge at the initial coordination conference.

(2) Electronic files of Submittal Information Blocks will be provided to Contractor for use on electronic Submittals.

b. Mark each Submittal by Project name and number, Contract title and number, and applicable Specification Section and Article numbers. Include in the letter of transmittal the drawing number and title, sheet number (if applicable), revision number, and electronic file name (if applicable). Unidentifiable Submittals will be returned for proper identification.

c. Check and approve Submittals of Subcontractors, Suppliers, and manufacturers prior to transmitting them to Engineer. Contractor's submission shall constitute a representation to Owner and Engineer that Contractor approves Submittals and has determined and verified all design criteria, quantities, dimensions, materials, catalog numbers, compliance with Laws and Regulations, and similar data, and Contractor assumes full responsibility for doing so; and Contractor has coordinated each Submittal with requirements of the Work and the Contract Documents.

d. At the time of each submission, call to the attention of Engineer in the letter of transmittal any deviations from requirements of the Contract Documents.

e. Make all modifications noted or indicated by Engineer and return the required number of revised Submittals until approved. Direct specific attention in writing, or on revised Submittals, to changes other than the modifications called for by Engineer on previous Submittals. After paper copy Submittals have been approved, submit copies thereof for final distribution. Previously approved Submittals 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.

f. Following completion of the Work and prior to final payment, furnish record documents and approved Samples and Shop Drawings necessary to indicate "as constructed" conditions, including field modifications, in the number of copies specified. Furnish additional copies for insertion in Equipment instruction books and operating manuals as required. All such copies shall be clearly marked "PROJECT RECORD."

(1) Submit a final record copy of the Master Field Drawing list which shall indicate the final revision status of each drawing on the list.

3. Quantity Requirements:

a. Except as otherwise specified, transmit all Shop Drawings in the following quantities:

(1) Initial Submittal:

(a) Electronic - One copy to Engineer.

(2) Resubmittals:

(a) Electronic - One copy to Engineer.

(3) Submittal for final distribution:

(a) Paper – Two copies to Engineer.

(b) Electronic - One copy to Engineer.

(4) As-constructed documents:

(a) Paper - Four copies to Engineer.

(b) Electronic - One copy to Engineer and one copy to Owner.

b. Transmit Submittals of product data as follows:

(1) Initial Submittal:

(a) Electronic - One copy to Engineer.

(2) Resubmittals:
(a) Electronic - One copy to Engineer.
(3) Submittal for final distribution:
(a) Electronic - One copy to Engineer.

c. Transmit Submittals of Material Samples, color charts, and similar items as follows:
(1) Initial Submittal – One to Engineer.
(2) Resubmittal - One to Engineer.
(3) Upon approval, no Sample(s) will be returned to Contractor.

d. Transmit Submittals of Equipment instruction books and operating manuals as follows:
(1) Initial Submittal:
(a) Electronic - One copy to Engineer. One copy to Owner.
(2) Resubmittals:
(a) Electronic - One copy to Engineer. One copy to Owner.
(3) Submittal for Final Distribution - Four paper copies and one electronic copy to Engineer.
(4) Submittal for Final Distribution – Four paper copies and one electronic copy to Owner, upon Engineer's written authorization.

e. When all Submittals have been updated to "as-constructed" conditions, transmit to Engineer and to Owner in electronic format.

f. Owner may copy and use for internal operations and staff training purposes any and all document Submittals required by this Contract and approved for final distribution, whether or not such documents are copyrighted, at no additional cost to Owner. If permission to copy any such Submittal for the purposes stated is unreasonably withheld from Owner by Contractor or any Subcontractor, manufacturer, or Supplier, Contractor shall provide to Engineer 20 copies plus the number of copies required by Contractor at each final distribution issue.

4. Contractor's erection drawings and other Submittals required for installation of Equipment furnished under this Contract for installation under other contracts will be transmitted to installing contractor by Engineer in the final distribution of such Submittals.

5. Information to Manufacturer's District Office: Contractor shall arrange for manufacturers and Suppliers of Equipment or Materials to furnish copies of all agreements, drawings, specifications, operating instructions, correspondence, and other matters associated with this Contract to the manufacturer's district office servicing Owner. Insofar as practicable, all business matters relative to Equipment and Materials included in this Contract shall be conducted through such local district offices.

E. Engineer's Review:

1. Engineer will review and take appropriate action on Submittals in accordance with the accepted Schedule of Submittals. Engineer's review and approval will be only to determine if items of Equipment and Materials covered by the Submittals are compatible with the design concept and conform to information given in the Contract Documents.

2. Such review and approval will not extend to design data reflected in Submittals which is peculiarly within the special expertise of Contractor or Contractor's Subcontractors or Suppliers. Review and approval of a component item as such will not indicate approval of the assembly in which the item functions.

3. Engineer's review and approval of Shop Drawings, product data, or Samples will not relieve Contractor of responsibility for any deviation from requirements of the Contract Documents unless Contractor has in writing called Engineer's attention to such deviation

at the time of submission, and Engineer has given written concurrence in and approval of the specific deviation. Approval by Engineer shall not relieve Contractor from responsibility for errors or omissions in Submittals.

F. Submittal Action Stamp:

1. Engineer's review action stamp, appropriately completed, will appear on all Submittals of Contractor when returned by Engineer. Review status designations listed on Engineer's action stamp are defined as follows:

A - SUBMITTAL APPROVED Signifies Equipment or Material represented by the Submittal conforms with the design concept and complies with the intent of the Contract Documents and is approved for incorporation in the Work. Contractor is to proceed with fabrication or procurement of the items and with related Work. Copies of the Submittal are to be transmitted to Engineer for final distribution.

B - SUBMITTAL APPROVED AS NOTED (RESUBMIT) Signifies Equipment or Material represented by the Submittal conforms with the design concept and complies with the intent of the Contract Documents and is approved for incorporation in the Work in accordance with Engineer's notations. Contractor is to proceed with fabrication or procurement of the items and with related Work in accordance with Engineer's notations and is to submit a revised Submittal responsive to notations marked on the returned Submittal or written in the letter of transmittal.

C - SUBMITTAL RETURNED FOR REVISION (RESUBMIT) Signifies Equipment or Material represented by the Submittal appears to conform with the design concept and comply with the intent of the Contract Documents but information is either insufficient in detail or contains discrepancies which prevent Engineer from completing his review. Contractor is to resubmit revised information responsive to Engineer's annotations on the returned Submittal or written in the letter of transmittal. Fabrication or procurement of items represented by the Submittal and related Work is not to proceed until the Submittal is approved.

D - SUBMITTAL NOT APPROVED (SUBMIT ANEW) Signifies Equipment or Material represented by the Submittal does not conform with the design concept or comply with the intent of the Contract Documents and is disapproved for use in the Work. Contractor is to provide Submittals responsive to the Contract Documents.

E - PRELIMINARY SUBMITTAL Signifies Submittals of such preliminary nature that a determination of conformance with the design concept or compliance with the intent of the Contract Documents must be deferred until additional information is furnished. Contractor is to submit such additional information to permit layout and related activities to proceed.

F - FOR REFERENCE, NO APPROVAL REQUIRED Signifies Submittals which are for supplementary information only; pamphlets, general information sheets, catalog cuts, standard sheets, bulletins and similar data, all of which are useful to Engineer or Owner in design, operation, or maintenance, but which by their nature do not constitute a basis for determining that items represented thereby conform with the design concept or comply with the intent of the Contract Documents. Engineer reviews such Submittals for general content but not for basic details.

G - DISTRIBUTION COPY (PREVIOUSLY APPROVED) Signifies Submittals which have been previously approved and are being distributed to Contractor, Owner, Resident Project Representative, and others for coordination and construction purposes.

G. Instruction Books and Operating Manuals:
   1. In addition to electronic Submittals specified above, Equipment instruction books and operating manuals prepared by the manufacturer shall include the following:
      a. Index and tabs.
      b. Instructions for installation, start-up, operation, inspection, maintenance, parts lists and recommended spare parts, and data sheets showing model numbers.
      c. Applicable drawings.
      d. Warranties and guarantees.
      e. Name and address of nearest manufacturer-authorized service facility.
      f. All additional data specified.
   2. Information listed above shall be bound into hard-back binders. Four manuals are required, two in heavy duty McBee Swing Hinge post type binders and two in standard binders. Sheet size shall be 8-1/2" x 11". Binder color shall be black. Capacity shall be a minimum of 1-1/2 inches, but sufficient to contain and use sheets with ease.
      a. Provide the following accessories:
         (1) Label holder.
         (2) Business card holder.
         (3) Sheetlifters.
         (4) Horizontal pockets.
      b. The following information shall be imprinted, inserted, or affixed by label on the binder front cover, See Appendix 013301-C for details:
         (1) Owner's name.
         (2) Owner's facility or plant name.
         (3) Equipment item name.
         (4) Volume number (if applicable).
         (5) Contract number.
         (6) Manufacturer's name and address.
      c. The following information shall be imprinted, inserted, or affixed by label on the binder spine:
         (1) Equipment item name.
         (2) Owner's name and Owner's facility or plant name.
         (3) Manufacturer's name.
         (4) Contract number.
         (5) Volume number (if applicable).
      d. Submit mockup of cover and spine for Engineer and Owner review.

H. Samples:
   1. Office Samples shall be of sufficient size and quantity to clearly illustrate the following:
      a. Functional characteristics of the product, with integrally related parts and attachment devices.
      b. Full range of color, texture, and pattern.
      c. Material, manufacturer, pertinent catalog number, and intended use.

1.04 INFORMATIONAL SUBMITTALS:

A. Informational Submittals are comprised of technical reports, administrative Submittals, and guarantees which relate to the Work, but do not require Engineer approval prior to proceeding with the Work. Informational Submittals include:
   1. Welder qualification tests.
   2. Welding procedure qualification tests.
   3. X-ray and radiographic reports.
   4. Test reports.
   5. Certification on Materials:
      a. Steel mill tests.
   6. Shipping and/or packing lists.
   7. Job progress schedules.
   8. Equipment and Material delivery schedules.
   9. Warranties and guarantees.

B. Transmittal of Informational Submittals:
   1. All Informational Submittals furnished by Contractor, Subcontractors, manufacturers, and Suppliers shall be submitted to Engineer by Contractor unless otherwise specified.
      a. Identify each Informational Submittal by Project name and number, Contract title and number, and the Specification Section and Article numbers marked thereon or in the letter of transmittal. Unidentifiable Submittals will be returned for proper identification.
      b. At the time of each submission, call to the attention of Engineer in the letter of transmittal any deviations from the requirements of the Contract Documents.
   2. Quantity Requirements:
      a. Technical reports and administrative Submittals except as otherwise specified:
         (1) Electronic: One to Engineer.
   3. Test Reports:
      a. Responsibilities of Contractor, Owner, and Engineer regarding tests and inspections of Equipment, Materials, and completed Work are set forth elsewhere in these Contract Documents.
      b. The party specified responsible for testing or inspection shall in each case, unless otherwise specified, arrange for the testing laboratory or reporting agency to distribute test reports as follows:
         (1) Owner: One copy.
         (2) Engineer: One copy.
         (3) Contractor: One copies.

C. Engineer's Review:
   1. Engineer will review informational Submittals for indications of Work or Material deficiencies.
   2. Engineer will respond to Contractor on those informational Submittals which indicate Work or Material deficiency.

PART 2 - PRODUCTS - Not Applicable.

PART 3 - EXECUTION - Not Applicable.

END OF SECTION 013301

APPENDIX 013301-A

SUBMITTAL SCHEDULE

LEGEND: E = Electronic; P(x) = Paper Copy (no. of copies); NTP = Notice to Proceed

Pkg ID	Package Description	Subj. To LDs *	With Proposal	For Approval (required prior to fabrication)	For Information/ Certification/Construction
1	Certificate of Insurance	No			P (1) - 14 ~~d~~Days after NTP
2	International Transportation Insurance Certificate, if applicable	No			P (1) - With Shipping Documents and forwarded to Purchaser at least six weeks prior to shipment
3	Acknowledge Acceptance and Return of Contract.	No			P (3) - 7 ~~d~~Days after Receipt of Contract
4	Letter of Credit or Performance Bond if required	No			P (1) - 1~~04 business~~ ~~d~~Days after NTP
5	Notice of any Cancellation, Termination, or Material Changes of Insurance Policies	No			30 ~~d~~Days before cancellation or change
6	Project Organizational Chart, including key personnel resumes.	No	E		
7	Installation & Commissioning Spare Parts List	No	E	E - 60 ~~d~~Days after NTP	
8	Recommended Two-Year Operational Spare Parts List	No	E		E - 120 ~~d~~Days after NTP, updated through project duration
9	Catalog Data Sheets with Dimensions	No	E		
10	Standard Training Classes	No	E		
11	Training Agenda, Schedule, Outline, and Materials	No		E - 90 ~~d~~Days prior to the start of training	
12	Preliminary Work Progress Schedule	No	E		E - 1~~04 business d~~Days after NTP
13	Detailed Work Progress Schedule	No		E - 30 ~~d~~Days after NTP, monthly thereafter	
14	Manufacturer Field Staffing Plan, including Names and Durations of Visits	No			E - 30 ~~d~~Days before arrival to Site
15	Progress Reports	No			E - 30 ~~d~~Days after NTP, monthly through engineering and fabrication, and with each invoice for partial payment.
16	Supplier Document List	No		E - 30 ~~d~~Days after NTP	E - with Monthly Progress Reports
17	Detailed Drawing Submittal Schedule	No		E - 30 ~~d~~Days after NTP, updated monthly thereafter	
18	Partial Lien Waiver	No			With Invoice
19	Quality Assurance / Quality Control Manuals, unless on file with Purchaser's QA/QC Department	No			E - 60 ~~d~~Days after NTP
20	Preliminary O & M Manuals	Yes			P (4), E - 120 ~~d~~Days prior to Contract Delivery Date
21	Final O & M Manuals	No			P (10), E - Prior to achievement of Substantial Completion
	Training Manuals	No			P (10), E - 15 ~~d~~Days prior to training
22	Factory Acceptance Test Procedures	No		E - 60 ~~d~~Days before each test	
23	Copies of Certified Test and Inspection Reports	No			E - 15 ~~d~~Days after test
24	Transportation / Shipping Plan	No			E - 90 ~~d~~Days before first shipment
25	Electronic Material List	No			E - 30 ~~d~~Days prior to each shipment
26	Notice of Shipment	No			E - ~~two weeks~~ 14 Days prior to shipment
27	Packing Lists	No			P (1), E – prior to shipment
28	List of all accessory equipment to be shipped loose to Site	No			E - 60 ~~d~~Days prior to Shipment

APPENDIX 013301-A

SUBMITTAL SCHEDULE

LEGEND: E = Electronic; P(x) = Paper Copy (no. of copies); NTP = Notice to Proceed

Pkg ID	Package Description	Subj. To LDs *	With Proposal	For Approval (required prior to fabrication)	For Information/ Certification/Construction
29	Shipment Bills of Materials	No			P (1), E - With Notice of Shipment and with each shipment
30	Unloading, Handling, and Lifting Requirements and Procedures	No			P (1), E - 60 ~~d~~Days prior to Shipment
31	Erection / Installation / Assembly Instructions	No			P(1), E - 90 ~~d~~Days prior to contract delivery date
32	Description and details of preservation and protection systems and recommended storage procedures	No	E	E - 30 days after NTP	P(4), E - 60 ~~d~~Days prior to shipment
33	Lubrication list and initial fill requirements	No			E - 90 ~~d~~Days before shipment of equipment
34	Material Safety Data Sheets (if applicable)	No			P (5), E - 30 ~~d~~Days prior to shipment
35	Design Data / Design Calculations	No			E - Prior to Final Payment
36	Final Bill of Materials	No			E - Prior to Final Payment
37	Final Lien Waiver	No			With Final Invoice
38	Final As-Manufactured Submittals	Yes			E - Prior to Delivery
39	All Remaining Submittals Not Listed, but Specified in Divisions 1 through 48	No		As required to meet schedule.	E - 90 ~~d~~Days after NTP
	MECHANICAL				
M1	Equipment General Arrangement Outline and Detail Drawings	Yes	E	E - ~~4 weeks~~ 28 Days after NTP	
M2	Process Flow Diagrams and Description of Operation	No	E	E - ~~1 week~~ 28 Days after NTP	
M3	Interface details for material injection into the ductwork at all injection locations, including port details, port locations, piping and access GA and loads.	Yes	E (Preliminary)	E - 90 ~~d~~Days after NTP	
M4	Lance Removal Criteria - Preliminary	No	E	E - ~~4 weeks~~ 28 Days after NTP	
M5	Piping and Instrumentation Diagrams - Preliminary	Yes	E	E - ~~3 weeks~~ 28 Days after NTP	
M6	Piping Drawings, 2D, including pipe support type, location, and loads.	Yes		E - ~~6 weeks~~ 42 Days after NTP	
M7	Pipe Support Detail Drawings	Yes	E (Typical pipe support details)	E - ~~8 weeks~~ 56 Days after NTP	
M8	Piping Information	No	E	E - ~~6 weeks~~ 42 Days after NTP	
M9	Equipment List	Yes	E	E - ~~4 weeks~~ 28 Days after NTP	
M10	Pipe Line List	No	E	E - ~~4 weeks~~ 42 Days after NTP	
M11	Valve Lists - Actuated and Manual	No	E	E - ~~6 weeks~~ 42 Days after NTP	
M12	Piping Specials List	No	E	E - ~~6 weeks~~ 42 Days after NTP	
M13	Physical Flow Model Test Report	No		E - 75 ~~d~~Days after NTP	
M14	Performance Correction Curves	No	E	E - 75 ~~d~~Days after NTP	
M15	Performance Test Procedures	No		E - 75 ~~d~~Days after NTP	
M1~~5~~6	CFD Flow Model Test Report	Yes		E - ~~75~~100 ~~d~~Days after NTP	
	STRUCTURAL				
S1	Preliminary Not to Exceed Foundation Loadings and Details, Preliminary (includes, but not limited to, stair tower, pipe rack, buildings, and all equipment)	No	E		
S2	Not to Exceed Foundation Loadings and Details, Preliminary (includes, but not limited to, stair tower, pipe rack, buildings, and all equipment)	Yes		E - ~~30 days after NTP~~ Stair tower/Silo: 30 Days after NTP. Pipe rack:15 Days after receipt of balance of plant loads and locations from Owner/Engineer.	

APPENDIX 013301-A

SUBMITTAL SCHEDULE

LEGEND: E = Electronic; P(x) = Paper Copy (no. of copies); NTP = Notice to Proceed

Pkg ID	Package Description	Subj. To LDs *	With Proposal	For Approval (required prior to fabrication)	For Information/ Certification/Construction
S3	Foundation Loadings and Details, Final (includes, but not limited to, stair tower, pipe rack, buildings, and all equipment)	Yes		E - ~~45 days after NTP~~Stair tower/Silo: 45 Days after NTP. Pipe rack: 30 Days after receipt of balance of plant loads and locations from Owner/Engineer.	
S4	Foundation Anchor Bolt and Setting Drawings, Preliminary	No		E - ~~30 days after NTP~~ Stair tower/Silo: 30 Days after NTP. Pipe rack:15 Days after receipt of balance of plant loads and locations from Owner/Engineer.	
S5	Foundation Anchor Bolt and Setting Drawings, Final	Yes		E - ~~45 days after NTP~~ Stair tower/Silo: 45 Days after NTP. Pipe rack: 30 Days after receipt of balance of plant loads and locations from Owner/Engineer.	
S6	Preliminary General Arrangement Drawings of stair tower, platforms, pipe rack, and pipe support steel including routing through boiler area.	No	E		
S7	General Arrangement Drawings of stair tower, platforms, pipe rack, and pipe support steel including routing through boiler area.	Yes		E - ~~30 days after NTP~~ Stair tower: 30 Days after NTP. Pipe rack:15 Days after receipt of balance of plant loads and locations from Owner/Engineer.	
S8	Structural Steel Design Drawings, Preliminary (includes, but not limited to, stair tower, platforms, pipe rack, pipe support steel through boiler area, and existing steel modifications in boiler area for pipe supports)	No		E - ~~45 days after NTP~~ Stair tower: 45 Days after NTP. Pipe rack: 30 Days after receipt of balance of plant loads and locations from Owner/Engineer.	
S9	Structural Steel Design Drawings, Final (includes, but not limited to, stair tower, platforms, pipe rack, pipe support steel through boiler area, and existing steel modifications in boiler area for pipe supports)	Yes		E - ~~60 days after NTP~~ Stair tower: 60 Days after NTP. Pipe rack: 45 Days after receipt of balance of plant loads and locations from Owner/Engineer.	
~~S10~~	~~Structural Steel Fabrication and Erection Drawings, Preliminary~~	~~No~~		~~E - 60 days after NTP~~	
S11	Structural Steel Fabrication and Erection Drawings, Final	Yes		E - 90 ~~d~~Days after NTP	
S12	Weld Procedures	No			E - 45 ~~d~~Days prior to fabrication
S13	Weld Procedure Qualifications	No			E - 45 ~~d~~Days prior to fabrication
	INSTRUMENTS & CONTROLS				
C1	System I/O and Alarm Lists (Preliminary, including hard wired points and communications.)	Yes	E	E - ~~4 weeks~~ 28 Days after NTP	
C2	System I/O and Alarm Lists (Final, including hard wired points and communications.)	Yes		E - The lesser of the following: 10 Days after P&ID approval or 60 ~~d~~Days after NTP	
C3	Instrument List	Yes	E	E - ~~4 weeks~~ 28 Days after NTP	
C4	Interconnection Wiring Diagrams	Yes		E - ~~4 weeks~~ 28 Days after NTP	
C5	Instrument Specification Sheets	Yes		E - ~~4 weeks~~ 28 Days after NTP	
C6	Control Logic Diagrams	Yes		E - ~~6 weeks~~ 42 Days after NTP	
C7	Control Logic Narrative	Yes	E	E - ~~6 weeks~~ 42 Days after NTP	
C8	Calibration Sheets	No		E - ~~8 weeks~~ 56 Days after NTP	
C9	Outline Drawings.	No		E - ~~8 weeks~~ 56 Days after NTP	
C10	Instrument Installation Details	No		E - ~~8 weeks~~ 56 Days after NTP	
C11	Certificates of Factory Test	No		E - ~~8 weeks~~ 56 Days after NTP	

APPENDIX 013301-A

SUBMITTAL SCHEDULE

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Pkg ID	Package Description	Subj. To LDs *	With Proposal	For Approval (required prior to fabrication)	For Information/ Certification/Construction
C12	Welding Procedures and Qualifications	No		E - ~~8 weeks~~ 56 Days after NTP	
	ELECTRICAL				
E1	Electrical Load List	Yes		E - ~~3 weeks~~ 21 Days after NTP	
E2	Motor Nameplate Data - Low Voltage Motors	No		E - ~~6 weeks~~ 42 Days after NTP	
E3	Motor Curves - Low Voltage Motors	No		E - ~~6 weeks~~ 42 Days after NTP	
E4	Electrical Schematic and Wiring Diagrams	No		E - ~~6 weeks~~ 56 Days after NTP	
E5	Electrical Equipment Layout	Yes		E - ~~6 weeks~~ 42 Days after NTP	
E6	Electrical One-Line Drawings	Yes	E	E - ~~3 weeks~~ 21 Days after NTP	
E7	MCC Submittals	Yes		E - ~~6 weeks~~ 56 Days after NTP	
E8	Panel board Schedules	Yes		E - ~~6 weeks~~ 56 Days after NTP	
E9	Electrical Bill of Materials	Yes		E - ~~6 weeks~~ 70 Days after NTP	
E10	Electrical Plan Drawings	Yes		E - ~~6 weeks~~ 42 Days after NTP	
E11	Electrical Raceway and Cable Tray Layouts in PCM	Yes		E - ~~6 weeks~~ 56 Days after NTP	
~~E12~~	~~Cable Schedule for cable connections to supplied equipment~~	~~Yes~~		~~E - 6 weeks after NTP~~	
	ARCHITECTURAL				
A1	HVAC Equipment Data and Drawings	No		E - 30 ~~d~~Days after NTP	
A2	HVAC Design Notes and Calculations	No		E - 30 ~~d~~Days after NTP	
A3	Door and Frame Data and Drawings	No		E - 30 ~~d~~Days after NTP	
A4	Preliminary PCM Building Details	Yes		E - 30 ~~d~~Days after NTP	
A5	PCM Building Details	No		E - 45 ~~d~~Days after NTP	
A6	Preliminary Equipment Building Details, if applicable	Yes		E - 30 ~~d~~Days after NTP	
A7	Equipment Building Details, if applicable	Yes		E - 45 ~~d~~Days after NTP	
A8	Protective Coating Data	No		E - 45 ~~d~~Days after NTP	
A9	All Remaining Submittals Specified in Divisions 8, and 9	No		E - 45 ~~d~~Days after NTP	
	Note: Submittals that have a scheduled due dateon a weekend day (Saturday or Sunday) shall be submitted no later than the following Monday.				

Appendix 013301-B

Submittal Description – As applicable to the Scope of Work of this Contract

System I/O list
- Tabulation of all inputs and outputs associated with the equipment provided.
- Engineers I/O Point name, Description.
- All signal type, level and power source.
- Control logic diagram.
- Cable no. and term info.

Electrical Schematic
- Detailed schematics showing each and every light, switch, controller, relay, timer, etc., associated with a systems control circuit
- All voltage and current ratings
- Special wiring requirements (coax, high temp., etc.)

Control Panel Front View & Internal Wiring Diagram
- Physical diagrams of all supplied control panels (internal and external)
- All light and switches including color
- All wiring internal to the panel
- All Tagging/Labeling
- Panel NEMA rating

Electrical Load List
- Tabulation of all motors (load in hp)
- Tabulation of all variable speed drives (load in kW)
- Tabulation of all 120V vital ac loads (load in kW)
- Tabulation including hp, voltage, and number of phases

Electrical Equipment Layout
- Physical drawing showing the location of each of the electrical interface points and elevation of equipment in respect to the plant elevation
- Location of each device that requires Owner's cable to be run to it

Equipment Installation Details
- Drawings showing how to install all devices that require field installation
- Details including support/mounting devices
- Instrument installation details including tubing installation from root valve to the instrument including tubing size, slope, valve manifold, etc.

Interconnection Wiring Diagrams
- Overall system diagram showing 100% of the field wiring required
- Interface of each device or panel being supplied in the system
- Voltage and current ratings

Control Logic Diagrams
- Normal start/stop sequence
- Alarm development
- Identification of all time delays
- Auto stop/start sequence
- Identification of digital control
- Identification of analog control

P&IDs
- System diagrams of all system piping
- Identification of all instruments, pressure switches, limit switches, temperature elements, etc.
- Identification of interface (PLC, DCS, or hard wired interlocks) for each device
- Identification of valves, pumps, etc.
- Identification of all pipe size, materials, and schedule

General Arrangement Drawings
- Dimension and location (plan and elevation) of all equipment including locating dimensions in respect to the plant columns and elevation of equipment in respect to the plant elevation
- Identification of all pull space requirements
- Identification of all access/maintenance requirements
- Stair tower, platforms, pipe rack, and pipe support steel including routing through the boiler area.

Foundation Details
- Foundation details/outlines depicting overall dimensions, pad and blockout requirements, anchor bolt locations and details, and any additional information necessary to establish the foundation arrangement
- Actual and "not-to-exceed" foundation design loads, and their points of application, for all applicable load cases and/or combinations (i.e., dead load, live load, wind, seismic, dynamic, etc., and all other loads for design of foundations and attachments)
- Identification of loading directions, magnitudes, and any other permanent data required for the foundation design

Structural and Miscellaneous Steel
- Certified shop drawings and erection diagrams for all structural steel and miscellaneous steel
- Documents prepared in accordance with the AISC specification for the design, fabrication, and erection of structural steel for stair tower, platforms, pipe rack, pipe support steel through the boiler area, and modifications to existing steel in the boiler area for pipe supports, and other references listed in the technical specifications.
- Connection details.
- Weld procedures.
- Welder Procedure Qualifications.

Outline Drawings
- Outline dimensional drawing
- Location of all interface connections (plan and elevation)
- Recommended/required mounting details clearly depicting bolting location, size, material, and projection requirements, or sufficient data such that the Engineer can establish such requirements (for dynamic equipment or machinery data include operating speeds, rotating masses, centers-of-gravity, eccentricities, etc.)
- Weight and center of gravity
- Type of interface connection (e.g., 150 lb. RF flange, welded, weld end preparation, wall thickness or schedule, etc.)
- Allowable loads for all nozzles
- Removal space/maintenance requirements
- Special rigging requirements
- Thermal movements of all nozzles (if applicable)

Piping Information
- Physical drawing showing the routing of all Contractor supplied pipe
- Location of pumps, valves, traps, strainers, instrument connections, etc. on the piping drawing
- Location of all Owner/Contractor interface points (plan and elevation) for large and small pipe
- Drawing including locating dimensions in respect to the plant columns and elevation or centerline of equipment
- Allowable loads and movements for all interface points
- Support locations and details
- Identification of pipe sizes, materials, valves, pumps, insulation, etc.
- Field weld locations
- Wall/floor penetration requirements
- Pipe movements in excess of 1 inch
- Design/service conditions (temperature/pressure)

Customer Interface Point List
- Interface Point Number and Description
- Interface Point Connection Size, Type, Rating, and Material
- Design Fluid/Gas Conditions at Interface Connection including Flow, Temperature, and Pressure
- Allowable Forces and Moments on Interface Connection
- Reference P&ID and Outline Drawing Showing Interface Connection

Equipment Outline Drawings
- Outline dimensional drawing
- Location of all interface connections (plan and elevation)
- Recommended/required mounting details clearly depicting bolting and anchor location, size, material, and projection requirements, or sufficient data such that the Engineer can establish such requirements (for dynamic equipment or machinery data include operating speeds, rotating masses, centers-of-gravity, eccentricities, etc.)
- Weight and center of gravity
- Type of interface connection (e.g., 150 lb. RF flange, welded, weld end preparation, wall thickness or schedule, etc.)
- Allowable loads for all nozzles
- Removal space/maintenance requirements
- Special rigging requirements
- Thermal movements of all nozzles (if applicable)

O & M Manuals
- Description of equipment
- Theory of operation
- Troubleshooting
- Equipment drawings
- Installation instructions
- Maintenance instructions
- Sub-supplier component list

Equipment Lists
- Tabulation of all equipment provided (including mechanical, electrical, controls, etc.)
- Identification of individual Tag Number used in Drawings and schedules
- Identification of manufacturer and model number
- Lists interface requirements for utility demands upon Owner
- Identification of sub-supplier for item

Line Lists
- Tabulation of all piping lines by Engineer-assigned number
- Identification of size, schedule, material, contents, pressure, temperature, and whether heat traced or not.

Valve Lists
- Tabulation of all valves
- Identification of size, type, class, material, pressure, temperature, manufacturer, model, and options.

Piping Special Lists
- Tabulation of all piping specials
- Identification of size, type, class, material, pressure, temperature, manufacturer, model, and options.

Pipe Support and Hanger Lists
- Tabulation of all pipe supports and hangers
- Listing of type, load limit, standard detail applicable

Control Logic Narrative
- A control logic narrative shall be included with a description for each logic diagram that includes the system operation (control and monitoring), permissives and interlocks, and alarms.

Operator Interface Screen or Panel Layouts
- Detailed physical diagrams of all supplied control panels (internal and external)
- All lights and switches including color
- All Tagging/Labeling
- For graphics, sketches of recommended graphic screens with I/O tags identified

Instrument Specification Sheets
- ISA type data sheets with information including process data

Instrument List
- Tabulation of all instrumentation
- Engineers Device Tag, description, P&ID no., interconnecting wiring diagram no., instrument specification sheet no., calibration form no., Outline drawing no.,
- Calibration "Low", "High" and "Units" range for analog signals, setpoints for switches,
- Manufacturer and model number

Instrument Installation Details
- Instrument installation details including tubing installation from root valve to the instrument including tubing size, slope, fittings, valves, valve manifold, etc.
- Identify the bill of material required for the installation.
- Instrument stand construction details.

Calibration Sheets
- Individual sheet for each supplied instrument.
- Low, High and Units of calibration.
- Sign off sheet verifying Device Calibration.

Electrical Cable List
- Tabulation of all cables required between equipment furnished with this contract
- Provide cable number, from device tag, from device description, to device tag, to device description, schematic number, cable supplied by, type of cable required,

Factory Acceptance Test Plan
- List and describe all procedures for factory testing of the control equipment prior to shipment.

Bill of Material
- Shall list all material items supplied
- Include item, tag, quantity, description, specification, drawings, manufacturer, purchase order number, model number, and delivery date
- Number and Description of equipment

Document List
- Shall list all Contractor document and drawings individually.
- Shall include Owner document number, document description, document revision, and document date.
- Shall include Specification Number, Unit Number, Drawing Number, Title, Revision Number, Contractor, Contractor Drawing Number, Sub-Contractor and Sub-Contractor Number, Transmittal Letter Number and native filename.

APPENDIX 013301-C

Typical Instruction Book or Operating Manual
Cover and Spine Layout

(Spine)	(Cover)	
Mercury Control Equipment	**Big Rivers Electric Corporation**	22
	MATS Compliance Project	18
Big River Electric Corporation	**(Instruction Book) (Operating Manual)**	16
	for	
MATS Compliance Project	**Mercury Control Equipment**	22
	Volume Number*_____	16
Contract Number 1340	**Contract Number 1340**	16
Volume Number*___	**<Enter Manufacturer's Name>**	22
	<Enter Manufacturer's Address>	18

NOTES:

1. Choose either "Instruction Book" or "Operating Manual."
2. All lettering shall be a block style font, imprinting color to contrast with binder color specified.
3. Cover lettering shall be point sizes indicated in column to right of cover illustration.
4. Spine letter shall be 14-point minimum.
5. *Volume number required only if instructions are contained in more than one volume.

APPENDIX 013301-D – DOCUMENT MANAGEMENT SYSTEM AND MANAGEMENT

Vendor Submittal Reference Document

Overview:

The following procedure is for vendors, suppliers, or contractors who will be issuing submittals to Burns & McDonnell (BMcD). If you have questions about uploading submittals, please email or call your BMcD contact.

It is a step by step guide on:

- Login options
  - Logging in
  - Resetting the Password
  - Forgotten Passwords
- Preparing and Delivering a Submittal
  - Creating a Submittal
  - Notification of Receipt
- Picking up a Reviewed or Rejected Submittal
  - Notification of Completed/Rejected Documents
  - Download of Completed/Rejected Documents

9400 Ward Parkway • Kansas City, MO 64114-3319
Tel: 816 333-9400 • Fax: 816 333-3690 • www.burnsmcd.com

Vendor Submittal Reference Document

Logging In:

Log into BMcD WebTools at http://webtools.burnsmcd.com using the username and password sent to you by Burns and McDonnell's IT support group.

Note: Accounts are user specific. Do not share the username and password. Others who wish to access the system should request a separate account.

Previously you were not able to change the password you received, but now it can be reset after using the initial password from BMcD. After changing the password it cannot be changed again for 24 hours. Previously used passwords cannot be used again. The Domain is BMCDEXT and should preface your username.

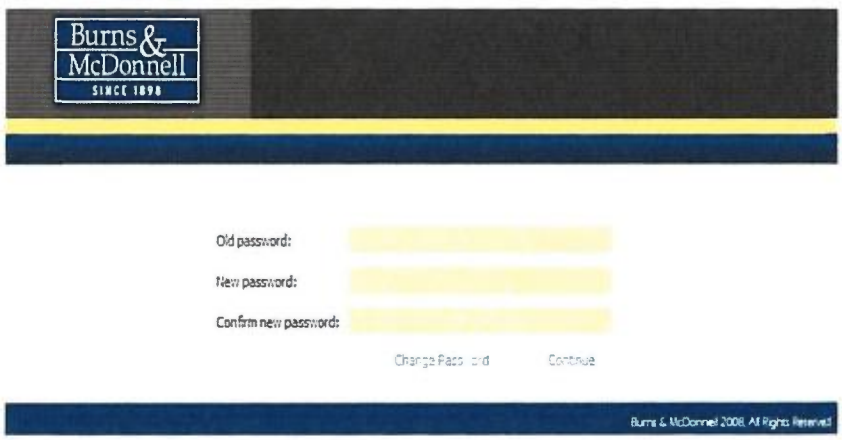
To Login:

The Domain is BMCDEXT and should be typed in before the user name. **NOTE: Make sure you select This is a private computer-this will remember your login information so you will not have to type in your username and password again. Example: BMcDext\[user ID] so the information would be BMcDEXT\ext_jdoe.**

a. You may change your password by checking the box for I want to change my password after logging on.
b. If you forgot your password you can have a new password sent to you by clicking the "Forgot your password?"

Login Screen:

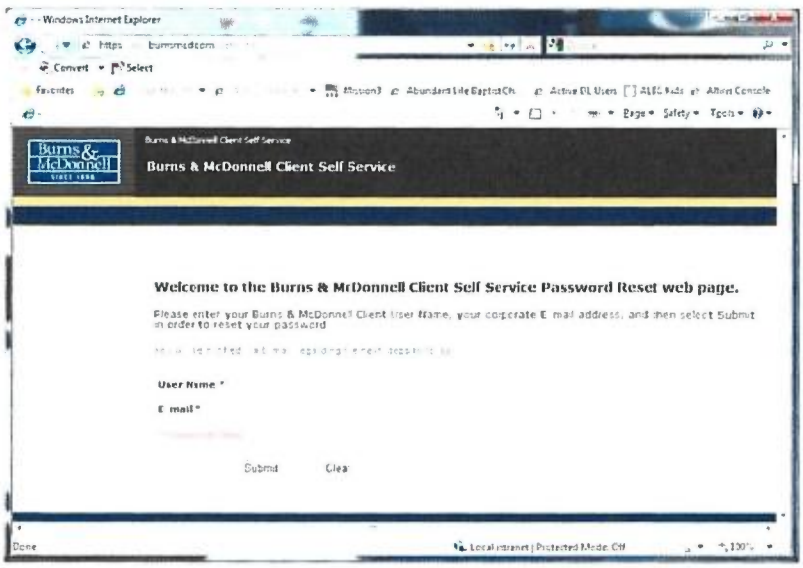
Set New Password screen:



- The new password must meet BMcD password requirements:
- The password has to be at least eight characters long.
- The password must contain characters from at least three of the following categories:
    - English uppercase characters (A - Z)
    - English lowercase characters (a - z)
    - Base 10 digits (0 - 9)
    - Non-alphanumeric (For example: !, $, #, or %)
    - The password cannot contain three or more characters from the user's account name.

If you forgot your password you can have a new password sent to you by clicking the "Forgot your password". If so, the following screen will appear for requesting a new password.

Request New Password screen:



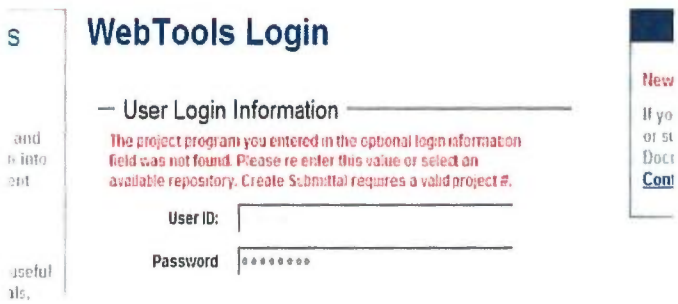
Creating a Submittal:

If your password does not need to be changed, use your current User ID and Password to log into WebTools.

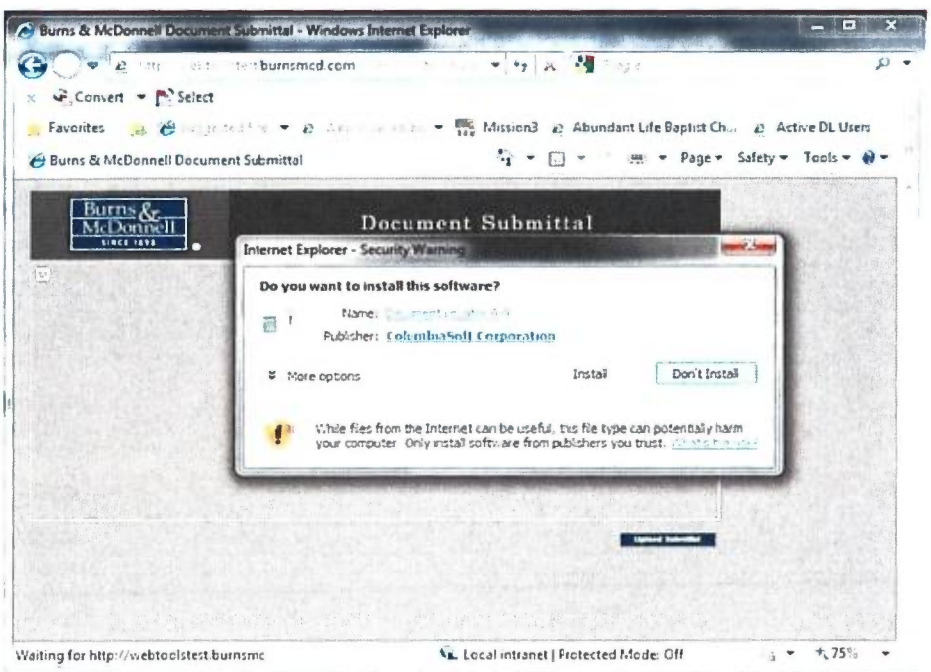
Your username and password information will be automatically populated into the BMcD Login screen.

1. To create a submittal click in the Project/Program text box and fill in with the appropriate project name or program number, then click Create Submittal.
   If a reminder of the appropriate project number is needed, log in to WebTools and view the available project number folders. By clicking on the "Documents" folder the list of available project number will be seen. Descriptions of those projects will be given on the right hand window pane. After the proper project number is verified, log back out to return to the Create Submittal option.
   Note: When creating a Submittal, the Repository information is not needed.

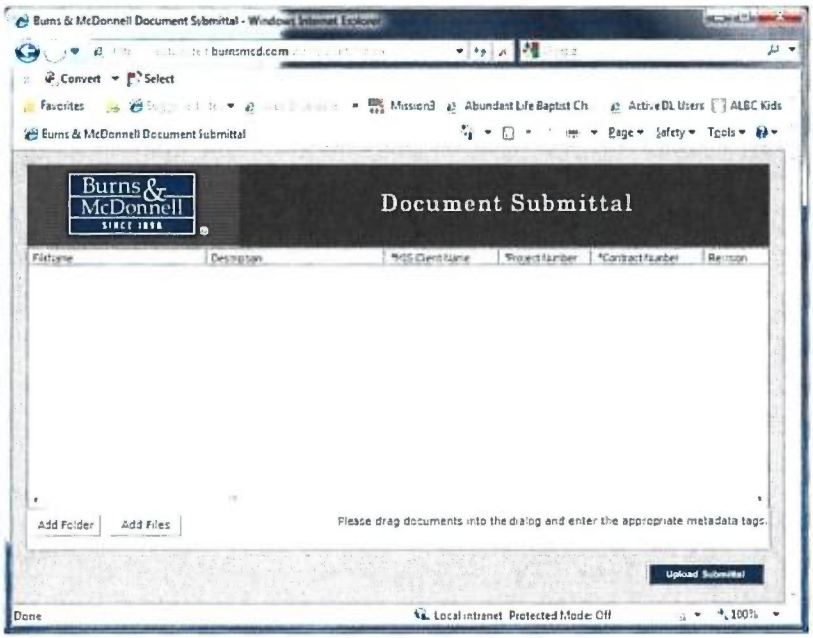
   If the number is incorrectly entered the following error message will be displayed.
   Check the number, if you believe you received this message in error you will need to contact your BMCD Document Control contact.



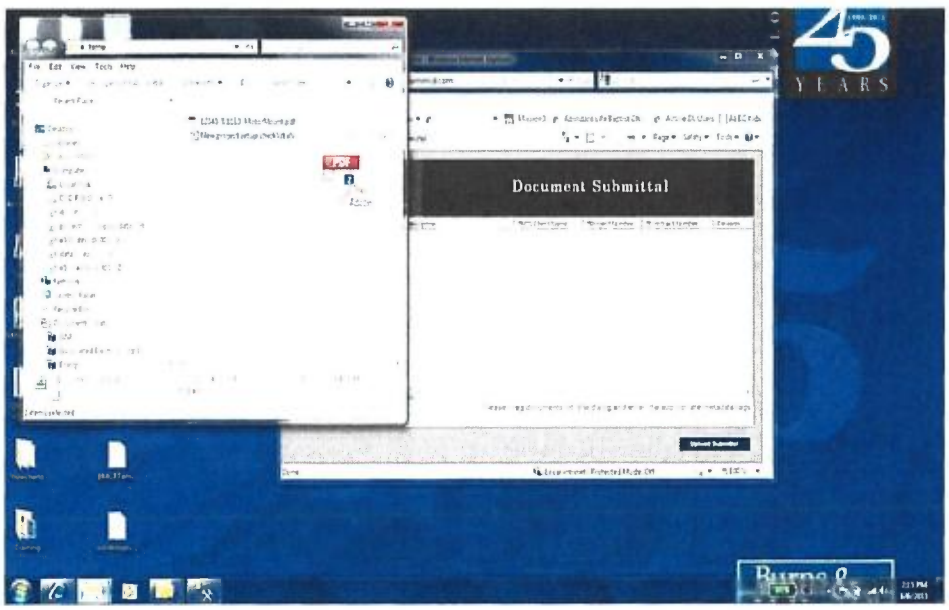
   - If this is the first time you are visiting the Submittal screen then you will be prompted to load the ActiveX Add-On that will allow you to drag and drop documents into the screen. Click on Install to load the ActiveX Add-On.
     Note: Some companies prohibit the install of an ActiveX Add-On. If this is the case for your system administrators please contact your BMcD representative.



- After installing the Active X component, the window is now ready for files to be drag and dropped directly into the grid part of the window.



2. Select the files from your system and drag them into the window.



Vendor Submittal Reference Document

One of three options may be used in the Create Submittal window:

- Drag and drop a File
- Drag and drop a Folder
- Use the Add Folder or Add Files buttons in the Document Submittal window.

Note: For document types and filenames see section 1.02 E of the 013300, 013301, 013304 or 013305 General Requirements specification.

A vendor transmittal number will be assigned to the Submittal upon receipt. If preferred, a transmittal may be created and added to the list of files as a separate document. Please check with your project team for specific submittal needs.

- The Filename, client name, and project number will be pre-populated in the Create Submittal window. Before dragging the files into the window make sure they follow the file naming requirements.
- **Filename** should be the same as the Drawing Name or Document Number.

  Do not include the following in the filenames:

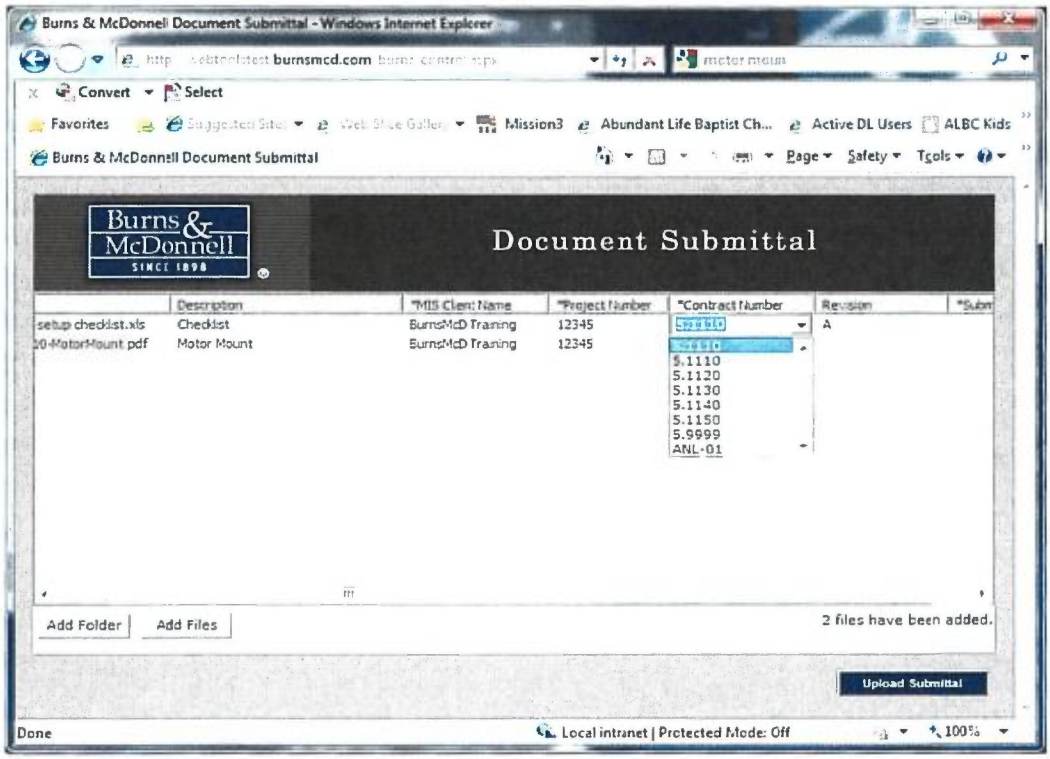
  a. Revision
  b. Dates
  c. File Description or Document Title
  d. Transmittal Information

  Note: If the document is being resubmitted then the filename must match EXACTLY with the previous submittal name.

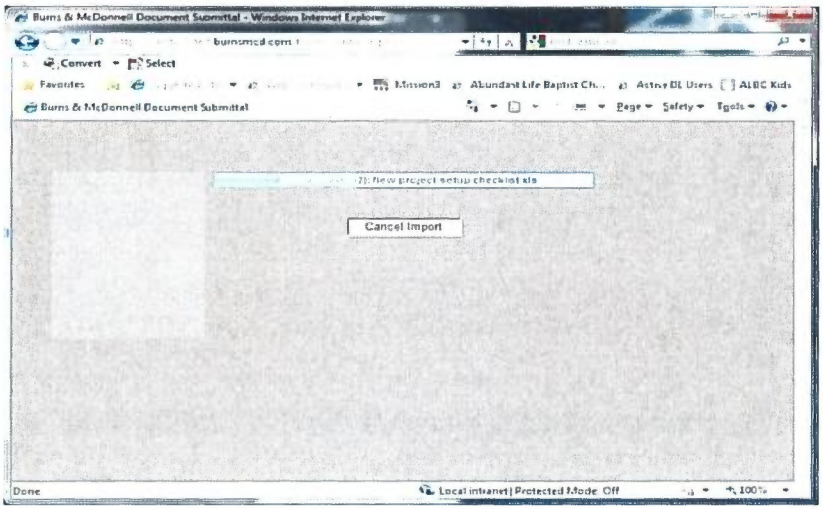
Valid filename examples: A07-9877-8-1.pdf, M-114-1-par.pdf, A-347-wps.pdf, 18555-18 ASME calcs.pdf, Terminal Point List.pdf

- **Description** is required and should relate to the **document title** from the title block of the drawing.
  Valid description include: General Arrangements, Weld Procedures, Code Calcs, Terminal Point List, Wiring Diagram – Analyzer.
- **Revision** should be the actual revision from the document title block. If the document does not have a revision enter a dash/hyphen (-).
- Items with an * in the column name are required. Items that do not include the * may still be required by your project. Please fill in as much detail as possible unless directed otherwise by your BMCD Document Control contact.
  Note: Columns in the window may be resized as needed. If a drop down list is supplied then only those values may be selected. To narrow a list of items or if a value is known, it may be typed or the copy/paste option may be used into the drop down.

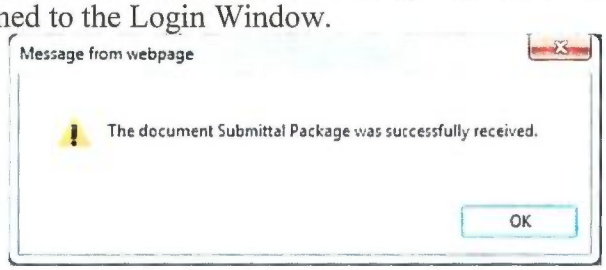
Vendor Submittal Reference Document



3. Click on the Upload Submittal and the files will begin to load.



4. When complete you will be prompted that the Package was successfully received. Click OK and you will be returned to the Login Window.



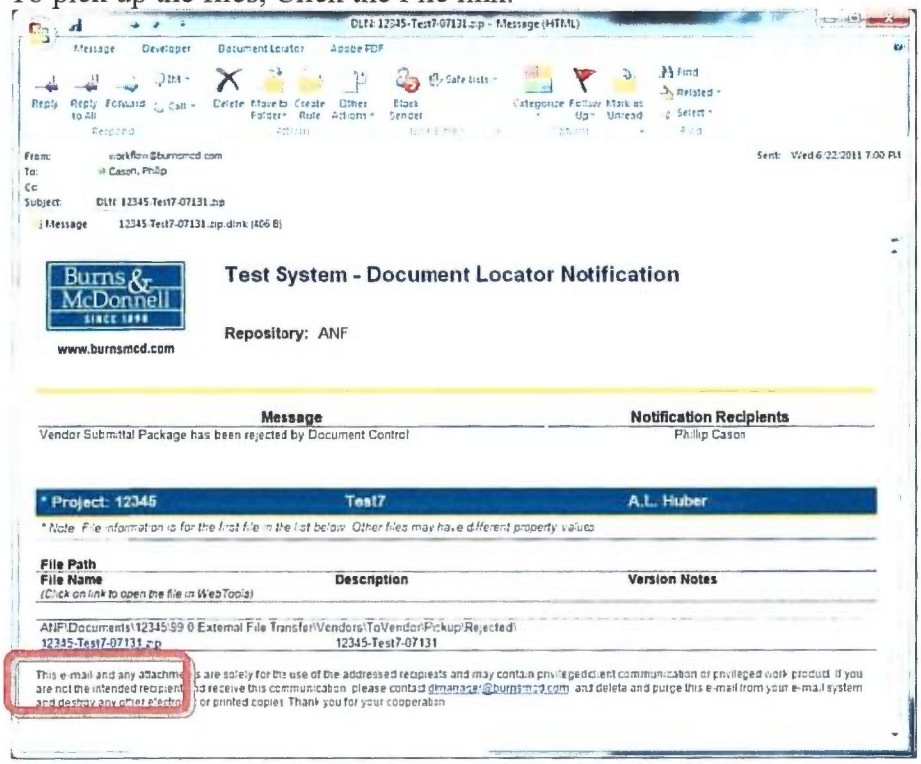
Notification of Receipt:

Within a few minutes you will receive an email notice that will include a link to a transmittal receipt. If there is a correction made to the submittal you may receive an additional notice that will include a link to the updated transmittal receipt.

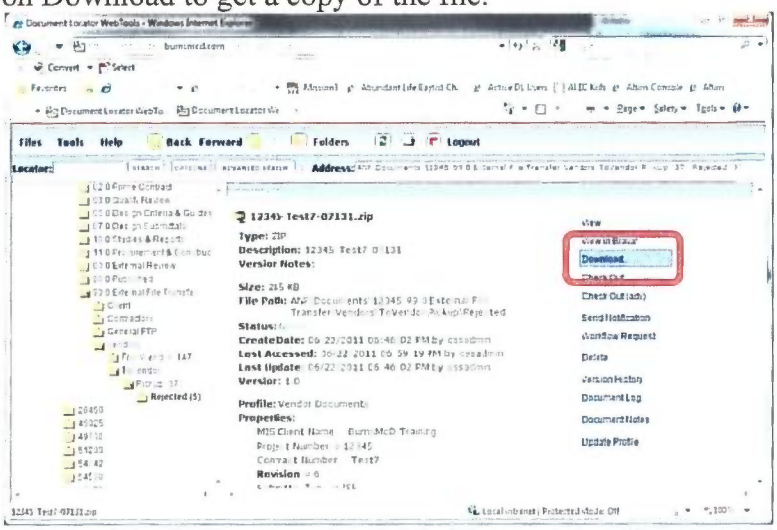
Picking up a Reviewed Submittal

If your Submittal is being return after a review or is rejected, you will receive an email from the system with a link to a zip file consisting of the files.

1. To pick up the files, Click the File link.



2. After logging into WebTools you will be directed to the document for pickup. Click on Download to get a copy of the file.



3. Select a location on your hard drive to save the file and click ok.

SECTION 016001 - EQUIPMENT AND MATERIALS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes general requirements for transportation and handling, delivery, storage, and protection of Contractor-furnished Equipment and Materials.

B. Related Work Specified Elsewhere:

1. Substitutions: RUS FORMS
2. SECTION 011101 – SUMMARY OF WORK.
3. SECTION 012304 – ALTERNATES.
4. SECTION 013301 – SUBMITTALS.

1.02 DEFINITIONS:

A. Definitions used in this paragraph are not intended to negate the meaning of other terms used in the Contract Documents, including such terms as "systems," "structures," "finishes," "accessories," "furnishings," "special construction," and similar terms. Such terms are self-explanatory and have recognized meanings in the construction industry.

1. "Products": Items purchased for incorporation in the Work, regardless of whether they were specifically purchased for the Project or taken from the previously purchased stock. The term "product" includes the terms "Material," "Equipment," "system," and other terms of similar intent.
2. "Equipment": A product with operational or nonoperational parts, regardless of whether motorized, manually operated, or fixed. Equipment may require service connections such as wiring or piping.
3. "Materials": Products that must be substantially cut, shaped, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form parts of the Work.

1.03 QUALITY ASSURANCE:

A. Equipment and Material Incorporated into the Work:

1. Conform to applicable Specifications, codes, standards, and requirements of regulatory agencies.
2. Furnish products that comply with the requirements of the Contract Documents, undamaged and, unless otherwise indicated, new and unused at the time of installation. Furnish products that are complete with all accessories, trim, finish, safety guards, and other devices and details needed for a complete installation and for the intended use and effect.
    a. Standard Products: Where they are available and comply with Specifications, furnish standard products of types that have been produced and used successfully in similar situations on other projects.
    b. Continued Availability: Where, because of the nature of its application, Owner is likely to need replacement parts or additional amounts of a product at a later date, either for maintenance and repair or replacement, furnish standard products for which the manufacturer has published assurances that the products and its parts are likely to be available to Owner at a later date.
3. Comply with size, make, type, and quality specified, or as specifically approved in writing by Engineer.
4. Manufactured and Fabricated Products:
    a. Design, fabricate, and assemble in accordance with the applicable standard trade, engineering, and shop practices.

b. Manufacture like parts of duplicate units to standard sizes and gages, to be interchangeable.
c. Two or more items of the same kind shall be identical, by the same manufacturer.
d. Equipment and Material shall be suitable for service conditions intended.
e. Equipment capacities, sizes, and dimensions shown or specified shall be adhered to unless variations are specifically approved in writing.

5. Do not use Material or Equipment for any purpose other than that for which it is designed or is specified.

B. Nameplates: Along with required labels and operating data, manufacturer or producer's nameplates, imprints, or trademarks may be placed on surfaces exposed to view.
1. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on accessible surfaces that are not conspicuous.
2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated Equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:
a. Name of product and manufacturer including address (and telephone number).
b. Model and serial number.
c. Capacity.
d. Speed.
e. Ratings.

C. Electronic Equipment Compliance:
1. Contractor warrants that all equipment, devices, items, systems, software, hardware, or firmware furnished shall properly, appropriately, and consistently function and accurately process date and time data (including without limitation: calculating, comparing, and sequencing). This warranty supersedes anything in the Specifications or other Contract Documents which might be construed inconsistently. This warranty is applicable whether the equipment, device, item, system, software, hardware, or firmware is specified with or without reference to a manufacturer's name, make, or model number.

1.04 EQUIPMENT, INSTRUMENT AND VALVE TAGGING:

A. All Equipment, instruments, and valves furnished under this Contract shall be provided with a permanently affixed tag with a tag identification number assigned by Contractor in accordance with the tagging scheme issued by Engineer after Contract Award. Tags shall be stainless steel, 0.040 thick, and, stamped with the identification number. Tags shall be permanently attached to the Equipment, instrument, or valve using 18-gage stainless steel wire prior to shipment.

B. All Equipment, instrument, and valve tagging shall conform to the Owner's standards. All documents provided shall utilize the Owner's tagging scheme to be provided after Contract award.

1.05 PROTECTIVE COATINGS:

A. Unless specified more explicity in the Technical Specification Sections, all manufactured Equipment shall be factory finish painted with a protective coating system suitable for the specified final service conditions and environment at the coal-fired power plant Project Site without any additional field painting for a reasonable design and operating service life of no less than two times the specified warranty period or five years, whichever is more. In addition, the factory finish painting system shall be field paintable without extensive surface preparation work in the event that the manufactured Equipment is to be repainted by others as part of a

Finish Painting Contract or in the future as part of routine plant maintenance repainting. Include with Submittals all factory finish painting information (surface preparation, number of coats, thickness of each coat, general type and manufacturer's product name/number of each coat, topcoat color name/number, and other applicable information) for consideration, evaluation, and Owner's future use.

B. Field Touch-Up Paint: In order to facilitate field touch-up coating of the fabricated steel, manufacturer shall provide touch-up paint materials to be shipped with the Equipment. Quantity shall be adequate to cover approximately 2% of each coating type and color of the Equipment furnished. Manufacturer shall include instructions for touch-up painting that shall be shipped with and stored with the touch-up paint materials. Manufacturer shall prepare touch-up paint adequately for a three-year shelf life. Containers shall be clearly identified by Contract Number, Contract Name, Equipment Name and Tag Number, MSDS information, paint product name and number, and other similar identification information.

1.06 TRANSPORTATION AND HANDLING:

A. Shipment Preparation:
   1. Contractor shall prepare Equipment and Materials for shipment in a manner to facilitate unloading and handling, and to protect against damage or unnecessary exposure in transit and storage. Provisions for protection shall include the following:
      a. Crates or other suitable packaging materials.
      b. Covers and other means to prevent corrosion, moisture damage, mechanical injury, and accumulation of dirt in motors, electrical equipment, and machinery.
      c. Suitable rust-preventive compound on exposed machined surfaces and unpainted iron and steel.
      d. Grease packing or oil lubrication in all bearings and similar items.

B. Marking: Tag or mark each item of Equipment and Material as identified in the delivery schedule or on Submittals and include complete packing lists and bills of material with each shipment. Each piece of every item need not be marked separately provided that all pieces of each item are packed or bundled together and the packages or bundles are properly tagged or marked.

C. Bills of Material: Contractor shall mail bills of material to Engineer (with copy to the Resident Project Representative) prior to delivery of each shipment and shall include bills of material with each shipment.

D. Delivery:
   1. Furnish Engineer and Owner all requirements for unloading and handling of Equipment and Materials upon delivery sufficiently in advance to allow installing contractor sufficient preparation time. Include type and capacity of unloading equipment required as applicable.
   2. Deliver all Equipment and Materials to Point of Delivery by truck.
   3. Deliver Equipment and Materials in an undamaged condition, in original containers or packaging, with identifying labels intact and legible.
   4. Mark partial deliveries of component parts to identify the Equipment or Material, to permit easy accumulation of parts, and to facilitate assembly.

E. Receipt and Unloading:
   1. Deliver all Equipment and Materials to the Point of Delivery complete with packing lists and bills of material. Installing contractor will furnish receipts to shipper upon delivery.

2. Installing contractor will receive, check, unload, inventory, accept, and store all Equipment and Materials delivered to the Point of Delivery in accordance with proper notice. Installing contractor will report any damage to Engineer prior to or during unloading and advise Engineer of any shortage at time of delivery. Engineer will verify such reports and so notify Contractor.

1.07 STORAGE AND PROTECTION:

A. Storage Requirements:

1. Furnish Engineer and Owner all requirements for storage and protection of all Equipment and Materials sufficiently in advance of delivery to allow installing contractor sufficient preparation time.
2. Installing contractor will furnish all facilities needed for storage of Equipment and Materials at the Project Site.
3. Installing contractor will assume responsibility for and protect all Equipment and Materials in accordance with Contractor's recommendations.

PART 2 - PRODUCTS - Specified in applicable Sections.

PART 3 - EXECUTION - NOT APPLICABLE.

END OF SECTION 016001

SECTION 017501 - MANUFACTURER'S FIELD SERVICES

PART 1 - GENERAL

1.01 SUMMARY: This Section includes requirements of manufacturers of Equipment and Materials for services to be performed at the Project Site in regards to erection, start-up, and testing of Equipment.

1.02 SERVICES REQUIRED:

A. Services With Equipment and Materials Furnished Under This Contract:

1. Furnish the services of qualified, competent field representative and necessary assistants for Equipment and Materials furnished under this Contract, as required to perform all manufacturers' Field Services called for in the Specifications. Field representative shall be certified by the manufacturer of the specified product or system as having the necessary knowledge and experience to perform the required functions.
2. Where such service is specified, installing contractor will not perform any Work related to the installation or operation of Equipment or Materials furnished under this Contract without direct observation and guidance of the Supplier's or manufacturer's field personnel unless Engineer concurs otherwise.
3. Contractor shall arrange to have the Supplier's or manufacturer's field personnel perform the following:
   a. Observe the erection, installation, start-up, and testing of Equipment.
   b. Instruct and guide installing contractor in proper procedures.
   c. Supervise the initial start-up, operational check, and any required adjustments of Equipment.
   d. Instruct Owner's designated personnel in proper operation and maintenance of all Equipment and Materials.
4. Contractor shall arrange for field personnel to report to the Site at times designated by Owner, advise Engineer of arrival at the Site, and furnish Engineer a written report covering all Work done at least once each week and when completed.
5. Field representative shall be acceptable to Owner and Engineer and shall not be changed during the installation operations without Owner's consent unless field representative proves unsatisfactory to Contractor.
6. Field representative shall represent Contractor at the Site, and all instructions given to him shall be as binding as if given to Contractor.
7. All Work by installing contractor in connection with the installation of Equipment and Materials shall be subject to approval of the field representative, but the direct responsibility for planning, supervising, and executing the installation Work will remain with installing contractor. Approval or acceptance by Engineer and said field representative will not relieve installing contractor of responsibility for defective Work.
8. All start-up, adjustments, and testing of Equipment will be performed in the presence of Contractor's field representative, unless otherwise agreed, and such operations will be in accordance with Contractor's instructions. No start-up or testing will be undertaken without Contractor's approval.
9. It shall be the duty of Contractor's field representative during the progress of installation, start-up and testing, and such other times as may be required, to instruct Owner's designated personnel in the proper operation and maintenance of the Equipment. Such instruction shall terminate only when both the field representative and Owner are satisfied that the Owner's personnel are properly instructed.

PART 2 - PRODUCTS: Specified in applicable Sections.

PART 3 - EXECUTION

3.01 OPERATION AND TESTING:

A. Duties of the field representative during erection or installation shall include:
   1. Instructing and guiding the installing contractor concerning proper methods and procedures on all technical phases of installation.
   2. Inspecting and indicating approval or disapproval of each phase of the Work as it progresses.
   3. Reporting his observations in writing to the installing contractor, with copies to Owner's Resident Project Representative, at least once each week unless otherwise agreed.
   4. Determining when Equipment is ready for start-up and operational checks.

B. Placing Equipment In Operation:
   1. Installing contractor will place all Equipment and Materials furnished by this Contract (and those furnished by Owner or others under separate contract) into successful operation according to instructions of the Supplier or manufacturer (or field representative), including making of all required adjustments, tests, operation checks, and the following:
      a. Cleaning, sounding, blowing-out, flushing of lubricating oil and water systems and other pipelines.
      b. Lubrication (lubricants supplied by Contractor unless specified to be furnished by Owner or others).
      c. Tests of lubrication system safety interlocks and system performance.
      d. Final alignment checks and measurements made under observation of Owner. Alignment checks shall include opening connections if required to ensure there are no abnormal stresses on Equipment from pipes, ducts, or other attachments. Alignment shall be within tolerances specified by the manufacturer, and measurements shall be recorded and furnished to Engineer and Owner.
      e. Motor rotation checks before connecting couplings.
      f. Inspection of sleeve bearings for adequate contact.
      g. Checking of anchor-bolt tensions, grout, and shims. Anchor bolts shall be tightened with calibrated torque wrenches using care not to over stress bolts.
   2. After "run-in" and acceptance of alignment, major Equipment shall be affixed in place using standard tapered dowels with jack-out nuts at head end to facilitate removal.
   3. All above operations shall be recorded on forms furnished by Engineer.
   4. Provide all necessary field representatives and assistants as part of the Work to accomplish the above operations until such time as individual items, systems, Equipment, or sections of the plant are acceptable for operation by Owner.
   5. Provide field representatives and assistants on continuous basis as required to complete events without interruption once they have been started.
   6. With advice of Contractor, Owner will provide steam, fuel, electricity, and water for placing Equipment in operation, and Owner's operating personnel will assist.

C. Performance Tests:
   1. Equipment and Materials Furnished under this Contract:
      a. Owner will conduct acceptance tests after installation to determine if the Equipment and Materials installed as part of the Work perform in accordance with Contract Documents. Final acceptance of Equipment and Materials will be based on acceptable results of such tests.

b. No tests will be conducted on Equipment or Materials for which manufacturer's Field Service is specified unless manufacturer's field representative is present and agrees that the Equipment and Materials are ready for such test.
c. Contractor will be notified by Owner so that Contractor can have a representative, or manufacturer's representative, present during any tests of Equipment or Materials furnished by this Contract for which manufacturer's Field Services are not specified.
d. The tests will be made as set forth in the Contract Documents unless the interested parties mutually agree upon some other manner of testing.

END OF SECTION 017501

SECTION 017801 - CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 SUMMARY:

A. Definition:

1. "Closeout": is defined to include general requirements near the end of Contract Time, in preparation for installation by others, performance and acceptance testing, final acceptance, final payment, normal termination of Contract, and similar actions evidencing completion of the Work. Specific requirements for individual units of Work are specified in Sections of all divisions following DIVISION 1. Time of closeout is directly related to "Substantial Completion" of the installation or erection contract, and therefore may be either a single time period for the entire Work or a series of time periods for individual units of the Work which have been certified as Substantially Complete at different dates.
2. "Substantial Completion": means the event when (i) erection or installation of the Equipment and Materials furnished by this Contract has been completed by the installing contractor and required Field Services have been furnished, (ii) the Equipment and Materials are operating safely for the purpose of commissioning and startup, (iii) all testing of the Work has been completed and all test data properly evaluated, (iv) the performance guarantees have been met and warranty period started, and (v) Contractor has delivered to Owner all operating instructions, maintenance manuals, and warranties.

B. Related Work Specified Elsewhere:

1. Prerequisites for Final Acceptance and Payment: RUS FORMS.
2. SECTION 013301 - SUBMITTALS.
3. SECTION 017501 – MANUFACTURER'S FIELD SERVICES.

1.02 REQUIREMENTS FOR FINAL PAYMENT:

A. General: Unless otherwise required elsewhere by these Contract Documents, the following shall be furnished to Owner prior to application for final payment.

1. Field Services.
2. Maintenance and operating instructions.
3. Guarantees.
4. Certifications of inspection.
5. "Record Document" Submittals.
6. Other documents as required by Contract Documents.
7. Spare parts.

B. Final Payment: Specified in RUS FORMS.

1.03 PROJECT RECORD DOCUMENTS:

A. General: In addition to documentation required by the Contract Documents, maintain at the Contractor's facilities (and at installation Site) one record copy of:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other Modifications to the Contract.
5. Approved Shop Drawings, product data, and Samples.

B. Recording:

1. Label each document "PROJECT RECORD" in neat, large, printed letters.

2. Record information concurrently with fabrication or Field Services progress.
3. Record Drawings: Legibly mark to record actual construction:
   a. Where Submittals are used for mark-up, record a cross-reference at corresponding location on Drawings.
   b. Field changes of dimension and detail.
   c. Changes made by Change Order or other Modifications. Note related Change Order numbers where applicable.
   d. Details not on original Contract Drawings.
4. Record Specifications and Addenda: Legibly mark each Section to record:
   a. Manufacturer, trade name, catalog number, and Supplier of each product and item of Equipment actually furnished, particularly optional and substitute items.
   b. Changes made by Addendum, Change Order, or other modifications.
   c. Related Submittals.
5. Record Product Data: Maintain one copy of each product data Submittal, and mark-up significant variations in actual Work in comparison with submitted information.
   a. Include both variations in product as delivered to Point of Delivery, and variations from manufacturer's instructions and recommendations for installation.
   b. Give particular attention to concealed products and portions of the Work which cannot otherwise be readily observed. Note related Change Orders and mark-up of record drawings and specifications.
6. Miscellaneous Record Submittals: Refer to other Sections of these Specifications for requirements of miscellaneous record keeping and Submittals in connection with actual performance of the Work.
7. Instruction Books and Operating Manuals: Specified in SECTION 013301.
8. Electronic Documentation:
   a. In addition to paper copies, provide electronic versions of record documents showing "as-constructed" conditions, master field drawing list showing final revisions, instruction books, and operating manuals on CD-ROM in the latest release of AutoCAD.

C. Delivery:
   1. Deliver Record Documents to Owner.
   2. Accompany submittal with transmittal letter in duplicate, containing:
      a. Date.
      b. Contract title and number.
      c. Contractor's name, address, and telephone number.
      d. Number and title of each Record Document.
      e. Signature of Contractor's authorized representative.

1.04 WARRANTIES AND BONDS: Specified in RUS Forms and elsewhere in the Contract Documents.

PART 2 - PRODUCTS - Not Applicable.

PART 3 - EXECUTION - Not Applicable.

END OF SECTION 017801

SECTION 051200 - STEEL

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes fabrication and delivery of the structural steel and other steel or metal items as defined in AISC Manual, Code of Standard Practice.

B. Related Work Specified Elsewhere:

1. SECTION 099000 – PROTECTIVE COATINGS.

1.02 REFERENCES:

A. Applicable Standards:

1. American Institute of Steel Construction (AISC):
   a. Steel Construction Manual.
   b. 303 - Code of Standard Practice for Steel Buildings and Bridges.
2. American Welding Society (AWS):
   a. A4.3 - Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding.
   b. A5.1 - Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   c. A5.4 - Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding.
   d. A5.5 - Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
   e. B4.0 - Standard Methods for Mechanical Testing of Welds.
   f. B5.1 - Specification for the Qualification of Welding Inspectors.
   g. C4.1 - Oxygen Cutting Surface Roughness Gauge and Chart for Criteria Describing Oxygen Cut Surfaces.
   h. C5.4 - Recommended Practices for Stud Welding.
   i. D1.1 - Structural Welding Code - Steel.
   j. D1.6 - Structural Welding Code - Stainless Steel.
   k. QC1 - Standard for AWS Certification of Welding Inspectors.
3. ASTM International:
   a. A1 - Carbon Steel Tee Rails.
   b. A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   c. A36 - Carbon Structural Steel.
   d. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   e. A106 - Seamless Carbon Steel Pipe for High-Temperature Service.
   f. A108 - Steel Bar, Carbon and Alloy, Cold-Finished. i
   g. A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   h. A143 - Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
   i. A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware – AASHTO No.: M232.
   j. A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   k. A193 - Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.

l. A240 – Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
m. A264 - Stainless Chromium-Nickel Steel-Clad Plate,.
n. A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
o. A312 – Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
p. A325 -Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
q. A384 - Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
r. A385 - Providing High-Quality Zinc Coatings (Hot-Dip)
s. A449 - Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
t. A490 - Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
u. A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
v. A563 - Carbon and Alloy Steel Nuts.
w. A572 - High Strength Low-Alloy Columbium-Vanadium Structural Steel,.
x. A588 - High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance - AASHTO No.: M 222.
y. A673 - Sampling Procedure for Impact Testing of Structural Steel.
z. A780 - Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
aa. A786 - Hot-Rolled Carbon Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
bb. A992 - Structural Steel Shapes.
cc. A1011/A1011M - Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
dd. B695 - Coatings of Zinc Mechanically Deposited on Iron and Steel.
ee. C1107 – Packaged, Dry Hydraulic Cement Grout (Nonshrink).
ff. F436 - Hardened Steel Washers.
gg. F593 - Stainless Steel Bolts, Hex Cap Screws, and Studs.
hh. F594 - Stainless Steel Nuts.
ii. F959 - Compressible-Washer-Type Direct Tension Indicator for Use with Structural Fasteners.
jj. F1554 - Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
kk. F2329 - Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

4. The National Association of Architectural Metal Manufacturers (NAAMM):
   a. MBG 531 - Metal Bar Grating Manual.
   b. MBG 532 - Heavy Duty Metal Bar Grating Manual.
   c. MBG 533 - Welding Specifications for Fabrication of Steel, Aluminum and Stainless Steel Bar Grating.
5. Research Council on Structural Connections (RCSC):
   a. Specification for Structural Joints Using High-Strength Bolts.
6. Society for Protective Coatings (SSPC) Surface Preparation Specifications:
   a. SP1 - Solvent Cleaning.
   b. SP3 - Power Tool Cleaning.

c. SP5 - White Metal Blast Cleaning.
d. SP6 - Commercial Blast Cleaning.
e. SP10 - Near-White Blast Cleaning.
f. SP11 - Power Tool Cleaning to Bare Metal.

7. Occupational Safety and Health Administration (OSHA) - All applicable OSHA regulations, including, but not limited to 29 CFR Part 1910 and Part 1926 Subpart R - Steel Erection.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 1.
B. Includes, but not limited to, the following:
1. Fabrication and erection drawings for all Work.
2. Fabrication and erection drawings shall be grouped in sets or sequences and shall be identified separately for each building, structure, or area.
3. In the event that drawing revisions are necessary, fabrication and erection drawings shall be clearly clouded showing all changes from the previous revision.
4. All necessary information for the fabrication, including connection material specifications and sizes as well as filler metal for welds, of the component part of the structure, presented on drawings to conform to recognized standard practice, AISC Manual and AWS Code.
5. Drawings showing each piece including anchor bolts marked for identification to correspond to erection drawings.
6. Proposed method and location for erection piece mark numbering.
7. Manufacturer's literature on products including, but not limited to, grating, stair treads, stair nosings, grout, concrete anchors, and protective coatings.
8. AWS Certified Welding Inspector Certificates.
9. Welder qualification records.
10. Qualified welding procedure specifications and procedure qualification test results if welding processes differ from those prequalified by AWS.
11. Design Information:
a. The Contractor shall furnish load data for each column or interface point to foundations for each load condition. The load data shall be broken down into components due to each individual load applied to the structure; i.e. dead load, live load, seismic, wind, snow, thermal expansion, internal pressure, ash, etc., at each column baseplate or connection point. In addition-If required by equipment supplier, provide both the maximum and minimum vertical values and the horizontal forces for each loading condition, which must be considered simultaneously. Direction or sensibility of each load shall be graphically defined. The load data shall be presented in such a manner as to clearly show which loads occur simultaneously at the various columns or support locations. Loads submitted shall be service loads only, without a safety factor or overstress factor applied. These drawings shall in addition include size of column base plates, anchor bolt requirements such as quantity, spacing, diameter, projection length, sleeve requirements, shear key dimensions, and any other data required for foundation design.
b. Drawings shall show details of all points where connections external to the equipment must be made, including ductwork connections.
c. Drawing shall show layout and details as required for all access platforms, stairs, ladders and handrails.

C. Mill Tests:
   1. Perform for each melt of material used in the fabrication.
   2. Furnish two copies of each certified mill test to Owner upon request.

D. High-Strength Connection Bolt and Nut Manufacturer's Inspections Certificate:
   1. Certify that bolts, nuts, and washers furnished comply with all of the requirements of these Specifications, and shall provide complete manufacturer's mill test reports (Manufacturer's Inspections Certificate).
   2. Certificate numbers shall appear on the product containers and correspond to the identification numbers on the mill test reports.
   3. Manufacturer's symbol and grade markings shall appear on all bolts and nuts.

1.04 QUALITY ASSURANCE:

A. Each piece of mill material shall be legibly marked with the heat number, size of section, length, and mill identification marks in accordance with ASTM A6 plus the fabrication mill order number. Alternate material tracking procedures may be used when approved by Engineer.

B. For material other than ASTM A36/A36M, the appropriate specification number, grade, heat number and fabrication mill order number shall be transferred to the remnant.

C. Mill material with specified minimum yield strength higher than 36 ksi (250 MPa) shall be marked with the color designated in ASTM A6/A6M. Alternate material tracking procedures may be used if approved by the Owner.

D. Welder Qualifications:
   1. Welders shall be previously qualified by passing the tests prescribed in the AWS D1.1 or by passing such other tests as Engineer may accept. Welders of stainless steel shall be previously qualified in accordance with AWS D1.6.
   2. Welders shall have been tested within the past 12 months, and their qualification shall be considered as remaining in effect unless the welder is not engaged in a given process of welding for a period exceeding 6 months.

E. Inspection: Material or workmanship may be subject to inspection in the shop. Engineer and Owner shall have unrestricted entry to fabrication facilities at all times while Work is being performed.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Handle and store all steel and appurtenances as specified in DIVISION 1.

B. Deliver steel in the order needed for erection as follows:
   1. Loose base plates.
   2. Steel embedded in concrete.
   3. Erection bolts.
   4. First tier columns and framing for all its levels (including stairs, ladders, and guardrail).
   5. Columns and framing for remaining tiers in order.

C. Handle and store all steel and appurtenances as specified in DIVISION 1.

D. Trucks shall be loaded and cribbed so they can be readily unloaded.

E. All steel and its coatings shall be protected from damage caused by handling, storage, and shipping.

F. All materials and documentation shall be inspected immediately upon receipt at the erection site to determine that all items in the bill of material have been supplied, to assure that all documentation has been received, and to check for any damage.

G. Store all steel and appurtenances blocked-up off the ground and in orderly stacks.

H. Protect all items with shop applied protective coatings from corrosion. Store in an environment and manner consistent with type of coating.

PART 2 - PRODUCTS

2.01 BASIC MATERIALS:

A. Steel: Conform to the following unless otherwise indicated or specified.
   1. Wide flange (WF) shapes and tees cut from WF: ASTM A992 (50 ksi yield strength) or ASTM A572, Grade 50.
   2. M shapes, S shapes, HP (bearing piles), channels, and angles: ASTM A36.
   3. Structural plates and bars: ASTM A36.

B. Corrosion-Resistant Steel: Conform to ASTM A588, Grade 50.

C. Stainless or Heat-Resisting Chromium-Nickel Steel: Conform to ASTM A167 and A240.

D. Connection Bolts, Nuts, Washers, and Compressible Washer-Type, Direct Tension Indicators:
   1. Conform to ASTM A325, Type 1, unless otherwise indicated or specified.
   2. Be galvanized when connecting galvanized steel.
   3. Conform to A325, Type 3, for use with A588, Grade 50.
   4. Compressible Washer-Type, Direct-Tension Indicators:
      a. ASTM F959 Type 325 for use with A325 bolts.
      b. ASTM F959 Type 490 for use with A490 bolts.
      c. Galvanized for use with galvanized bolts.
   5. Nuts: Heavy Hex conforming to ASTM A563 Grade DH.
   6. Flat and beveled washers: Conform to ASTM F436.

E. Anchor Bolts:
   1. Conform to ASTM F1554, Grade 36, unless otherwise indicated to be stainless steel or high strength.
   2. Machine Bolts: Conform to ASTM F1554, Grade 36.
   3. Stainless Steel: Conform to ASTM F593, Type 304, with nuts conforming to ASTM F594. Sleeves shall conform to ASTM A312.
   4. High Strength: Conform to ASTM A449 with nuts conforming to ASTM A563.
   5. Washers:
      a. For ASTM F1554 and A449 Bolts: Conform to F436.
      b. For Stainless Steel Bolts: Conform to ASTM A167, Type 304, and dimensional tolerances of F436.
   6. Galvanize all anchor bolts, nuts, and washers except stainless steel.

F. Pipe for Structural Uses, Guardrail, and Handrail: Conform to ASTM A53, Type E or S, Grade B, or ASTM A106, Grade B.

G. Square and Rectangular Tubing Hollow Structural Sections (HSS): Conform to ASTM A500, Grade B.

H. Grating:
   1. Main Bars: Conform to ASTM A1011, Commercial Steel (Type B).
   2. Cross Bars: Same as main bars.

I. Checkered Plate: Conform to ASTM A786 with A36 material and with deformations of the 4-way type.

J. Threaded Rods: Conform to ASTM A36.

K. Welding:
   1. For ASTM A36 steel, use E70 electrodes for shielded metal arc welding, F7 series electrodes for submerged arc welding, E70T series electrodes for flux-cored arc welding, and ER70S series electrodes for gas metal arc welding. Select "matching" electrodes in accordance with Table 3.1 AWS D1.1.
   2. For ASTM A588 steel, use E70 low-hydrogen electrodes for shielded metal arc welding, F7 series electrodes for submerged arc welding, E70T series electrodes for flux-cored arc welding, and ER70S series electrodes for gas metal arc welding. Select "matching" electrodes in accordance with Tables 3.1 and 3.3, AWS D1.1
   3. For ASTM A572, Grade 50 steel or ASTM A992 steel, use E70 low-hydrogen electrodes for shielded metal arc welding, F7 series electrodes for submerged arc welding, E70T series electrodes for flux-cored arc welding, and ER70S series electrodes for gas metal arc welding. Select "matching" electrodes in accordance with Table 3.1, AWS D1.1.
   4. For ASTM A167 or ASTM A312 stainless steel, use shielded metal arc welding, gas metal arc welding, gas tungsten arc welding, or flux-cored arc welding. Select "matching" electrodes in accordance with Table 3.3 of AWS D1.6.

L. Galvanizing:
   1. Conform to ASTM A123.
   2. Nuts, bolts, and washers shall be hot-dip galvanized to conform to ASTM F2329 or mechanically galvanized to conform to ASTM B695.

2.02 STEEL FABRICATION:

A. Fabricate all steel to conform to AISC Code of Standard Practice for Structural Steel Buildings and Bridges, AISC 360, and applicable portions of OSHA 29 CFR Part 1910 and Part 1926.

B. Permissible variations for sweep, camber, length, and cross section of all steel members shall conform to ASTM A6, AISC Manual, Part 1 and AISC Code of Standard Practice unless indicated otherwise.

C. Field-measure existing steel and structures where necessary to ensure fabrication fit-up of new steel.

D. All pieces shall be clearly marked with a permanent identifying erection mark number. Method and location of marking shall be approved by Engineer. Erection markings for galvanized steel shall be mechanically stamped on steel tags with 1/8" minimum thickness. Tags shall be bent to provide clearance for galvanizing between the member and the tag, except at the tag ends. Tag ends shall be welded to the member

E. Fabricator shall mark all shear connector locations (if field-applied) for composite beams by means of center punch and paint circle or other approved means so that field layout of shear connectors is not required. Do not paint shear connector contact surface.

F. Provide grout holes in base plates having the least dimension greater than 24 inches. Holes shall be as close to center as practicable and minimum of 2 inches in diameter.

G. Structural steel components, such as, but not limited to, the stair tower, platforms, pipe rack, and piping support steel, shall be fabricated and delivered in as large of sections as possible for shipment to facilitate ease of installation by others.

H. The stair tower support legs shall be fabricated from wide flange (WF) shapes. Galvanized serrated stair treads and grating shall be used on the stair tower.

I. Shop Milling:
   1. Perform at the base of columns and at the top of column base plates, except that rolled-steel bearing plates of 4-inch thickness or less may be straightened by pressing.
   2. Perform on butted ends for bolted or partial penetration-welded column splices. Shop milling is not required for welded column splices with full penetration welds.

3. Perform at ends of columns which butt against a plate.

J. Welding:
   1. All welding shall be shielded metal arc, submerged arc, or flux-cored arc, or gas metal arc. For gas metal arc welding, the short-circuiting mode of filler metal transfer is not permitted. Other welding processes may be used provided they are qualified by applicable tests as prescribed in the AWS D1.1 (AWS D1.6 for stainless steel) and approved by Engineer prior to use. For the use of any other welding process, submit a qualified welding procedure specification and the procedure qualification test results. Welding processes shall be approved for use only after receipt of specific written approval from the Engineer.
   2. Conform to AWS Code and AISC Manual.
   3. Perform fabrication welding inspection in accordance with AWS D1.1. (AWS D1.6 for stainless steel). This welding inspection shall be performed by AWS Certified Welding Inspector(s) (CWI). All such Certified Welding Inspectors shall be qualified and certified in accordance with the provisions of AWS QC1. Only individuals so qualified shall be authorized to perform fabrication/erection or verification inspection of the welding performed under the provisions of AWS D1.1 (AWS D1.6 for stainless steel) and these Contract Documents. Certifications verifying the qualifications of welding inspectors shall be submitted prior to commencement of structural welding operations or prior to welding inspection performed by an individual welding inspector. Defective welds shall be corrected.

K. Shop Connections:
   1. Weld or bolt except when otherwise indicated or specified.
   2. Shop portions of connections may be welded equivalent to any bolted connection specified if Engineer concurs.
   3. Welded connections shall be as indicated or in accordance with acceptable alternative designs:
      a. Welds of connection angles to beam webs shall conform to AISC Manual, Part 10, Table 10-2 with particular regard for minimum web thickness. Provide longer connection angles or reinforce web as required.
      b. All butt-joint groove welds shall be complete penetration welds unless otherwise indicated and shall conform to the applicable standards in AISC Manual, Part 8, with special emphasis on maintaining root opening. Accomplish this for single-bevel, butt-joint welds by using backup plates or by chipping out and welding on the opposite side.
      c. Prepare weld bevels with a mechanically guided cutting torch or by grinding.
      d. Remove all run-out tabs.
   4. Bolted connections shall conform to AISC Manual, Parts 9 and 10.
      a. All bolted connections shall be made using 3/4-inch or larger bolts, nuts, and washers unless otherwise indicated or specified.
      b. Slip-Critial Type Connections: Capacity of beam connections shall have a minimum capacity of that specified in AISC Manual, Part 10, Table 10-1 for "Oversize and Short-Slotted Holes" in slip-critical connections with the number of bolt rows indicated. Hardened washers shall be provided under all bolt heads and/or nuts adjacent to any ply with oversized or short slotted holes.
      c. Bearing Type Connections: Capacity of beam connections shall have a minimum capacity of that specified in AISC Manual, Part 10, Table 10.1 for "Standard Holes" in bearing type connections (thread condition N) with the number of bolt rows indicated. A minimum of one hardened washer shall be supplied with each bolt.

d. Use the minimum number of rows of bolts for beam connections so that bottom row is at or below the centerline of the beam.

L. Provisions for Field Connections:
1. Furnish with bolted connections unless otherwise indicated or specified. The number of rows and number of bolts indicated on the Drawings or stated in the Specifications is the minimum number of rows or bolts. Furnish additional bolts or connection devices, if necessary, to comply with OSHA regulation 29 CFR 1926, Subpart R - Steel Erection.
2. Furnish for field welding only when so indicated or where approved by Engineer.
3. Furnish all members to be field-welded with bolted erection connections adequate to resist erection stresses prior to field welding.
4. Quantity of bolts, nuts, washers, and compressible washer-type direct-tension indicators furnished by this Contract for erection by others shall be 110% of the number indicated or specified for each length of bolt.

M. Comply with OSHA 29 CFR 1926, Subpart R - Steel Erection.

2.03 GUARDRAIL AND HANDRAIL:

A. Pipe: 1-1/2-inch nominal (1.9-inch od) round, black standard-weight pipe.
B. Post spacing shall not exceed 6 feet from center-to-center.
C. Form and weld all pipe railing. Grind all welds smooth and even with the surface of the pipe, including field welds required for erection.
D. Carefully form all pipe railing where change of direction or elevation occurs.
E. Guardrail posts shall be vertical (plumb).

2.04 KICK PLATES:

A. Furnish at the edge of uncovered openings and at the edge of walkways and platforms, except as otherwise indicated.

2.05 STEEL FLOOR GRATING:

A. One-piece, resistance-welded, carbon-steel construction without notching of bearing or cross bars before welding and conforming to NAAMM MBG 531 or 532.
B. Main Bearing Bars:
1. Thickness: 3/16-inch; 3/8-inch for heavy duty grating.
2. Depth: 1-1/4-inch minimum.
3. Spacing: Not more than 1-3/16 inches on center; 1-3/8 inches on center for heavy duty grating.
4. Configuration of top surface of main bars:
a. Exterior - Exposed to Weather: Serrated.
b. Interior - Not Exposed to Weather: Plain.

C. Cross Bars:
1. Spacing: 4 inches oc.
2. One of the following shapes and minimum sizes:
a. Hexagon: 5/16-inch diameter of inscribed circle; 7/16-inch for heavy duty grating.
b. Rectangular: 1/2" x 3/16"; 5/8" x 1/4" for heavy duty grating.
c. Square: 1/4-inch with spiral twist; 1/2-inch for heavy duty grating.
d. Round: 3/8-inch diameter, 1/2-inch for heavy duty grating.

D. Fabrication:
1. Fabrication shall conform to NAAMM MBG 531; MBG 532 for heavy duty grating, and MBG 533.

2. Crossbars shall match crossbars of adjacent sections to form a continuous pattern of straight lines.
3. Furnish all openings in grating indicated and as required for installation of all piping, wiring, and equipment installed under this Contract.
4. Band all openings 4 inches and larger with a metal bar same size as main bearing bar and extend 4 inches above top of grating. Band bars shall be same depth as bearing bars. Weld to each bearing bar with a 3/16-inch fillet weld 3/4 inch long. Tack weld to all crossbars.
5. Trim-band all locations as follows:
   a. Open end of grating at head of a ladder.
   b. Manway opening.
   c. Hinged sections.
   d. Grating panels with four crossbars or less.
   e. Other locations as indicated.
6. Furnish kickplates and all handrail on floors or platforms 4 foot or more above adjacent floors or ground where persons can pass or machinery is located.

E. Shop Finish:
1. Hot-dip galvanize after fabrication.

F. Grating shall be manufactured by one of the following:
1. Reference Appendix 011101-B.

G. Provisions for Grating Connections:
1. Furnish sufficient quanitity of grating connecting devices to have two fasteners at each support plus 10% extra fasteners.
2. Clip-type connections using mechanical beam clamps:
   a. Hilti X MGR Grating Fastening System.
   b. Grating Fasteners, Inc. G-Clips.
   c. Lindapter North America Grate-Fast.
3. Finish of grating fasteners shall match finish of grating.

2.06 STAIRS:

A. General Construction:
1. Cross-brace stringers to provide lateral stability where the horizontal run exceeds 12 feet.
2. Furnish struts and hangers where required for proper support.

B. Treads:
1. Open-riser type with grating conforming to PART 2 - STEEL FLOOR GRATING, this Section, and of the same type as specified herein, with main bars 1" x 3/16".
2. Treads damaged during construction shall be replaced immediately.
3. Nosings for grating stair treads shall be:
   a. Standard checkered-plate nosing.
   b. Shop Finish: Galvanized.
4. Bolt tread to each stringer with a minimum of two 3/8-inch bolts.

C. Grating Landings:
1. Landings shall be of grating conforming to PART 2 - STEEL FLOOR GRATING, this Section.

2.07 CHECKERED PLATE:

A. Plate shall be of thickness indicated with surface deformations of the 4-way type.
B. Fasten in place with screws spaced at 18 inches with a minimum of one at each corner of each piece or as otherwise indicated.

C. Screws shall be 1/4-inch countersunk stainless steel.

2.08 CONCRETE ANCHORS:

A. At locations where embedded anchor bolts are not indicated or required, furnish manually expanded and adhesive anchor types.
B. Furnish sizes indicated to conform to manufacturer's printed instructions.
C. Anchors shall be manufactured by one of the following:
   1. Hilti Inc., Tulsa, Oklahoma.
   2. ITW Ramset/Red Head, Wood Dale, Illinois.
   3. Simpson Strong-Tie Co., Pleasanton, California.
D. Concrete anchors that are not specifically indicated to be high strength steel or stainless steel shall be carbon steel with surface plating or galvanizing in accordance with manufacturer's standard.
E. Anchors indicated to be high strength steel anchors shall be surface plated or galvanized in accordance with manufacturer's standard.
F. Anchors indicated to be stainless steel shall be manufactured from 300 series stainless steel per the manufacturer's standard unless specifically indicated to conform to Type 304, 316.

2.09 SHOP-PROTECTIVE COATING:

A. All steel not indicated to be hot-dipped galvanized or stainless steel shall receive a protective coating system.
B. Prepare surface and apply all coats of protective coatings as specified in SECTION 099000.
C. Apply all coats in shop to all steel including connections, except for the following surfaces:
   1. Where encased in concrete.
   2. Within 3 inches adjacent to field welds.
   3. On faying surfaces of bolted connections when using alkyd primer.

2.10 GALVANIZING:

A. General:
   1. Galvanize all steel indicated to be galvanized after fabrication.
   2. Do not galvanize ASTM A490 bolts.
   3. Conform to ASTM A123 for structural shapes and plates.
   4. Nuts, bolts, and washers shall be hot-dip galvanized to conform to ASTM F2329 or mechanically galvanized to conform to ASTM B695.
B. Fabrication:
   1. Safeguard against embrittlement in accordance with ASTM A143.
   2. Safeguard against warping and distortion in accordance with ASTM A384.
   3. Fabrication details shall be in accordance with ASTM A385 to allow for the creation of high quality zinc coatings.
   4. Cutting, drilling, and welding shall be performed before galvanizing.
   5. Weld slag shall be removed before galvanizing.
   6. Edges of tightly contacting surfaces shall be seal welded using minimum 1/8 inch fillet welds.
   7. Vent holes shall be provided for piping or tubular assemblies (including guardrail and handrail) as required by ASTM A385.
   8. Potential issues which could cause a problem in galvanizing shall be brought to the Owner's attention prior to galvanizing.
C. Galvanizing of Steel Hardware:
   1. Nuts shall be tapped oversize in accordance with ASTM A563.

2. Nut threads shall be re-tapped after hot-dip galvanizing to provide proper fit.
3. Direct tension indicators shall be mechanically galvanized by the manufacturer in accordance with Class 50 of ASTM B695.

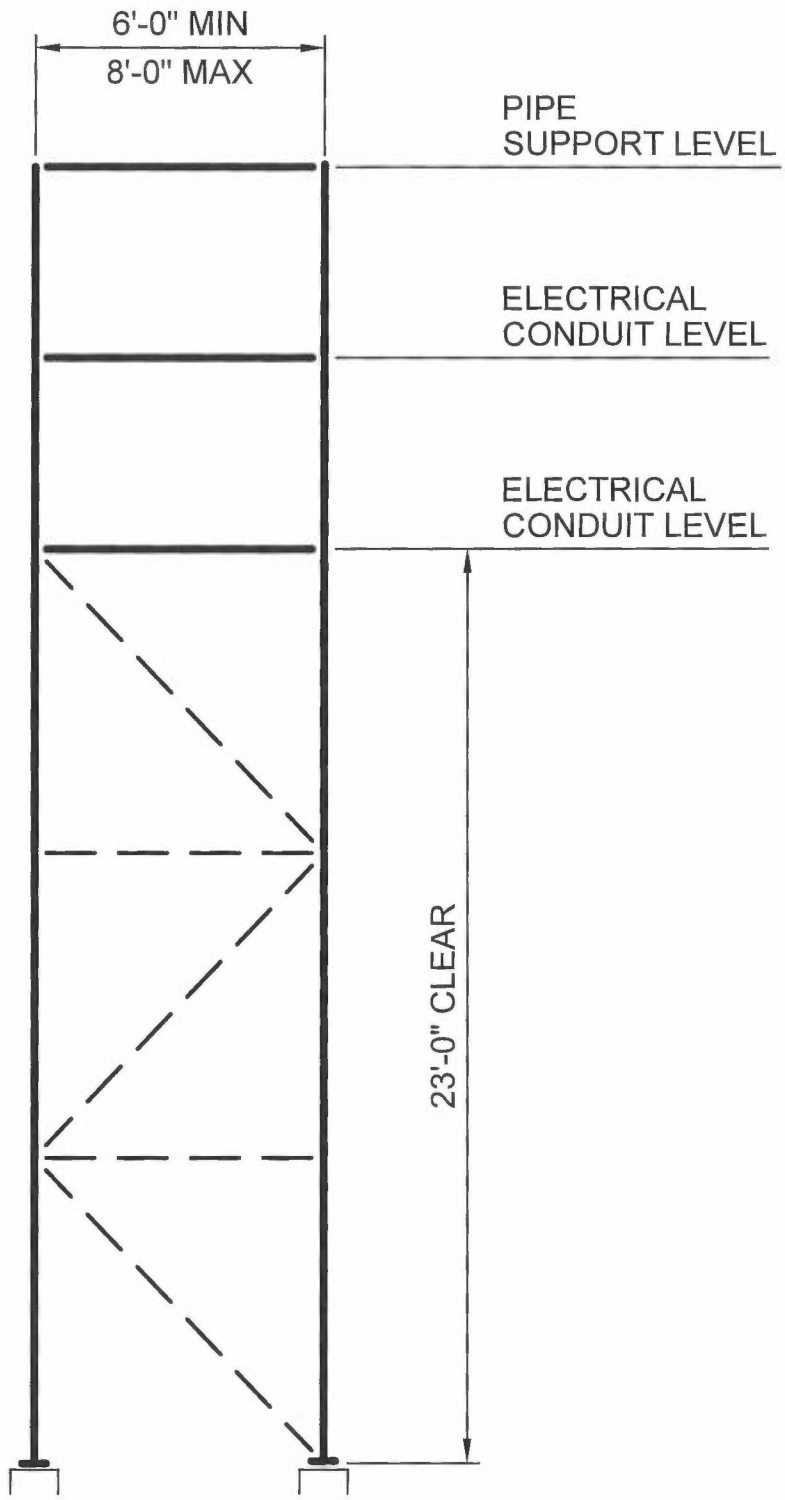
D. Repair:
1. Any damage to galvanizing shall be repaired in accordance with ASTM A780.
2. Before repair of damaged galvanized coating, exposed substrate metal shall be cleaned to bright metal and free of all visual rust, oil, or grease. Any nonadhering galvanizing shall be removed to the extent that the surrounding galvanizing is integral and adherent.
3. If surface defects exceed 2% of a member's area, the defects shall be repaired by redipping the member in the zinc bath.
4. Cold repair using an organic zinc rich coating shall be permitted if the following conditions exist:
   a. Total damaged area is less than 1% of the total coated area of the member being repaired
   b. No single repair is greater than 2 square inches (1300 mm^2)
   c. No single repair is greater than 12 inches (300 mm) long.
5. For cold repair:
   a. Repair areas in accordance with ASTM A780, Method A2.
   b. Apply organic zinc-rich primer containing a minimum of 93% zinc in dry film by weight. Apply in multiple coats (allowing proper recoat time) to achieve 8 mils dry film thickness.
   c. Color shall approximately match the color of galvanizing.
   d. Cold galvanizing compound shall be one of the following:
      (1) Crown North American Professional Products Co. Inc. - Cold galvanizing compound.
      (2) Sentry Chemical Company - Galvonic.
      (3) Subox, Division of Carboline - Galvanox Type II.
      (4) ZRC Worldwide - Cold Galvanizing Compound.
6. Hot repairs shall be made in the shop if any of the following conditions exist:
   a. Total damaged area is greater than 1% but less than 2% of the total coated area of the member being repaired
   b. Any single repair is at least 2 square inches (1300 mm^2) in area
   c. Any single repair is 12 inches (300 mm) long or more
7. Hot repair shall be made using zinc alloy rod or powder manufactured for the repair of galvanized steel.
8. Flux, heavy ash, or heavy dross inclusions shall be removed by brushing, grinding, or filing as required.
9. Galvanized steel which has been rejected shall be stripped, regalvanized, and submitted again for inspection.
10. Correction of excessive warpage that exceeds ASTM A6/A6M criteria shall be performed by press straightening if possible.
11. The application of localized heating to straighten shall be approved by Owner.
12. If galvanized tension control bolts are used, all bare steel surfaces (i.e., bolt ends) shall be repair galvanized in accordance with this Section.

PART 3 - EXECUTION – Not Applicable

END OF SECTION 051200

NOTES:

1. PIPE RACK SHALL BE DESIGNED AND FURNISHED BY CONTRACTOR.
2. FURNISH AND DELIVER FULLY SHOP ASSEMBLED BENT TO THE GREATEST EXTENT POSSIBLE BY SHIPPING.
3. FOUNDATIONS WILL BE PROVIDED BY OTHERS.
4. CONTRACTOR SHALL POSITION BENTS AND FOUNDATIONS TO AVOID BELOW GRADE OBSTRUCTIONS AND THE ACCESS ROAD.



ELEVATION

Burns & McDonnell SINCE 1898

date AUGUST 7, 2013

designed S. RICHART

TYPICAL PIPE RACK BENT

project 73827

contract 1340

EX-001

SECTION 099000 - PROTECTIVE COATINGS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes coating of exterior and interior surfaces throughout the Project and which are listed in PART 2, with systems specified on "coating system" sheets at the end of this Section.

B. Coating systems include surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and equipment. Shop preparation, prime coat, and finish coats to be shop-applied, may be specified elsewhere or referenced to this Section so that a complete system is specified and coordinated.

1. Where surface preparation and first (prime) coat are specified in other Sections to be shop-applied, such as for structural steel, hollow metal doors or equipment, only the touch-up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat regardless if done in shop or field.
2. If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.
3. Concealed surfaces are generally not required to have finish-coats unless otherwise specified, but prime coat should be applied and touched up prior to concealment.
4. Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop-applied.

C. Colors:

1. Subject to sample submittal and approval, provide colors as follows.
   a. Steel framing and miscellaneous metal at interior and exterior: Safety Blue.
   b. Interior and exterior doors: Match siding
   c. Interior and exterior handrails and guards: Safety Yellow.
   d.
   e. Safety colors for danger, caution and other indications required by code or recommended by the Contractor's Engineer or Architect of Record.
2. When first and second coats only are specified and are of same or different types, tint or use an alternate color on first coat to enable visual coverage inspection of the second coat.

1.02 REFERENCES:

A. Applicable Standards:

1. American National Standards Institute (ANSI):
   a. A13.1 - Scheme for the Identification of Piping Systems.
   b. Z53.1 - Safety Color Code for Marking Physical Hazards.
2. American Society for Testing and Materials (ASTM):
   a. D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
   b. D4258 - Surface Cleaning Concrete for Coating.
   c. D4259 - Abrading Concrete.
   d. D4260 - Acid Etching Concrete.
   e. D4261 - Surface Cleaning Concrete Unit Masonry for Coating.
3. Society for Protective Coatings (SSPC) Surface Preparation Specifications:
   a. SP1 - Solvent Cleaning: Removes oil, grease, soil, drawing and cutting compounds, and other soluble contaminants.
   b. SP2 - Hand Tool Cleaning: Remove loose material. Not intended to remove adherent mill scale, rust, and paint.

c. SP3 - Power Tool Cleaning: Removes loose material. Not intended to remove all scale or rust.
d. SP5 - White Metal Blast Cleaning: Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.
e. SP6 - Commercial Blast Cleaning: Two-thirds of every nine square inches free of all visible residues; remainder only light discoloration.
f. SP7 - Brush-Off Blast Cleaning: Removes only loose material, remaining surface tight and abraded to give anchor pattern.
g. SP10 - Near-White Blast Cleaning: At least 95% of every nine square inches shall be free of all visible residues.
h. SP11 - Power Tool Cleaning to Bare Metal.
i. SP12 – Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultrahigh Pressure Water Jetting Prior to Recoating.

4. National Sanitation Foundation (NSF):
   a. 61 - Drinking Water Treatment Chemicals - Health Effects.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 1.
B. Includes, but not limited to, the following:
   1. Schedule of products and paint systems to be used. Schedule shall include the following information:
      a. Surfaces for system to be applied.
      b. Surface preparation method and degree of cleanliness.
      c. Product manufacturer, name, and number.
      d. Method of application.
      e. Dry film mil thickness per coat of coating to be applied.
   2. Color charts for selection and acceptance.
   3. Technical and material safety data sheets.
   4. Sample panels, two approximately 4" x 8", of selected colors for the following system(s):
      a. Epoxy topcoat.
      b. Urethane topcoat.
   5. Certification(s) by coating manufacturer(s) that all coatings are suitable for service intended as stated on each coating system sheet. If manufacturer has an equivalent product as that specified, and it is suitable for the intended purpose, Contractor shall submit the recommended product for approval at no increase in cost, and state reasons for substitution.
   6. Contractor shall certify in writing to the Engineer/Architect that applicators have previously applied all the systems in this Specification and have the ability and equipment to prepare the surfaces and apply the coatings correctly.
C. Submittals for industrial maintenance coatings shall be prepared by, or have assistance in preparation of, a corrosion engineer or industrial coatings technical representative of the coating manufacturer.

1.04 QUALITY ASSURANCE:

A. A coating report shall be completed daily by Contractor at each phase of the coating system starting with surface preparation.
B. In the event a problem occurs with coating system, surface preparation, or application, Contractor shall require coating applicator and coating manufacturer's technical representative to promptly investigate the problem and submit results to Engineer/Architect.

C. Specified VOC shall mean unthinned maximum VOC certified by manufacturer. VOC content as a result of thinning shall not exceed that allowed by federal or local environmental regulations.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Delivery of Materials:
   1. Deliver in sealed containers with labels and information legible and intact. Containers shall also have correct labels with required information.
   2. Allow sufficient time for testing if required.

1.06 REGULATORY REQUIREMENTS:

A. In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the U.S. EPA and the local and regional jurisdictions. Notify Engineer/Architect of any coating specified herein that fails to conform to the requirements for the location of the Project or location of application.
B. Lead Content: Use only coatings that are totally lead free.
C. Chromate Content: Do not use coatings containing zinc-chromate or strontium chromate.
D. Asbestos Content: Materials shall not contain asbestos.
E. Mercury Content: Materials shall not contain mercury or mercury compounds.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Proprietary names and product numbers are specified in most systems for material identification from these manufacturers:
   1. Reference Appendix 011101-B

2.02 GENERAL:

A. Materials furnished for each coating system must be compatible to the substrate.

B. When unprimed surfaces are to be coated, entire coating system shall be by the same coating manufacturer to assure compatibility of coatings.
C. When shop-painted surfaces are to be coated, ascertain whether finish materials will be compatible with shop coating. Inform Engineer/Architect of any unsuitable substrate or coating conditions.

2.03 COATING SYSTEMS:

A. Specified on the "Protective Coating System" sheets at the end of this Section.

2.04 SURFACES TO BE COATED:

A. System A-3: Interior and Exterior Steel.
   1. All structural steel.
   2. Miscellaneous metal.
   3. Exterior of Silos.
   4. Items requiring painting include but are not limited to: Beams, columns, bracing, purlins, girts, man doors, coiling doors, door frames, un-insulated ferrous metal pipes and lines, stairs, rails, ladders, balconies, platforms, supports and similar items. Do not paint galvanized steel floor gratings and associated galvanized steel floor plates.
   5. If galvanized steel paints, use System A-3 with manufacturer's recommended preparation and primer.

6. Prior to acceptance of the work, all coating blemished to be prepared and touched up to match the original coating texture, sheen and color.

B. Interior of silos shall be factory lined with a high performance, high-build, reinforced, chemical and abrasion resistant coating system suitable for the intended final service conditions of the contents of each silo.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:

A. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparation specifications listed.
   1. If grease or oils are present, SSPC-SP1 shall precede any other method specified for metal substrates.
   2. Remove surface irregularities such as weld spatter, burrs, or sharp edges prior to specified surface preparation.

B. Depth of profile will be as specified or as recommended by the manufacturer for each system, but in no instance shall it exceed one-third of the total dry film thickness of complete system.

C. Prepare only those areas which will receive the first coat of the system on the same day.
   1. On steel substrates, apply coating before rust bloom forms.

D. For new galvanized steel to be coated, if absence of hexavalent stain inhibitors is not documented, test as described in ASTM D2092, Appendix X2, and remove by one of the methods described therein.

3.02 APPLICATION:

A. Apply coatings in accordance with coating manufacturer's recommendations.

B. Use properly designed brushes, rollers, and spray equipment for all applications.

C. On unprimed surfaces apply first coat of the system the same day as surface preparation.

D. Dry film thickness of each system shall fall within the thickness range indicated, and shall not be less than 20% below the low end of the range, or more than 20% above the high end of the range.

E. Shop and field painting shall remain 3 inches away from unprepared surface of any substrate such as areas to be welded or bolted.

F. Environmental Conditions:
   1. Atmospheric temperature must be 50°F or higher during application, unless otherwise approved by coating manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur within coating recoat cure times.
   2. Wind velocities for exterior applications shall be at a minimum to prevent overspray or fallout and not greater than coating manufacturer's limits.
   3. Relative humidity must be less than 85%. The ambient temperature and the temperature of the surface to be painted must be at least 5°F above the dew point.
   4. Provide adequate ventilation in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Material Safety Data Sheets for the specific coatings being applied.

G. Recoat Time: In the event a coating, such as an epoxy, has exceeded its recoat time limit, prepare the applied coating in accordance with manufacturer's recommendations.

H. Protection:
   1. Cover or otherwise protect surfaces not to be painted. Remove protective materials when appropriate.
   2. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.
   3. Provide cover or shields to prevent surface preparation media and coatings from entering orifices in electrical or mechanical Equipment. Where ventilation systems must be kept

in operation at time of surface preparation, take precautions to shield intakes and exhausts to prevent the materials from entering system or being dispersed.

4. Do not remove or paint over Equipment data plates, code stamps on piping, or UL fire-rating labels.

3.03 INSPECTION:

A. Contractor shall provide and use a wet film gauges to check each application approximately every 15 minutes in order to immediately correct film thickness under or over that specified.

B. Contractor shall provide and use a dry film gauge to check each coat mil (mm) thickness when dry, and the total system mil (mm) thickness when completed.

C. Use holiday or pinhole detector on systems over metal substrates to detect and correct voids when indicated on system sheet.

D. Perform periodic checks on both relative humidity and temperature limits.

E. Check air temperature and temperature of the substrate at regular intervals to be certain surface is 5°F or more above the dew point.

3.04 CLEANING AND REPAIRS:

A. Remove spilled, dripped, or splattered paint from surfaces.

B. Touch up and restore damaged finishes to original condition. This includes surface preparation and application of coatings specified.

END OF SECTION 099000

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PROTECTIVE COATING SYSTEM

System: A-3

SERVICE: Steel – Severe Exposure (Nonimmersion)
Exterior or Interior

Surface Preparation: Shop or Field First Coat: SSPC-SP10 and profile depth 1.5 to 2.5 mils (38 to 63 microns).
Field Touch-Up (of Shop-applied first coat): SSPC-SP11 and profile depth 1.0 to 1.5 mils (25 to 38 microns).

First (Prime) Coat: Shop: Two package inorganic zinc-rich primer with minimum 80% zinc in dry film by weight. Apply at 2.0 to 4.0 mils (50 to 100 microns) dry film thickness.
Field: Touch up with organic zinc-rich primer with minimum 80% zinc in dry film by weight. Apply at 2.0 to 4.0 mils (50 to 100 microns) dry film thickness.

Second Coat: High-Build polyamide epoxy with minimum 65% solids by volume. Apply at 4.0 to 6.0 mils (100 to 150 microns) dry film thickness.

Third Coat (Exterior): High solids aliphatic acrylic polyurethane gloss enamel with minimum 65% solids by volume. Apply at 3.0 to 5.0 mils (75 to 125 microns) dry film thickness.

System Total: Minimum 10.0 mils (250 microns) dry film thickness(Exterior).
Minimum 6.0 mils (150 microns) dry film thickness (Interior).

Volatile Organic Content: Maximum 2.8 lb/gal (340 g/L).

COATING MANUFACTURER	PRODUCT DESIGNATION			
	FIRST COAT	TOUCH UP	SECOND COAT	THIRD COAT
PPG	Dimetcote 9 Series	Amercoat 68HS	Amercoat 385	Amercoat 450H
Carboline	Carbozinc 11Series	Carbozinc 859	Carboguard 893 Series	Carbothane 134HG
Devoe - AkzoNobel	Catha-Coat 304 Series	Catha-Coat 303H	Devran 220	Devthane 379
International	Interzinc 22 Series	Interzinc 52	Intergard 475 HS	Interthane 990 HS
Sherwin-Williams	Zinc Clad II Plus B69VZ12/B69VZ13	Zinc Clad IV B69A8/B69V8	Macropoxy 646 B58-600/B58V600	HS Polyurethane B65-300 Series
Tnemec	Series 90E-92 Tneme-Zinc	Series 90-97 Tneme-Zinc	Series N69 Epoxoline II	Series 1074 Endura-Shield II
Rust-oleum	Submit equivalent products for approval			

DIVISION 13 – POWER CONTROL MODULE

SECTION 133423 – POWER CONTROL MODULE

PART 1 - GENERAL

1.01 SUMMARY:

A. This Specification covers requirements applicable to the Power Control Module. The Power Control Module (PCM) shall be environmentally controlled, and shall consist of a coordinated grouping of electrical power and control equipment. All drawings and other related documents accompanying this specification shall be considered part of this specification.

B. The Contractor shall furnish, install, interconnect and test the Equipment and Materials specified herein, as well as any Equipment specified in any related documents. Major equipment supplied in the PCM by this contract is listed below:

1. Two (2) 480Vac Motor Control Centers with a main breaker as specified in SECTION 262419.
2. Two (2) 480V-120/208Vac transformers.
3. Two (2) 480V-480/277Vac transformers.
4. Two (2) 277/480Vac power panel.
5. Two (2) 120/208Vac power panels.
6. Manual Transfer Switch for compressed air system provided by this Contract.
7. Variable Frequency Drives as required.
8. Lights, light switches and receptacles.
9. HVAC Equipment.
10. Fire Annunciator Panel.
11. Fire Extinguishers.
12. Intercommunication Equipment.
13. Interior cable tray.
14. Conduit and accessories.
15. Contractor shall provide and install all wire and cable interfaces between equipment in the PCM.
16. Support steel as required.
17. Personnel doors, frames and hardware.

C. Site conditions shall be as indicated in SECTION 011101. These conditions shall be considered when sizing and designing Equipment.

D. Related Work Specified Elsewhere:

1. SECTION 260100 – REQUIREMENTS FOR SKID MOUNTED EQUIPMENT.
2. SECTION 262400 – PANELBOARDS, SWITCHBOARDS AND TRANSFORMERS.
3. SECTION 262419 – 480-VOLT MOTOR CONTROL CENTER EQUIPMENT.

1.02 REFERENCES:

A. All Materials, Equipment and labor supplied by Contractor shall be in strict compliance with the statutes, codes and standards listed herein. Where conflicts exist between statutes, codes, and standards, the more stringent requirement shall prevail. Applicable statutes, codes and standards are as listed below:

1. American Institute of Steel Construction (AISC).
2. American Society of Heating, Refrigeration, and Air conditioning Engineers (ASHRAE).
3. American National Standards Institute (ANSI).
4. American Society of Testing and Materials (ASTM).
5. American Welding Society (AWS):

a. D1.1- Structural Welding Code - Steel.
6. Metal Buildings Manufacturers Association (MBMA).
7. National Fire Protection Association (NFPA):
   a. 70-National Electric Code (NEC).
8. National Electrical Manufacturers Association (NEMA).
9. Steel Door Institute (SDI):
   a. 100-Steel Doors and Frames.
10. Underwriters' Laboratories (UL).
11. International Building Code (IBC) 2000.
12. American Society of Civil Engineers (ASCE):
   a. 7-Minimum Design Loads for Buildings and Other Structures.
13. Kentucky Building Code – 2007.
14. Occupational Safety and Health Administration (OSHA).
15. Door and Hardware Institute (DHI):
   a. Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
16. Steel Door Institute (SDI):
   a. 105 - Recommended Erection Instructions for Steel Frames.
   b. 107 - Hardware on Steel Doors (Reinforcement-Application).
   c. 108 - Recommended Selection and Usage Guide for Standard Steel Doors.
   d. 111 Series: 111A-111F - Recommended Details, Steel Doors and Frames.
   e. 112 - Galvanized Standard Steel Doors and Frames.
   f. 117 - Manufacturing Tolerances Standard Steel Doors and Frames.

1.03 QUALITY REQUIREMENTS:

A. The PCM shall be manufactured under an established autonomous quality assurance program.
   1. The PCM manufacturer may be required to submit for approval, any and/or all quality plans, forms, and procedures applicable to the manufacture of the building, if requested.
   2. The PCM manufacturer shall be a Qualified Manufacturer for the Kentucky Industrialized Building System (KIBS) program. The Power Control Module shall be designed and manufactured to meet all requirements of the KIBS program and the Kentucky Building Code.
   3. Notify Engineer two (2) weeks prior to factory tests.
   4. Engineer or Engineer's representative will be present during factory testing of equipment installed in the PCM.
   5. Factory testing requirements are specified in PART 3 of this Section.

1.04 SUBMITTALS:

A. Includes, but not limited to, the following:
   1. General notes and installation details.
   2. Building's plan view including dimensions and weights, and indicating equipment arrangement and all door and penetration locations.
   3. Building's structural base detail.
   4. Recommended foundation and support details.
   5. Building HVAC calculations including heat loss of all equipment to be installed in Building.
   6. Building's elevation view.
   7. Door and Hardware Schedules: For hollow metal doors, frames, and door hardware. Include details of reinforcement and installation requirements.

8. Schematic and wiring diagrams of the complete electrical systems.
9. Panelboard schedules.
10. Bill of material.
11. Lifting details.
12. All drawings, details, bills of materials, and related items, shall be submitted on hard copy, and recordable compact disc (CD) with all drawing files in AutoCAD version 8.0 format, Adobe Acrobat (PDF), or Raster Image (TIF).
13. Welder qualification documents if requested by Engineer.

PART 2 - PRODUCTS

2.01 EQUIPMENT QUALIFICATION:

A. All Equipment and Material designs furnished shall be identical to equipment and material designs having an acceptable history of domestic service for a period of not less than three years at comparable temperature, voltage, and design stress levels.

B. Equipment and Material designs with less than three years of actual service will be considered from established manufacturers, but shall be furnished only if accepted by Engineer prior to award of Contract.

C. Equipment shall be installed and pre-wired to the greatest extent practical in order to minimize field erection.

2.02 MANUFACTURERS:

A. Reference Appendix 011101-B.

2.03 GENERAL ARRANGEMENT

A. The general arrangement, overall building length and width and equipment spacing shall be designed by Contractor, however, shall not exceed the maximum dimensions shown on the general arrangements, which is 25' x 15', without permission from Owner and Engineer.

B. Working space, access aisleways, and means of egress shall comply with NEC, OSHA, and Life Safety Code.

C. Exact equipment sizes shall be determined by this Contract.

D. Exact building height shall be determined by this Contract.

E. All field cables will enter the PCM from the side.

F. The Contractor shall confirm that the equipment layout accommodates the following requirements:
   1. Number of shipping splits is minimized.
   2. Adequate space for equipment ventilation.
   3. Adequate space for personnel and equipment movement.
   4. Adequate space for cable entry.
   5. Adequate space for door swings.
   6. Placement of operator controls and meters between 4' and 6' from the floor.
   7. Ventilation flows are not obstructed.
   8. Floor openings are unobstructed by support beams.
   9. Minimize wiring that crosses shipping splits, if required.
   10. Allow for proper bending radii of cables.
   11. Raceways and ductwork do not obstruct lighting.

G. The Contractor shall determine the maximum height, length and width of the PCM shipping sections that can be safely transported to the site.

2.04 STRUCTURE :

A. The PCM shall be designed and constructed for outdoor use under wind and seismic load conditions per SECTION 011101.

B. PCM Structures shall be designed to rest on concrete slab furnished and installed by others. Attachment locations and mounting details shall be provided as Submittals by this Contract.

C. The building and all components mounted thereon shall be designed for and anchored sufficiently for transportation to the jobsite.

D. Building Construction:

1. Base:
   a. The base frame shall be of all welded, seamless construction utilizing ASTM A36 structural steel members, sized and arranged for proper strength, and able to withstand the stress and loads which will result when lifting the complete factory fabricated and equipped assemblies and other loads as indicated. Welding shall be in accordance with the requirements of AWSD1.1. Welders certified through the 4G position shall perform all welding. Contractor shall be prepared to show welders' certificates.
   b. The base structural members shall not interfere with or obstruct the areas designated for routing of power cables or control wiring.
   c. Deflection during lifting or supporting shall not exceed L/240.
   d. The base shall have removable lifting/jacking devices to facilitate handling and installation. The normal lifting for transportation and installation shall be by means of a crane making a single point lift using suitable rigging.
   e. The base shall have four (4) copper grounding pads located at each corner of the structure. The ground pads shall be mechanically bonded to the base steel and electrically connected with a minimum of #4/0 bare or coated cable or 2" x ¼" bare copper busbar to a 2" x ¼" bare copper busbar perimeter loop located 6" below ceiling inside the PCM. Each ground pad assembly shall include two 3/8"-16 UNC threaded brass studs to permit connection of a NEMA 2-hole cable lug.
   f. Provide structural base with 8- to 10- mil coverage of undercoating.
2. Floor:
   a. The floor loading shall be rated not less than 250 pounds per square foot distributed load.
   b. The PCM floor shall be a minimum of ¼-inch steel plate welded to the perimeter members and to the cross members of the base.
3. Frame:
   a. The entire PCM shall be framed to provide moment resisting welded connections at base to walls, side walls to end walls, and walls to roof, so as to minimize overall deflection, twisting, and elastic instability during lifting and supporting.
   b. All wall openings, such as doors, windows, etc. shall be framed with 3-inch square steel tubing or equivalent.
   c. All frame connections shall be welded.
4. Walls:
   a. The height from floor to ceiling shall be adequate for cable tray and cable tray separation requirements.
   b. The exterior and interior walls shall be 16 gauge paint quality galvanized steel, and shall consist of formed vertical panels.
   c. The nominal thickness of the wall, including the required frame structure shall be 3 inches.

d. Interior walls, supporting panels, and structural, shall be designated so that interior loads of 400 pounds per linear foot of wall length may be attached to the wall without compromising the design wind load.
e. Should damaged exterior wall panels need to be replaced, tubular frame design shall facilitate replacement without disrupting the integrity of the roof and adjoining wall panels or adjacent walls.

5. Roof and Ceiling:
   a. The exterior roof shall be 12 gauge paint quality galvanized steel panels.
   b. The roof design live load shall be 30 PSF.
   c. The roof shall have a pitch design and shall be designed to support interior or exterior loads of 100 pounds per linear foot without compromising the roof load design.
   d. Roof shall be a centerpeak design without any trusses on split buildings and sloped or centerpeak on non-length wise split buildings.
   e. The ceiling shall consist of formed 12 gauge paint quality galvanized steel panels. The ceiling assembly shall be designed to retain the insulation and to provide a smooth ceiling surface.

E. Platform and Stair Construction:
1. The bottom of the PCM will be on a concrete slab 6 inches above grade level.
2. Provide 4 feet minimum wide platforms and stairs as required to access each personnel and equipment access door.
3. Provide 4 feet minimum wide platforms and stairs for all personnel door locations.
4. Provide 4 feet minimum wide platforms and stairs for all equipment access doors. Platforms for equipment access doors shall have stairs at each end.
5. Handrail:
   a. Handrail shall conform to the requirements of the Building Code specified in Section 1.02.
   b. Handrail shall conform to ASTM A53, Type E or S, Grade B or ASTM A106, Grade B.
   c. Handrail posts and rails shall be 1-1/2-inch nominal (1.9-inch od) round, black standard-weight pipe.
   d. Post spacing shall not exceed 6 feet from center-to-center.
   e. Form and weld all handrail. Grind all welds smooth and even with the surface of the pipe, including field welds required for erection.
   f. Hot-dip galvanize after fabrication in accordance with ASTM A123 and ASTM A153.
   g. Handrails within 10 feet of all doors shall be removable to facilitate removal of equipment from PCM.
6. Kick Plates:
   a. Furnish at the edge of uncovered openings and at the edge of walkways and platforms 4 foot or more above adjacent floors or ground where persons can pass or machinery is located.
   b. Hot-dip galvanize after fabrication in accordance with ASTM A123 and ASTM A153.
7. Steel Floor Grating:
   a. One-piece, resistance-welded, carbon-steel construction without notching of bearing or cross bars before welding and conforming to NAAMM MBG 531.

b. Main Bearing Bars:
   (1) Exterior - Exposed to Weather: Serrated.
   (2) Interior - Not Exposed to Weather: Plain.
c. Fabrication shall conform to NAAMM MBG 531 and MBG 533.
d. Hot-dip galvanize after fabrication in accordance with ASTM A123 and ASTM A153.

8. Stairs
   a. Stairs shall conform to the requirements of the Building Code specified in Section 1.02.
   b. Treads:
      (1) Open-riser type with grating as specified herein.
      (2) Nosings for grating stair treads shall be standard checkered-plate nosing.
   c. Stairs shall extend to 1-1/2" above top of concrete. Grout will be used between stairs and concrete. The use of 6" leveling pad is not acceptable.
   d. Hot-dip galvanize after fabrication in accordance with ASTM A123 and ASTM A153.
9. Vertical Supports:
   a. Vertical supports shall extend to 1-1/2" above top of concrete. Grout will be used between stairs and concrete. The use of 6" leveling pad is not acceptable.
10. Hot-dip galvanize after fabrication in accordance with ASTM A123 and ASTM A153.

F. Prior to shipment the open end/sides of each shipping section shall be crated (weatherproofed) for transit to the jobsite. A company recognized and experienced in the trade must perform the crating.

G. Wall Penetrations:
1. All cables entering or leaving the PCM shall be through wall penetrations provided by this Contract.
2. Wall penetrations shall use Roxtec B or G Series transit frames.
3. All Roxtec transition frames shall have blanking plates installed (Roxtec part: DD Cover)
4. All wall penetrations shall be made in the walls prior to bending with the appropriate machinery. No manual cutting of wall penetrations via jigsaw, plasma torch, etc. shall be permitted.
5. Wall penetrations shall be framed openings.

H. All fastening hardware shall be zinc plated or stainless steel. Welding of galvanized steel and rivets shall not be an acceptable method of exterior fastening. Base bolts may be carbon steel Grade 8 zinc dichromate plated.

I. The walls, roof and floor shall be fully insulated, with a minimum of R-18 insulation.
1. The walls, and roof shall be provided with fiberglass batt type insulation or urethane board type insulation.
2. The floor shall be provided with spray type insulation that is fire resistant with a flame spread rating of 25 or less.

2.05 DOORS :

A. Provide a minimum of two (2) - 36 by 84-inch single doors.

B. The doors shall have solid core metal exterior doors that can accommodate a 2500 pound magnetic door latch for securing the door and rim exit type panic hardware and hinge preps for three 4" x 4" hinges per door.

C. Provide a 2 hour fire rated 12" x 12" window in each door with safety glass.

D. The active entry/exit doors shall have a low profile rim exit device, a grip handle style door knob outside trim with cylinder lock in the knob, and a heavy duty reversible door closure with hold/open feature.
E. Provide six (6) sets of keys.
F. Provide a drip shield above each door.
G. Provide removable transom above all interior and exterior single and double doors.
H. Hinged doors shall be provided in the walls to allow access to the rear of 480V switchgear. Each rear access door shall be formed from 11-guage steel, and will be sealed with a continuous neoprene gasket attached to the doorsill. Each access door will be secured by a single handled, 3-point latch system and shall include a door prop, drip shield, and provisions for padlocking. Provide "DANGER, HIGH VOLTAGE, KEEP OUT" warning signs on rear access doors.

2.06 PAINT:

A. The paint used shall be a sever duty paint. The PCM will be located in an environment that will have a corrosive atmosphere at times.
B. The skid shall be sandblasted to remove rust and scale prior to painting. A minimum of 4 mil application of epoxy iron oxide primer shall be provided.
C. The floor shall be provided with a 2-3 mil application of "Red" epoxy iron oxide primer, followed by a 2-3 mil application of ANSI-61 gray epoxy, with a non-skid finish.
D. The exterior and interior of the building shall be provided with a polyester powder coat per manufacturer's standard procedures. The interior shall be painted white. Owner will provide color sample or chip for exterior color. Samples of paint that will be used shall be submitted for Owner review.
E. All coatings shall be in accordance with SECTION 099000.

2.07 HVAC:

A. Provide PCM with an appropriately sized HVAC system. The system shall consider ambient Site conditions, dimensions of PCM, solar heat gain within PCM, and heat generated by equipment within PCM. Selected system shall be designed such that system capacity will maintain an ambient temperature within PCM of between 70°F winter and 77°F summer at design conditions
B. Heating calculations shall assume no electrical load in space and a minimum 2 air changes of infiltration.
C. Provide system with an electronic, automatic changeover thermostat.
D. HVAC units shall be located on end walls.
E. Upon system failure a trouble signal shall be sent to the plant DCS.
F. HVAC units shall be shut down by fire/smoke detector in the event of an emergency.

2.08 LIGHTING AND RECEPTACLES:

A. Furnish all lighting and receptacle distribution equipment as follows:
   1. Contractor shall wire one Unit 1 MCC breaker to a 480-120/208V, 3-phase transformer and then wire the transformer to a 120/208V power panel. Provide 125VAC, 20-ampere, duplex receptacles at each entry door and interior doors and wire to this panel. Provide enough GFCI breakers for all Unit 1 silo receptacles and eyewash stations provided by this Contract.
   2. Contractor shall wire one Unit 2 MCC breaker to a 480-120/208V, 3-phase transformer and then wire the transformer to a 120/208V power panel. Provide enough GFCI breakers for all Unit 2 silo receptacles and eyewash stations provided by this Contract.

3. Contractor shall wire one Unit 1 MCC breaker to a 480-277/480V, 3-phase transformer and wire the transformer to a 277/480V power panel. This Contract shall wire all indoor and outdoor PCM lighting to this panel. Provide enough breakers for all Unit 1 silo lighting provided by this Contract.
4. Contractor shall wire one Unit 2 MCC breaker to a 480-277/480V, 3-phase transformer and wire the transformer to a 277/480V power panel. Provide enough breakers for all Unit 2 silo lighting provided by this Contract.

B. The building shall be provided with dual T8, 32 watt, rapid start, fluorescent lighting fixtures, 277VAC, controlled via three-way wall switches to be located at each entry door. Interior light levels shall be 50 foot candles at 3 feet above the floor and shall be installed to avoid blockage by the cable trays and conduits.
C. Provide outdoor photocell controlled lighting above each door, on each building side, and above each HVAC unit.
D. Exterior lights shall be wall mounted 75-watt, metal halide, suitable for use in wet locations and have automatic dusk to dawn photo control. Exterior lights shall be shielded and focused downward to mitigate light pollution.
E. Provide battery powered exit lights inside the building with red LED lamps, 6-volt battery, 277-volt operation, capable of operating for 180 minutes on battery.
F. Provide battery powered emergency fixtures with 12-watt halogen heads, 6-volt battery, 277-volt operation, capable of operating for 180 minutes on battery.
G. Exit light and battery powered halogen heads may be included as a single combined unit for fixtures located above doorways.
H. Emergency lighting shall meet the minimum requirements in the Life Safety Code (NFPA 101).

2.09 WIRING:

A. All PCM lighting, receptacle, and HVAC wiring shall be single conductor, stranded copper, with THHN/THWN 600V insulation with a minimum size of #12 AWG.
B. Power for lights, receptacles, HVAC and other PCM building services shall be derived from the 480V Motor Control Centers, 120/208V power panels and 277/480V power panels.
C. Wire each VFD to a breaker its respective Unit's MCC.
D. Wire manual transfer switch for compressed air system to a starter in each Unit's MCC.
E. All wiring internal to the PCM shall be installed by this Contract and includes, but is not limited to the following services.
    1. Power cables:
        a. Building services (lighting, receptacles, and HVAC).
        b. Power feeds to 120 VAC receptacles.
    2. Power Cables furnished installed by Others.
        a. A single power feed from the 480V Switchgear to 480V MCCs.
    3. Control cables:
        a. All interconnecting control circuits indicated on the one line diagrams and schematics including circuits for control and protection (switchgear, UPS, HVAC, etc.).
        b. Cabling between 480V switchgear and remote control panel.
    4. Cable shall meet the requirements of the cable specifications attached to SECTION 260100:
        a. BC1—Ground cable.
        b. CEN1—Control cable.
        c. IEN1—Instrument cable.

d. SEN4—600 Volt – Multi-conductor power cable.
e. SW1—SIS wire.

5. Power circuits shall be sized per NEC and #12 AWG minimum. Building HVAC shall not be considered when calculating cable size.
6. Furnish all wiring integral to all Equipment, including wiring across shipping splits, if required.
7. Wire markers shall be stamped to indicate the cable number, schematic number or other designation that will identify the opposite end destination.
8. Make all internal wiring connections at Equipment terminals or terminal blocks; splices in wiring will not be acceptable.

2.10 RACEWAY:

A. A 6" x 6" metal wireway, with hinged or bolted cover shall be provided around the PCM perimeter at the junction of the walls and ceiling. This wireway shall contain all PCM facilities wiring such as lighting, receptacles, and HVAC.
B. Aluminum ladder type cable tray shall be provided as required to maintain cable class separation and shall include 20% spare capacity. Sufficient cable tray shall be provided to support cables installed by this Contract. Buildings having cable tray systems shall be provided with structural steel channel supports in the ceiling. The use of unistrut fastened directly to the ceiling for cable tray support shall be permitted only if the ceiling is properly designed for the load of the cable tray system and cables. The support from the channel supports shall be via all thread and unistrut hangers. Provide double nuts on hanger rods.
C. Rigid galvanized steel conduit shall be utilized for all applications. EMT conduit is not permitted.
D. Size conduits as required by the NEC.
E. Use sealing fitting as required by the NEC.

2.11 GROUNDING:

A. All equipment shall be grounded per NEC.
B. Provide continuous bare copper bus bar for interior perimeter ground located on the upper portion of the PCM walls.
C. Provide bare copper bus bar from interior perimeter ground bus to exterior ground pads located on PCM base.
D. Provide continuous bare copper ground on the exterior of all cable tray and tie to building perimeter ground

2.12 FIRE/HEAT DETECTION:

A. Provide smoke and heat detectors to cover the PCM. Coordinate detectors for compatibility with existing fire protection system.
B. Provide pull stations at each personnel door.
C. Provide annunciator panel for smoke and heat detectors and pull stations to be wired back to Owner's fire system by others. Annunciator shall be Notifier Spartan Fire Panel or equivalent. Annunciator shall have dry contacts to shut down HVAC units upon detection of smoke and heat. Annunciator shall have dry contacts to wire to Owner's fire protection panel.

2.13 FIRE EXTINGUISHERS:

A. Provide four (4) 10 lb. hand portable dry-chemical fire extinguishers.
B. Extinguishers shall be multi-purpose (suitable for type A, B and C fires) and shall be UL approved.

2.14 STORAGE CABINETS AND DESKS

A. Provide the following equipment in each PCM:
   1. One (1) storage cabinet for spare parts and OEM manuals. Cabinet shall be a heavy duty floor standing cabinet.
   2. One (1) storage cabinet for personal protective equipment (PPE). Owner will provide all PPE. Storage cabinet shall be a heavy duty free standing cabinet with a section for hanging clothing.
   3. One (1) industrial workbench for installation in each PCM. Workbench shall be a minimum of 6 feed in length. Workbench top shall be made of wood or metal.

2.15 NAMEPLATES:

A. Phenolic nameplates shall be fabricated from laminate, matte finish, white plastic with black core.
B. Nameplates shall be 1.5" high and 6 inches long for panelboards, transformers, control panels and equipment enclosures.
C. Nameplates shall be 1" x 3" for individual devices such as HVAC equipment and welding receptacles.
D. Engraving:
   1. Gothic style
   2. 3/8-inch-high characters with 45-mil line width on "Master" nameplates.
   3. 3/16-inch-high characters with 30-mil line width on individual device nameplates
   4. Engraving designations shall be approved by Engineer
E. Attach nameplates with a stainless steel mounting screws.
F. Engrave nameplates with equipment tags provided on the Contract drawings. Where tags are not indicated, provide tags on submittal drawings for review and engrave on nameplates.

2.16 INTERCOMMUNICATIONS:

A. Provide and install one (1) handset-speaker station Gai-Tronics model 700-102 consisting of:
   1. Model 701-302 handset/speaker amplifier
   2. Model 702A enclosure
B. Provide one (1) outdoor area type speaker station mounted on the PCM exterior.
   1. Gai-Tronics model 13302-002 horn with U-shaped mounting bracket.
   2. Gai-Tronics model 13314-002 driver.

2.17 MAINTENANCE EQUIPMENT AND SPARE PARTS:

A. Provide a recommended spare parts list with prices with the proposal. Owner will select the spare parts.

PART 3 - EXECUTION

3.01 EQUIPMENT INSTALLATION:

A. Install and ground equipment as required by NEC.
B. Assemble shipping sections together and make up all wiring and bus connections.
C. Level equipment and anchor to the floor.

3.02 RACEWAY INSTALLATION:

A. Install raceway as required by NEC.
B. Install cable tray above MCC's.
C. Flexible conduit shall not exceed 6 feet.

3.03 WIRE INSTALLATION:

A. Install cabinet-to-cabinet wiring as required by NEC and as follows:
   1. Connect all wiring as indicated on approved Suppliers schematics.
   2. Maintain separation between power, control and instrument/communication cables.
   3. Install all cable in tray, conduit or wireway.
   4. Maintain the manufacturer recommended bending radius for all cables.
   5. Provide as-built panel indexes in each power panel.
   6. Analog signal cables shall be left in the cable jacket to within 6" of terminations.

3.04 SHIPPING PREPARATION:

A. Prior to shipment, wiring that crosses a shipping split shall be coiled, tagged, and secured to ensure that the cable is not damaged during shipment and installation. The cable tag shall clearly and unambiguously define the termination location for the cable. A matching tag shall be attached to the termination location.

3.05 TESTING AND INSPECTION:

A. Continuity test of all wiring installed by this Contract.
B. Test cable insulation of all power cables installed by this Contract with a 500 volt megger for one minute.
C. All installed equipment shall be functionally tested in accordance with the specifications.
D. Torque and megger all power panels, MCC bus, and ground bus.
E. The following provisions shall be made by this Contract for the witnessed factory tests.
   1. Allow for up to five (5) people representing the Owner to witness the factory tests.
   2. Allow time for the Owner's representatives to visually inspect the equipment and review reports of completed tests.
   3. Factory testing shall include witnessed functional testing specified in other Sections of the Specification.
   4. Operate all circuit breakers from the remote control panels.
F. The Contractor shall have in place a system of recording, correcting, and verifying resolution of discrepancies discovered during the inspection and testing process.
G. A copy of the discrepancies list shall be provided to the Owner following the factory test.
H. The discrepancies list shall be resubmitted after shipment indicating the status of each item.
I. Test reports shall be available upon request.
J. A final copy of all certified test reports shall be provided in the O&M manuals. Electronic copies shall be provided on a CD with all other final Contract Documents.

3.06 FIELD SERVICES:

A. The PCM will be unloaded, installed, tested and commissioned by others. If requested, the Contractor shall furnish service personnel as required and at the Contractor's published rates included in the Bid Proposal.
B. Bid Price shall include one (1) round trip and five (5) days for the supervision of PCM reassembly. Manufacturer shall add additional days to the bid if more days are required time to perform the specified field services. Pricing shall include all expenses.
   1. Removal of temporary shipping covers.
   2. Mating of building shipping splices.
   3. Roofing and water sealing of shipping splices.
   4. Leveling of the PCM.
   5. Re-termination of cables that cross the shipping splits.
   6. Installation of shipped loose items.

7. Check operation of HVAC units.

C. Field service time charged to the Owner shall not include field services required to correct manufacturing defects.

END OF SECTION 133423

DIVISION 13 – SPECIAL CONSTRUCTION

SECTION 133425 – EQUIPMENT ENCLOSURE

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section covers requirements applicable to the Equipment Enclosure. Enclosure shall be environmentally controlled, contain all necessary and specified equipment, motors, drivers, exhaust systems, piping, electrical power, and lighting. Any Drawings or any other related documents accompanying this Specification shall be considered a part of this Specification.
B. Enclosure shall provide sufficient interior space to house the mechanical equipment, and to provide minimum 3'-0" clear working and maintenance space around the equipment. Working and maintenance space may overlap space required for removal and replacement of the equipment.
C. Structural grid base and floor system shall be designed for applicable floor loading, allowing building to be lifted and transported with interior equipment installed.
D. Furnish, install, interconnect, and test the Equipment and Materials specified herein, as well as any Equipment specified in any related documents.
E. Site conditions shall be as indicated in SECTION 011101 and 011101-A. These conditions shall be considered when sizing and designing Equipment.
F. Design, furnish, and install all pipe supports required for piping supplied by this contract located within the enclosure boundary.
G. Design the enclosure for incoming electrical service required for equipment within the enclosure.

1.02 REFERENCES:

A. All Materials, Equipment, and labor supplied shall be in strict compliance with the statutes, codes, and standards listed herein. Where conflicts exist between statutes, codes, and standards, the more stringent requirement shall prevail. Applicable statutes, codes, and standards are as listed below:
    1. American Institute of Steel Construction (AISC).
        a. Specifications for Structural Steel Buildings.
        b. Specification for the Design of Cold-Formed Steel Structural Members.
    2. American Society of Heating, Refrigeration, and Air conditioning Engineers (ASHRAE).
    3. American National Standards Institute (ANSI).
    4. American Society of Testing and Materials (ASTM).
        a. ASTM A36 - Standard Specification for Carbon Structural Steel.
        b. ASTM A992 - Standard Specification for Structural Steel Shapes.
    5. American Welding Society (AWS):
        a. D1.1- Structural Welding Code - Steel.
    6. Kentucky Building Code (KBC).
        a. 2007 edition.
    7. International Building Code (IBC).
        a. IBC 2009 edition.
    8. Metal Buildings Manufacturers Association (MBMA).
    9. National Fire Protection Association (NFPA):
        a. 13-Standard for Installation of Sprinkler Systems.
        b. 20-Standard for Installation of Stationary Pumps for Fire Protection.
        c. 70-National Electric Code (NEC).

d. 72-National Fire Alarm Code.
e. 101 – Life Safety Code.
10. National Electrical Manufacturers Association (NEMA).
11. Steel Door Institute (SDI):
a. 100-Steel Doors and Frames.
12. Underwriters' Laboratories (UL).
a. Fire Protection Equipment Directory.
13. American Society of Civil Engineers (ASCE):
a. ASCE7-05 Minimum Design Loads for Buildings and Other Structures.
14. Occupational Safety and Health Administration (OSHA).

1.03 QUALITY REQUIREMENTS:

A. Equipment Enclosure shall be manufactured under an established quality assurance program.
1. Enclosure manufacturer shall submit for approval any and/or all quality plans, forms, and procedures applicable to manufacture of Buildings, if requested.
2. Enclosure shall be designed and manufactured to meet the requirements of the
a. 2007 Kentucky Building Code as specified in SECTION 011101 and by reference 2009 International Building Code.
b. Kentucky premanufactured building (KIBS) requirements.
3. Owner or Owner's representative will be present during factory testing of equipment installed in the enclosure.
4. Factory testing requirements are specified in Part 3 of this Section.
5. Enclosure manufacturer shall notify Owner a minimum of two (2) weeks prior to factory test date.

1.04 SUBMITTALS:

A. Submit as specified in SECTION 013301.
B. Includes, but not limited to, the following:
1. General notes and installation and handling details.
2. Enclosure's plan view including dimensions and weights, and indicating equipment arrangement and all door and penetration locations.
3. Enclosure's structural base detail.
4. Recommended foundation and support details.
5. Enclosure's HVAC calculations including heat loss of all equipment to be installed in Enclosure.
6. Outline – Plan View (general arrangement, internal equipment layout, center of gravity, weights, floor opening sizes and locations, recommended pier and tie down locations, mounting details, and door swing requirements).
7. Outline – Elevation View (general arrangement in elevation, recommended pier and tie down locations, wall opening sizes and locations, location of platforms and stairs).
8. Wall Panels including R-value, material properties, attachment and connection details, and manufacturers standard colors.
9. Roof Panels including R-value, material properties, attachment and connection details, and manufacturer's standard colors.
10. Schematic and wiring diagrams of the complete electrical systems.
11. Structural fabrication detail drawings.
12. Panel board schedules.
13. Photos of enclosure lifting at the factory.

14. Bill of material.
15. Lifting details and recommended lifting instructions.
16. Detailed pipe support details for all piping locating within the boundary of the enclosure.
17. Drawings, specifications and calculations signed and sealed by an engineer licensed in the State of Kentucky for permitting approval by the local building authority.
18. Provide AutoCAD file of the drawing(s) enclosure including equipment housed within.

PART 2 - PRODUCTS

2.01 EQUIPMENT QUALIFICATION:

A. All Equipment and Material designs furnished shall be identical to equipment and material designs having an acceptable history of domestic service for a period of not less than three years in comparable service conditions.

B. Equipment and Material designs with less than three years of actual service will be considered from established manufacturers, but shall be furnished only if accepted by Owner prior to award of Contract.

2.02 GENERAL ARRANGEMENT

A. The enclosure size and and equipment layout shall be based on the following:
   1. Enclosure shall house any equipment provided by this Contract which requires indoor installation per Contractor's design. If Contractor's design allows, equipment may also be installed in the silo skirt areas.
   2. Enclosure shall provide working and maintenace space around the equiment and space to facilitate the removal and replacement of the equipment.
   3. Arrange doors and pipe penetrations as required for fitting the equipment and pipe routing constraints.
   4. Building footprint, door swing path, and pipe shall not extend beyond the indicated Equipment Boundary on the general arrangements.
   5. General arrangement of the equipment inside the enclosure shall be coordinated with Owner and Engineer.

B. Working space, access aisle ways, and means of egress shall comply with NEC, OSHA, and NFPA 101 - Life Safety Code.

C. Equipment sizes shall be determined by this Contract.

D. Enclosure height shall be determined by this Contract but shall not be less than 10'-0" high clear. Coordinate clear height with piping layout for equipment. Coordinate height of overall enclosure with space designated to house the enclosure.

E. The Contractor shall confirm that the equipment layout accommodates the following requirements:
   1. Adequate space for equipment pull-out and maintenance.
   2. Minimize the number of shipping splits.
   3. Adequate space for equipment ventilation.
   4. Adequate space for personnel and equipment movement.
   5. Adequate space for door swings.
   6. Placement of operator controls and meters between 4 to 6 feet from the floor.
   7. Floor openings are unobstructed by support beams.
   8. Minimize wiring that crosses shipping splits.
   9. Equipment and components do not obstruct lighting.

F. The Contractor shall determine the maximum height, length and width of the Equipment Enclosure shipping sections that can be safely transported to the Site.

2.03 EQUIPMENT ENCLOSURE:

A. Enclosure shall be designed and constructed for outdoor use under the ambient temperature, wind, and seismic load conditions specified in SECTION 011101.
B. Enclosure and all components mounted thereon shall be designed for and anchored sufficiently for transportation to the jobsite.
C. Enclosure Construction
   1. Base:
      a. The base frame shall be of all welded, seamless construction utilizing ASTM A36, or A992 structural steel members, sized and arranged for proper strength, and able to withstand the stress and loads which will result when lifting the complete factory fabricated and equipped assemblies and other loads as indicated. Welding shall be in accordance with the requirements of AWS D1.1. Welders certified through the 4G position shall perform all welding. Contractor shall be prepared to show welders' certificates.
      b. Deflection during lifting or supporting shall not exceed L/240.
      c. The base shall have removable lifting/jacking devices to facilitate handling and installation. The normal lifting for transportation and installation shall be by means of a crane making a single point lift using suitable rigging.
      d. The base shall have a minimum of four (4) stainless steel grounding pads located at each corner of the structure. The ground pads shall be mechanically bonded to the base steel and electrically connected to a 2" x ¼" bare copper busbar perimeter loop located 6" below ceiling inside the enclosure. Each ground pad assembly shall include two 3/8"-16 UNC threaded brass studs to permit connection of a NEMA 2-hole cable lug.
      e. Provide structural base with an 8-mil to 10-mil coverage of epoxy paint undercoating. Coating thickness shall be accomplished in two coats unless otherwise recommended by the coating manufacturer.
   2. Floor:
      a. Provide equipment bases and structural base that are suitable for a float finished grout floor to be placed within the base frame. The grout floor will be installed in the field by others.
   3. Frame:
      a. The entire enclosure shall be framed to provide moment resisting welded connections at base to walls, side walls to end walls, and walls to roof, so as to minimize overall deflection, twisting, and elastic instability during lifting and supporting.
      b. All wall openings, such as doors, windows, conduit penetrations, etc. shall be framed with 3-inch square steel tubing or equivalent.
      c. All frame connections shall be welded.
   4. Walls:
      a. Exterior walls for enclosure shall be fabricated from factory insulated interlocking panels attached with concealed fasteners. The exterior walls shall be a minimum of 24 gauge prefinished galvanized steel, and shall consist of formed vertical foam insulated panels. Coating system shall be fluoropolymer, Kynar or equal. Panels

shall be insulated with minimum 3-inches of polyisocyanurate insulation. "R" value for the finished wall system shall be 19 minimum.

b. Should damaged exterior wall panels need to be replaced, tubular frame design shall facilitate replacement without disrupting the integrity of the roof and adjoining wall panels or adjacent walls.

c. Enclosure shall include wall openings for connections to all equipment within.

5. Roof and Ceiling:
   a. The roof shall be designed according to the requirements of SECTION 011101.
   b. Roof shall have a 1:12 minimum slope and shall be designed to support the roof structure in accordance with the loading conditions prescribed by the ISBC or IBC, whichever is greater without compromising the roof load design.
   c. Framing of the roof supporting the roof panels shall be galvanized cold formed steel joists to form a center peak. Trusses are not acceptable.
   d. Roof panels will be prefinished factory insulated interlocking panels attached with concealed fasteners. Panels shall be 24 gauge galvanized steel inside and out, prefinished, insulated with minimum 4-inches of polyisocyanurate insualtion. Coating system shall be fluoropolymer, Kynar or equal. "R" value for the finished roof system shall be 20 minimum. Provide rain diverters over door openings.
   e. The roof shall be designed with a 20 psf collateral load to support fire suppression piping and other appurtenances as required.

D. For enclosures that must be shipped in multiple shipping sections, provide miscellaneous NEMA 4X junction boxes at the shipping splits for easy breakdown of the Buildings' wiring for shipment and reconnecting at jobsite. Prior to shipment, open end/sides of each shipping section shall be crated (weatherproofed) for transit to jobsite.

E. Where wall bulkhead penetrations are required, cutouts shall be completely framed with 1/4" aluminum coverplates with neoprene gasket. All wall penetrations shall be made in walls prior to bending with appropriate machinery. No manual cutting of wall penetrations via jigsaw, plasma torch, or similar means will be permitted.

F. All fastening hardware shall be zinc plated or stainless steel. Welding of galvanized steel and rivets shall not be an acceptable method of exterior fastening.

G. Provide flanged connections for all exterior connections where piping is routed to additional equipment and system components. Flanged piping connections shall be between 2 ft and 4 ft above the bottom of the skids.

H. Enclosure shall be provided with an automatic wet pipe sprinkler system if required by NFPA 850, Factory Mutual, the international Fire Code, or the authority having jurisdiction. The sprinkler system shall be in compliance with NFPA 13. The sprinkler system shall have a minimum density of 0.30 gpm/sq. ft. over the entire enclosure area.

I. Enclosure shall include the following additional accessories:
   1. 120V weatherproof utility electrical outlets on each enclosure wall.
   2. Drain piping for equipment as required.
   3. Equipment drains and associated drain piping routed to the perimeter of the enclosure base, ready for field connection by others.
   4. Fire extinguishers will be provided by others.

2.04 DOORS :

A. Provide enclosure with doors adequate for equipment removal with a minimum of one pair 36" x 84" double door.

B. Doors shall be 18 gauge, double wall steel construction, primed for field finishing, with R-11 insulation, reinforced for hardware. Frames shall be 16 gauge steel, fully welded, primed for

field finishing. Knock-down frames are not acceptable. Door hardware shall include three-4"x4" hinges per door leaf, closer, panic device, rim cylinder, flush bolts with dust proof strike, weatherstripping, threshold, and rain drip. Hinges and other exposed metal hardware to be stainless steel. Provide key lockset compatible with adjacent enclosures.

C. Provide six (6) sets of keys.

D. If required to allow installation and removal of equipment, provide removable transom above each personnel door sized for that purpose.

2.05 PAINT:

A. Exterior and interior exposed steel for the enclosure shall be painted using two-coat epoxy coating system.

B. Interior steel to be painted white to match interior wall panels.

2.06 VENTILATION:

A. General:
   1. Indoor maximum temperature shall be maintained at the greater of the following resultant temperatures: ambient temperature plus 10 °F or the equipment temperature limit.
   2. Ventilation fans and intake louvers shall be interlocked with space mounted thermostats.
   3. Ventilation system shall be opertated via on-off-auto selector switch.

B. Ventilation Louver:
   1. Provide weatherproof louver frame and blades of minimum of 14-gage aluminum, in natural mill finish. Louver shall be sized to minimize water infiltration.
   2. Louvers shall be complete with aluminum mesh insect screen.
   3. Ventilation louver shall be motor actuated based on temperature and include spring return for positive close off of dampers.
   4. Ventilation louver shall include a local unit mounted starter.

C. Exhaust fan:
   1. Fan shall consist of shutter, fan assembly, wall sleeve and rear guard.
   2. Motor shall be totally enclosed motor for continuous duty with thermal overload protection built in.
   3. Fan assembly shall include motor actuated weather resistant damper.
   4. Exhaust fan shall include a local unit mounted starter.

2.07 ELECTRICAL:

A. Provide complete electrical system for all equipment in the enclosure in accordance with SECTION 260100. Provide transformers, terminal boxes, power panels, wiring, conduit and other items as required for a complete system.

B. Design the electrical system for one 480 V power feed.

2.08 LIGHTING:

A. The enclosure shall be provided with twin tube, rapid start, fluorescent lighting fixtures, 277VAC, controlled via three-way wall switches to be located at each entry door. Interior light levels shall be 20 foot candles at 3 feet above the floor and shall be installed to avoid blockage by the cable trays.

B. Provide outdoor photocell controlled lighting above each door.

C. Photo-electric controlled lights shall have a local off-auto-manual selector switch to allow lights to be turned on during the day for maintenance.

D. Exterior lights shall be wall mounted 175-watt, metal halide (MH) fixtures with IES Type II or V distribution prismatic glass refractor, suitable for use in wet locations and have automatic

dusk to dawn photo control. Exterior lights shall be shielded and focused downward to mitigate light pollution.

E. Provide battery powered exit lights inside the enclosure with red LED lamps, 6-volt battery, 277-volt operation, capable of operating for 90 minutes on battery.
F. Provide battery powered 12-watt halogen heads, 6-volt battery, 277-volt operation, capable of operating for 90 minutes on battery.
G. Exit light and battery powered halogen heads may be included as a single combined unit.
H. Emergency lighting shall meet minimum requirements in the Life Safety Code (NFPA 101).

2.09 GROUNDING:

A. All equipment shall be grounded per NEC.

PART 3 - EXECUTION

3.01 TESTING AND INSPECTION:

A. The following testing and inspection shall be performed on buildings:
   1. Continuity checks of all wiring installed by this Contract.
   2. Operational check of all Contractor-furnished and installed electrical equipment.
   3. Torqueing and meggering of all power panels and ground buses.
   4. Other tests as specified in each applicable Equipment section included in this Contract.
   5. Tests to certify that equipment shipped from other manufacturing facilities has been properly assembled per manufacturer recommendations.
B. Provide a certified test report.

END OF SECTION 133425

SECTION 260100 – REQUIREMENTS FOR SKID MOUNTED EQUIPMENT - ELECTRICAL

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section applies to the complete shop installation of power, control and instrumentation wiring and other electrical systems to be supplied under this Contract and required for a complete equipment skid. In general, Work includes, but is not limited to, the following:
   1. Installation of wiring connections on equipment skids furnished by this Contract.
   2. Furnish and install Equipment as required for complete and operational systems unless otherwise indicated.
   3. Local control panel required to create a complete functional system.
   4. Non-skid mounted Equipment furnished by this Contract shall be identified during the Bid Period and shall conform to the applicable provisions of this Section.

B. Related Work Specified Elsewhere:
   1. SECTION 133423 – POWER CONTROL MODULE.
   2. SECTION 262400 – PANELBOARDS, SWITCHBOARDS AND TRANSFORMERS.
   3. SECTION 262419 – 480-VOLT MOTOR CONTROL CENTER EQUIPMENT

1.02 REFERENCES:

A. Design, construct, assemble and test all electrical equipment furnished to conform with, but not limited to, all applicable sections of the following standards.
   1. Institute of Electrical and Electronics Engineers (IEEE).
   2. American National Standards Institute (ANSI).
   3. National Electrical Manufacturer's Association (NEMA).
   4. National Fire Protection Association (NFPA).
   5. Local and state ordinances.
   6. Instrument Society of America (ISA).
   7. National Electrical Safety Code (NESC).

B. Use electrical materials conforming with, but not limited to, all applicable sections of the following standards:
   1. American Society for Testing and Materials (ASTM).
   2. Insulated Cable Engineer's Association (ICEA).
   3. National Electrical Code (NEC).
   4. Underwriters' Laboratories (UL).

1.03 SUBMITTALS:

A. Bill of materials indicating manufacturer, style, type, and catalog number of all electrical Equipment and instruments supplied.
B. Electrical load list.
C. Wiring diagram indicating connections for power and DCS signals.
D. Product data sheets including motor data sheets for all motors supplied.
E. For variable frequency drives:
   1. Provide documentation on communication system interface along with a complete list of all available parameters and associated addresses.
   2. Provide paper and electronic copy of programmable logic controller program.
F. Wire and cable data sheets.
G. Control Panel Front View & Internal Wiring Diagram
H. Outline Drawings
I. Factory test results.

PART 2 - PRODUCTS

2.01 GENERAL:

A. All Equipment and Materials shall be in accordance with the National Electrical Code (NEC).

B. All Equipment conductor termination provisions shall be UL listed for 90°C conductors, unless specified otherwise.

C. Requirements for Electrical Equipment:

1. All Equipment and Material shall be suitable for the temperature, pressure, voltage, and design stress levels to which they will be subjected.
2. Ship Equipment as completely assembled as possible, consistent with shipping facilities and construction requirements at the Site. Optimize shop fabricated assemblies to reduce overall costs.
3. Factory wire all panels and install control devices in panels wherever possible.
4. Furnish with all necessary auxiliary systems required for a complete overall workable mechanical and electrical system conforming to the intent of these Specifications.
5. Furnish complete, coordinating the physical arrangement and electrical connections with equipment and structures also furnished by this Contract.
6. Furnish new Equipment of manufacturer's standard design as far as is consistent with the intent of these Specifications.
7. Furnish with all necessary Material required for complete field assembly and installation which shall be performed by others.
8. Furnish Equipment of dead front construction and designed for heavy-duty power plant operation.
9. Provide engraved laminated plastic nameplates, white with black lettering, for each major piece of Equipment and each instrument or control device mounted on the Equipment.

D. General Requirements for Electrical Material:

1. Use new, unused, first-quality materials free of defects.
2. Use materials suitable for their application, and for the mechanical and electrical stresses to which they will be subjected.
3. Furnish as required for complete installation ready for operation.
4. Use high conductivity copper for all primary current-carrying parts.

2.02 POWER SOURCES:

A. Equipment shall be provided which utilize the following power sources:

1. 480Vac, 3-phase, 60-hertz, 3-wire solidly grounded power system.
2. All skid mounted Equipment shall have all devices requiring remote electrical connections wired to one common terminal box per skid by this Contract.
3. This Contract shall distribute power and furnish and install, disconnect switches, terminal boxes, wire, cable, etc. on the skid as required for a complete operational system unless otherwise specified.
4. Others will install one power source to each equipment skid from a breaker in the PCM provided by this Contract.

2.03 TERMINAL BOXES:

A. Construction:

1. General Requirements:
   a. Terminal boxes shall meet the requirements of NEMA 4X enclosures.

b. Construct terminal boxes of 11-gauge 316L stainless steel with stainless steel doors and continuous hinges.
c. Construct with no bolt heads or fastenings visible from the exterior.
d. Construct with 1/4-inch radius corners.
e. Provide interior panels for mounting terminal blocks as required and specified.
f. Provide full height hinged and gasketed access doors to allow easy access to all terminals.
g. Provide nameplates for all devices mounted on or inside the control panel as specified in this Section, PART 2 - NAMEPLATES. Attach with stainless steel screws.
h. Terminal boxes shall be designed to be installed on the skid frame.
i. Doors:
   (1) Full length, minimum 11-gage steel flush type with full-length piano hinge and three-point latch.
   (2) Chrome-plated handle on each door.
   (3) Provide a print pocket to store all panel drawings.
   (4) Neoprene door gaskets.
j. Furnish with sufficient number of lifting eyes to facilitate ease in handling of equipment.

2. Wiring:
   a. Provide all wiring necessary for all equipment specified unless indicated otherwise, including internal wiring for all spare equipment.
   b. Interior panel wire shall be as specified on Wire and Cable Specification Sheet SW1.
   c. Size all wire in conformance with NEC, but not smaller than listed in the following table:

Type of Circuit	Minimum Wire Size
Instrumentation	16 AWG
Control	14 AWG
Power supply	10 AWG
Thermocouple	16 AWG

   d. Label all wires at each end with plastic slipover marker sleeves. "Suflex" or approved equal, machine printed to indicate wire number and destination terminal as indicated on Contractor Drawings.
   e. Supply internal ground bus and connect all internal grounds to bus. Provide bolted connection for external ground to bus.

3. Terminal Blocks:
   a. Reference 011101 Appendix-B Approved Suppliers.
   b. Provide the following clear space between terminal strips, between terminal strips and devices, and between terminal strips and inside wall of control panel, for field cabling:
      (1) Minimum: 6 inches.
      (2) Normal: 1.5 inches for each 15 terminals high.
   c. Mount terminal blocks in one or more vertical rows. Location of terminal blocks and arrangement of external circuits shall be subject to approval by the Engineer and Owner.

d. Identify each terminal on each block by stamping or marking a unique designation permanently on the block.
e. Provide 20% extra terminals.
f. Binding screw-type terminals for power cables and slide link type terminals for control and instrument cables.
g. Thermocouple type terminals for appropriate thermocouple applications.
h. Designed and sized for the cables being terminated.
i. Compression type terminal blocks shall not be permitted.
j. Rated current carrying capacity equal to or greater than the cable being terminated.
k. Marking strip on blocks for power, control and instrument cables.

2.04 CONDUIT AND ACCESSORIES:

A. General:
1. This Contract shall size, furnish and shop install all conduit, fittings, boxes, and accessories required to protect wiring between motors as required, control panels, switches, instruments and other individual devices mounted on the skid.
2. All Work including Equipment and Materials in hazardous (classified) or corrosive locations shall conform to NEC requirements for the specified area. This Contract is responsible for identifying, conforming to, and furnishing properly rated NEMA materials for all classified and corrosive areas on the skid.
3. Exposed conduit shall be Polyvinyl Chloride (PVC) coated rigid galvanized steel conduit.
4. Flexible metallic conduit shall be used for short extensions to motors and other equipment where rigid connections are not practical.
5. Stainless Steel (316) pull and terminal boxes will be used on exposed conduit runs and at cable tray to conduit transitions where required.

B. PVC Coated Rigid Galvanized Steel Conduit:
1. Hot-dipped galvanized rigid steel conduit as specified in ANSI C80.1.
2. Prior to application of PVC coating, clean interior and exterior surfaces to remove grease, oil, dirt, and other extraneous contaminates. The surface shall be cleaned in such a manner that the galvanized surface of the conduit is not harmed or eroded and treated with chromic acid to provide a suitable surface for bonding.
3. The interior and the threads of the conduit shall have a urethane coating with a nominal thickness of 2 mils. Coat externally except for prethreaded ends with PVC to a nominal 40 mils (0.035-inch to 0.050-inch) by the platisol dip method.
4. Uniformly coat around outside diameter and full length of the conduit.
5. Exceed the tensile strength of PVC coating with bond between metal and coating.
6. Conduit shall be bendable without damage to either interior or exterior coating.
7. Treat and coat couplings, elbows, and other conduit fittings with the same process and coating tolerances as conduit. Couplings shall have longitudinal ribs to protect the coating during installation.
8. Each coupling and fitting shall include a PVC sleeve that overlaps the conduit by a minimum of one pipe diameter or 2 inches, whichever is less.
9. Final cured PVC coating shall have a dielectric strength of 400 volts/mil at 60 cycles.
10. Supply stainless steel encapsulated screws with all fittings.
11. Right angle beam clamps shall have a minimum of 40 mil PVC coating throughout. Supply all "U" bolts with PVC encapsulated nuts that cover all exposed portions of the threads.

C. Flexible Steel Conduit:
   1. Liquid-tight conduit with flexible galvanized-steel core and polyvinyl chloride covering.
   2. Flexible conduit shall only be used for connection between rigid conduit and rotating vibrating or pipe mounted equipment.
   3. Maximum length shall be in accordance with NEC.
   4. Suitable for use in -20°C through 60°C.
   5. Suitable for oil-resistant applications.

D. Conduit Fittings for Rigid Metallic Conduit:
   1. Heavy-Duty Cast Malleable Iron or Aluminum for All Types of Fittings:
      a. All fittings and couplings shall be full-threaded type. Split or set screw types are not allowed.
      b. Mogul type for conduit sizes 1-1/2 inches and larger.
      c. LBD or roller action type LB for right angle fittings for conduit sizes 2 inches and larger.
      d. Full-threaded hubs and rubber-gasketed covers.
      e. Zinc, cadmium-plated, or bronze hardware bolts, screws, and bushings for assembly.
      f. Iron type fittings to be cadmium-plated or galvanized.
      g. Standard, junction fittings, couplings, and elbows fabricated from the same material as conduit, and each treated and coated as required for the conduit.

E. Conduit Boxes for Rigid Metallic Conduit:
   1. Boxes shall be self-oxidizing, self-renewing aluminum alloy that is "copper-free" (less than 0.3 of 1%) to assure resistance to corrosion.
   2. Provide threaded conduit entrances or waterproof hubs.
   3. Include provisions for mounting cable supports where required by NEC.

F. Conduit Boxes for PVC Coated Rigid Metallic Conduit:
   1. Cast Boxes – PVC coated malleable iron.

G. Support System:
   1. Use aluminum conduit clamps to support all exposed metallic conduit.
   2. Use nonmagnetic clamps to support nonmetallic conduits.
   3. Fabricate from structural aluminum or manufactured framing members equal to "Unistrut" P-1000 series as manufactured by Unistrut Corporation unless otherwise specified.
   4. Provide all necessary rods, anchors, inserts, clamps, spacers, shims, bolts, and miscellaneous steel.
   5. Provide galvanized or cadmium-plated members.
   6. Use noncorrodible metal, galvanized metal, or cadmium-plated metal for nuts, bolts, washers, shims, and other small accessories.
   7. Construct with sufficient rigidity to hold all mounted equipment and material in permanent and neat alignment.
   8. Do not exceed load requirements in NEC and NEMA standards.
   9. Paint all field cuts or welding of supports with an organic zinc rich primer.
   10. All raceway shall be designed overhead.

2.05 WIRE, CABLE AND ACCESSORIES:

A. General:
1. This Contract shall furnish and shop install all electrical wire, cable, and accessories required for a complete system.
2. Definition:
a. Burns & McDonnell type designations such "SEN4," "CEN1" and "IEN2," indicated or specified are for identification purposes only and are not intended to correspond to any trade designation.

B. Wire and Cable:
1. Control cable shall be as specified on Wire and Cable Specification Sheet CEN1.
2. Power cable shall be as specified on Wire and Cable Specification Sheet SEN4.
3. Instrumentation cable shall be as specified on Wire and Cable Specification Sheet IEN2.
4. Type E thermocouple cable shall be as specified on Wire and Cable Specification Sheet TCE1.
5. Size all wire in conformance with NEC, but not smaller than listed in the following table:

Type of Circuit	Minimum Wire Size	Rating
Power supply	10 AWG	600 V
Control	12 AWG	600 V
Instrumentation	16 AWG	600 V
Thermocouple	16 AWG	300 V

6. Flat cable constructions shall not be used.
7. Cables shall be multiconductor assemblies in sizes AWG No. 2 and smaller and single conductor in sizes larger than AWG No. 2.
8. HVAC, Lighting and Convenience Power cable shall be unjacketed, single conductor, rated 75° C, stranded copper with thermoplastic insulation type THHN/THWN, XHHW insulated cable.
9. All HVAC, lighting and convenience power wiring shall be enclosed in a completely separate conduit system.

C. Connectors:
1. General Requirements:
a. Designed and sized for specific cable being connected.
b. Solderless, pressure-type connectors constructed of noncorrodible tin-plated copper.
c. Rated current-carrying capacity equal to or greater than the cable being connected.
d. Application tooling for connectors shall contain die or piston stops to prevent over-crimping and cycling or pressure relief to prevent under-crimping. Dies of all application tooling shall provide dot or wire size coding for quality control verification. All tooling shall be manufactured by the connector manufacturer.
2. Power Connectors:
a. Noninsulated ring-tongue type.
b. Ring tongue sized to match terminal stud size. Oversized ring tongue terminals will not be permitted.
c. Brazed barrel seam.
d. Application tooling designed to crimp the wire barrel (conductor grip) with a one-step crimp.
e. Approved supplier's cross-reference chart is listed at end of this Article.
3. Control, Instrument and Specialty Cable Connectors:
a. Vinyl or nylon preinsulated ring tongue. (Spade type will not be allowed).

b. Sized to match terminal stud size. Oversized ring tongue terminals will not be permitted.
c. Have insulation grip sleeve to firmly hold to cable insulation.
d. Insulation grip sleeve shall be funneled to facilitate wire insertion and prevent turned-back strands.
e. Application tooling designed to crimp the wire barrel (conductor grip) and the insulation grip sleeve or ring with a one-step crimp.
f. Approved supplier's cross-reference chart is listed at end of this Article.

Acceptable Connector Manufacturer's Cross-Reference Chart

Type	Size (AWG or MCM)	Amp Special Industries	Thomas & Betts	Panduit Corp.	3M
Control	22-18	PIDG	RA18	PN18	MNG-18
	16-14	PIDG	RB14	PN14	MNG-14
	12-10	PIDG	RC10	PN10	MNG-10
Power	12-10	Solistrand	C10	P10	M10
(600V and	8	Solistrand	D8	P8	M8
Below)	6	Solistrand	E6	P6	M6

D. Motor Lead Termination/ Splice:
1. Splices shall be made using compression-type connectors bolted together. The compression-type connectors shall be properly sized for the cables. Reference acceptable connector manufacturer's cross-reference chart.
2. Splice to be covered with heat-shrinkable tubing connector insulators.
3. Splicing shall be done in accordance with the instructions provided with the Minnesota Mining and Manufacturing (3M) 5300 Series Motor Connector Kit, Raychem Brand MCK or RVC Motor Connector Kit.

E. Cable Ties:
1. Reference 011101 Appendix-B Approved Suppliers
2. Nylon self-locking type.
3. Normal service temperature range of –40 to 85°C.
4. Weather-resistant, UV-resistant type for outdoor use.
5. Conforms to Military Specifications MIL-S-23190D.

F. Cable Identification Tags:
1. Designed to provide a permanent wire and cable identification system
2. This Contract shall assign an individual and unique circuit number to each cable.
3. Show complete cable number and match with cable number indicated on the Contract Submittal Drawings.
4. Cable number may be stamped or typed, but shall be legible and permanent.
5. Character size for cable numbers shall be a minimum of 3/16-inch if hand-lettered or 1/8-inch if stamped or typed.
6. Material shall be nonmetallic and impervious to moisture.
7. Be securely attached to cables and accessible for inspection.
8. Cable identification tags, marking and attachment methods shall be subject to approval of the Engineer and Owner.

2.06 GROUNDING:

A. General:
   1. Size, furnish, shop install and connect a complete ground system directly connected with copper conductor to all electrical devices mounted on the skid.
   2. Grounding shall be designed to provide a low resistance to earth ground for safe touch and step potentials under maximum ground fault conditions.
   3. Connect skid frame members to the skid ground system.
   4. Bare copper conductors shall be type BC2 as detailed in the Cable Data Sheet at the end of this SECTION.
   5. Connections to the plant ground grid will be installed by others.
   6. Provide NEMA CC1, 2 or 4 – hole grounding pads located on opposite corners of the equipment.

2.07 NAMEPLATES:

A. General: Where phenolic nameplates are required, they shall be as follows:
   1. Fabricated from laminated matte finish white plastic with black core and 1/16-inch thick.
   2. Size:
      a. 1-1/2 inches high and 6 inches long for "Master" nameplates, such as for control panels, power panels, equipment enclosures, etc.
      b. 1 inch high and 3 inches long for individual device nameplates.
   3. Engraving:
      a. Gothic style.
      b. 3/8-inch-high characters with 45-mil line width on "Master" nameplates.
      c. 3/16-inch-high characters with 30-mil line width on individual device nameplates.
      d. Engraving designations shall be as indicated or approved by Engineer.
   4. Internal device nameplates shall be attached with a permanent adhesive. No double-sided tape allowed. Nameplates on exterior panel surfaces shall be attached with slotted screws.

2.08 POWER SWITCHING AND CONTROL DEVICES:

A. All non-motor operated valve motor starters shall be fed from their respective unit's MCC.
B. Provide integral disconnect switches for all heating, cooling and ventilation equipment.
C. Distribute power on equipment skids using the devices specified in this Section, PART 2.
D. Reference 011101 Appendix-B Approved Suppliers
E. Low-Voltage Motor Starters:
   1. For vent fans and motor operated louvers.
   2. Rated 120Vac, 1 pole for all single-phase motors rated 115 volts and below
   3. Rated 600Vac, 3 pole for all three-phase motors rated 460 volts.
   4. Reversing or nonreversing and proper NEMA size for the motor horsepower and voltage as required.
   5. Overload relays (externally reset): Three required in all 3-pole starters, one required in all 1-pole and 2-pole starters.
   6. Provide one contact for the control circuit and one additional 120VAC wetted contact for alarm to Owner's control system.
   7. Overload heaters based on nameplate data.
   8. NEMA 4X enclosure constructed of 11 gauge 316L stainless steel with stainless steel doors and continuous hinges.

9. Nameplate on cover of starter enclosure engraved as indicated by Engineer on review of submittal drawings.
10. Interposing relays shall have a strap to lock the relay to the terminal base.

F. Low-Voltage Air Circuit Breakers:
1. Rated 600Vac for 480Vac and 277Vac circuits; 240Vac for 115Vac circuits; and 250Vdc for 125Vdc circuits.
2. Number of poles as required.
3. Molded-case type, manually operated, trip free from the handle, and provided with inverse time thermal element overload protection and instantaneous magnetic short-circuit protection on all poles unless otherwise indicated.
4. Trip ratings as required.
5. Interchangeable trip units on all breakers larger than 100-ampere frame size.
6. Interrupting rating not less than 65,000 rms amperes symmetrical for 600V breakers and 10,000 rms amperes symmetrical for 240Vac or 250Vdc breakers.
7. NEMA 4 - Watertight enclosures.
8. External operating handle which clearly indicates when breaker is "on," "off," or "tripped," and is lockable in the "off" position.
9. Nameplate on cover of enclosure engraved as indicated by Engineer on review of submittal drawings.

G. Low-Voltage Disconnect Switches:
1. Heavy-duty type.
2. Ampere ratings as required.
3. Single or double throw and with number of poles as required.
4. Rated 600Vac for 480V circuits; and 240Vac for 120-, 208- and 240Vac circuits; and 250Vdc for 125Vdc circuits.
5. Nonfused or fusible with cartridge type fuses and ampere rating as required.
6. NEMA 4X - Watertight enclosures constructed of 11-gauge 316L stainless steel with stainless steel doors and continuous hinges.
7. Externally operated power disconnect, lockable in the "off" position.
8. Nameplate on cover of enclosure engraved as indicated by Engineer on review of submittal drawings.

2.09 LOCAL CONTROL PANELS:

A. Control panels shall be skid-mounted.
B. Control panels shall meet the requirements of NEMA 4X.
C. Indication and indicator lights for all equipment and controls by this Contract shall conform to the following color scheme:
1. Red – Running, Open, or Energized.
2. Green – Stopped, Closed, or De–energized.
3. Amber – Alarm or Trouble.
4. Blue – Auto.

D. Construct control panels of 11-gauge 316L stainless steel with stainless steel doors and continuous hinges.
E. Subpanels shall be subject to approval of the Engineer.
F. Provide interior side panels for mounting auxiliary equipment and terminal blocks as required.
G. Provide access panels or doors, or both as required to allow easy access for maintenance of all items.

H. Provide exhaust fans, louvers, filters, etc., according to the recommendations of the various component manufacturers for continuous operation without loss of function or reduced normal life under maximum ambient temperature of 120°F outside the control panel.

I. Provide nameplates for all devices mounted on or inside the control panel. Attach with screws. Provide a master nameplate on the exterior of the control panel. Nameplate specifications shall be as indicated in this SECTION.

J. All free standing panels or cabinets shall be supplied with receptacles, fluorescent lights and door operated light switches to provide adequate lighting to allow plant operations and maintenance staff to operate and maintain components mounted within the cabinets.

K. Wiring:

1. Provide all wiring necessary for all equipment specified unless indicated otherwise, including internal wiring for all spare equipment.
2. Wire shall be as specified on Wire and Cable Specification Sheet SW1.
3. Size all wire in conformance with NEC, but not smaller than listed in the following table:

Type of Circuit	Minimum Wire Size
Control	14 AWG
Power supply	10 AWG

   a. Wire with no splices and with all connections made on equipment studs or terminal blocks. Bring all wiring requiring field connections out to terminal blocks conveniently grouped to receive Owner's cables. Wire all spare contacts on control switches, relays, contactors and starters to external terminal blocks. Not more than two wires shall be terminated at any one connection point.
   b. Terminate all wiring with ring tongue, compression type lugs with preinsulated barrels.
   c. Install internal wiring in horizontal and vertical wiring troughs or channels with removable covers for easy accessibility to interior panel wiring. Terminal blocks shall not be mounted in Panduit raceway, channel, or raceway.
   d. Label all wires at each end with wire identification markers as specified.
   e. Supply internal ground bus and connect all internal grounds. Provide bolted connection for external ground to bus.

4. Terminal Blocks:
   a. Provide quantity as required and additional 20% spare.
   b. Provide the following clear space between terminal strips, between terminal strips and devices, and between terminal strips and inside wall of control panel, for field cabling:
      (1) Minimum: 6 inches.
      (2) Normal: 1.5 inches for each 15 terminals.
   c. Mount terminal blocks in one or more vertical rows. Location of terminal blocks and arrangement of external circuits shall be subject to approval by the Engineer.
   d. Identify each terminal on each block by stamping or marking a unique designation permanently on the block.
   e. Multi-tiered terminal blocks will not be allowed.

5. Alarms and automatic system responses to monitor unusual conditions such as feeder over-maximum flow rate, under-minimum flow rate, VFD malfunction, and hopper fill malfunctions.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. All work shall be in accordance with the National Electrical Code (NEC).

B. Conduit:
   1. Size conduit in accordance with NEC requirements.
   2. Make all conduit connections with waterproof hubs to protect during wash down.
   3. Terminate all conduit runs with insulated bushings.
   4. Coat all cut threads, scars or wrench abrasions with an organic zinc rich primer.
   5. Provide all fittings necessary for a complete installation.
   6. Provide conduit supports per NEC and to provide a rigid well supported conduit system. Contractor shall design conduit system, by routing in beam webs or extra supports, to minimize damage to conduits by personnel during normal operation and maintenance of the skid.
   7. Repair all cut threads, scars or wrench abrasions on PVC coated conduit.

C. Wire, Cable and Accessories:
   1. Wiring between devices which are connected to the same skid frame but are not bolted together shall be routed in conduit. If the devices will be shipped as one unit, the wiring and conduit shall be shop installed and shipped in place to Owner's Site. If shipping splits require the devices to be shipped separately, then the wiring and conduit shall be shop installed, then removed, properly labeled and shipped separate for field installation.
   2. Wiring between devices that are bolted together and share a common wall shall be routed in plastic wireways passing between the devices. All cables shall be protected with plastic wireways from sharp metal edges of the device walls.
   3. Install all connectors with tooling UL approved for use on connectors installed.

D. Power Switching and Control Devices:
   1. Install devices on equipment skids including all necessary mounting materials.
   2. Surface-mount in all other areas.
   3. Mount at convenient operating height above floor (4 feet to centerline above floor when possible).
   4. Locate and arrange with adequate clearances from other skid mounted equipment and material to obtain good accessibility for operation and maintenance per Owner's approval.
   5. Provide a minimum of 1/4-inch clearance between device enclosures and supports to prevent corrosion of enclosure by surface moisture.
   6. Clean all welds, scars, and abrasions and remove metal splatter, rust and foreign material.
   7. Apply a protective organic zinc-rich coating.
      a. Carboline - 858.
      b. International/Porter - Zinc-Lock 308.
      c. Tnemec - 90-93.
   8. Local control device location is subject to the review and approval of the Engineer.

3.02 TESTING:

A. Test all electrical Equipment and Materials upon completion of shop installation to ensure that the Equipment and Material operates satisfactorily, was shop installed properly and conforms to Contract Documents.

B. All Equipment and Materials shall be tested thoroughly to ensure the total system operates as specified.

END OF SECTION 260100

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	BC2 **B&McD TYPE:**	**NEC TYPE:**

BARE COPPER GROUND CABLE

GENERAL REQUIREMENTS:

Annealed, coated, bare copper (ASTM B33)

SPECIFIC REQUIREMENTS:

1. Solid in sizes 4 AWG and smaller.
2. Class B stranded in sizes 2 AWG and larger (ASTM B8).

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	CEN(*) **B&McD TYPE:**	**TC-ER** **NEC TYPE:**

600 VOLT - MULTI-CONDUCTOR CONTROL CABLE

GENERAL REQUIREMENTS:

CONDUCTOR: 10AWG, 12AWG or 14AWG Class B bare stranded annealed copper per ASTM B3, B8.

INSULATION: 30 mils of flame retardant cross-linked polyethylene "XLPE" (ICEA S-73-532 / NEMA WC57).

COLOR CODE: Per ICEA S-73-532, Appendix E, Method 1, colors per Cable Type Table below.

SHIELD: Per Cable Type Table below.

CABLE JACKET: Lead free, flame retardant, chlorinated polyethylene "CPE" (ICEA S-73-532/NEMA WC57).

IDENTIFICATION: Surface printing on the cable shall show manufacturer's name, insulation type, jacket type, number and size of conductors, voltage rating, and numbered footage markers.

Cable Type Table

*B&McD Type	SHIELD	COLOR CODE (ICEA S-73-532 Table)
CEN1	None	E-2
CEN1A	None	E-1
CEN2	Aluminized polyester tape and tinned copper drain wire.	E-2
CEN2A	Aluminized polyester tape and tinned copper drain wire.	E-1
CEN3	5 mil tinned Cu tape applied helically over the core assembly w/ 20% min overlap.	E-2
CEN3A	5 mil tinned Cu tape applied helically over the core assembly w/ 20% min overlap.	E-1

SPECIFIC REQUIREMENTS:

TEMP. RATING: Cable shall be suitable for operation under the following maximum conductor temperature:
90°C --- Continuous, wet or dry locations

FACTORY TESTS:
1. All cable shall be tested in accordance with requirements of ICEA S-73-532/NEMA WC57.
2. The cable shall meet the requirements of IEEE 1202.
3. The singles of the multi conductor cables shall meet the requirements of UL 44 VW-1 flame test.

CERTIFICATION: Cables shall be certified to be in conformance with all applicable requirements of ICEA S-73-532/NEMA WC57, UL44 XHHW-2, and UL 1277 TYPE TC-ER

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	IEN(*) **B&McD TYPE:**	**TC** **NEC TYPE:**

300, 600 VOLT - SHIELDED INSTRUMENT CABLE
(WITH SHIELDED OR UNSHIELDED TWISTED PAIRS OR TRIADS)

GENERAL REQUIREMENTS:

CONDUCTOR:	Class B stranded coated annealed copper per ASTM B8, ASTM B33.
INSULATION:	Cross-linked polyethylene "XLPE" (ICEA S-73-532/NEMA WC57).
COLOR CODE:	Per ICEA S-73-532 Appendix E, Method 9 per Cable Type Table below and Note 1.
PAIR/TRIAD SHIELD:	Per Cable Type Table below.
CABLE SHIELD:	Per Cable Type Table below.
CABLE JACKET:	Lead free, flame retardant, chlorinated polyethylene "CPE" (ICEA S-73-532).
IDENTIFICATION:	Surface printing on the cable shall show manufacturer's name, insulation type, jacket type, number of pairs or triads, size of conductors, voltage rating, and numbered footage markers.

Cable Type Table

*BMcD Type	Size (AWG)	Voltage	Pair shield	Cable shield	Insulation thickness (mils)	Color Code (ICEA S-73-532)
IEN1	16 PR	300	Aluminized polyester tape and tinned Cu drain wire.	Aluminized polyester tape and tinned Cu drain wire.	20	Note 1 below
IEN2	16, 18 PR	600	Aluminized polyester tape and tinned Cu drain wire.	Aluminized polyester tape and tinned Cu drain wire.	25	Note 1 below
IEN3	16, 18 PR	600	None	Aluminized polyester tape and tinned Cu drain wire.	25	Note 1 below
IEN4	16, 18, 20 PR/TRI	300	Aluminized polyester tape and tinned Cu drain wire.	Aluminized polyester tape and tinned Cu drain wire.	20	Note 1 below

Note 1: Pairs shall be colored black & white, triads shall be colored black, white and red. Multiple pairs and triads shall be numbered per Method 9.

SPECIFIC REQUIREMENTS:

TEMP. RATING:	90°C --- Continuous, wet or dry locations
JACKET THICKNESS:	Jacket thickness shall be in accordance with ICEA S-73-532/NEMA WC57.
CABLING:	Pairs and triads twisted per ICEA S-73-532/NEMA WC57.
FACTORY TESTS:	1. All cable shall be tested in accordance with requirements of ICEA S-73-532/NEMA WC57. 2. All 600V cables and singles of multi-conductor cables supplied shall meet the requirements of UL 1277. 3. All 300V cables shall meet the requirements of UL 2250 and UL13.
CERTIFICATION:	Cables shall be certified to be in conformance with all applicable requirements of ICEA S-73-532/NEMA WC57.

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	SEN4 **B&McD TYPE:**	**TC** **NEC TYPE:**

600 VOLT - 3 CONDUCTOR POWER CABLE WITH GROUND

GENERAL REQUIREMENTS:

CONDUCTOR:	Class B stranded annealed copper per ASTM B8.
INSULATION:	Cross-linked polyethylene "XLPE" per UL 44 color coded per ICEA Method 4.
CABLE JACKET:	Thermoset Chlorinated Polyethylene (XL-CPE) per UL 1277.
IDENTIFICATION:	Surface printing on the cable shall show manufacturer's name, cable type XHHW-2, insulation type, jacket type, number and size of conductors, voltage rating and Underwriters Laboratories label (UL).

SPECIFIC REQUIREMENTS:

TEMP. RATING:	Cable shall be suitable for operation under the following maximum conductor temperatures: 90°C --- Continuous, wet or dry locations 130° --- Emergency 250° --- Short Circuit
INSULATION THICKNESS:	Insulation thickness shall be in accordance with UL 44 Type XHHW-2 and ICEA S-95-658/NEMA WC70.
GROUND WIRE SIZE:	Ground wires shall be stranded copper per ASTM B8 sized in accordance with UL 1277.
JACKET THICKNESS:	Jacket thickness shall be in accordance with UL 1277 and ICEA S-95-658/NEMA WC70.
FACTORY TESTS:	All cable shall be tested in accordance with requirements of ICEA S-95-658 and of UL 1277. a) All cables shall meet the flame test requirements of IEEE1202. b) All single conductors shall pass the UL44 VW-1 flame test.
CERTIFICATION:	Cables shall be certified to be in conformance with all applicable requirements of UL44, UL 1277 TYPE TC-ER (2AWG & larger), ICEA S-95-658.

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	SW1 B&McD TYPE:	**SIS** NEC TYPE:

600 VOLT - SINGLE CONDUCTOR - POWER CABLE

GENERAL REQUIREMENTS:

CONDUCTOR: Class B stranded annealed copper per ASTM B8.

INSULATION: Ethylene-propylene "EP" (UL44); or cross-linked polyethylene "XLPE" (UL44).

IDENTIFICATION: Surface printing shall show manufacturer's name, insulation type (SIS), VW-1, conductor size, conductor type, voltage rating, and Underwriters Laboratories label (UL).

SPECIFIC REQUIREMENTS:

TEMP. RATING: Cable shall be suitable for operation under the following maximum conductor temperatures:
90°C --- Continuous, dry locations only

MATERIAL THICKNESS:

Conductor Size (AWG or MCM)	Insulation Thickness (Mils) (UL44-Table 24.2)
14-9	30
8, 7	45
6-2	60
1-4/0	80

FACTORY TESTS: All cable shall be tested in accordance with requirements of UL44 including the flame test VW-1.

CERTIFICATION: Cables shall be certified to be in conformance with all applicable requirements of UL44.

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	TCE1 **B&McD TYPE:**	**TC** **NEC TYPE:**

300 VOLT SHIELDED CHROMEL/CONSTANTAN THERMOCOUPLE EXTENSION WIRE (WITH SHIELDED TWISTED PAIRS)

GENERAL REQUIREMENTS:

CONDUCTOR:	Positive -- chromel solid conductor Negative -- constantan solid conductor
INSULATION:	Cross-linked polyethylene "XLPE" (ICEA S-82-552 Part 3) or ethylene propylene "EP" (ICEA S-82-552 Part 3) and color coded per ICEA Method 1 with colored pigmented compounds. Specific conductor color shall be in accordance with ASA C96.1 Para. 1, Table 6 and each conductor of multiple pair to be numbered to distinguish pairs.
PAIR SHIELD:	Aluminized mylar or polyester tape and tinned copper drain wire.
SHIELD ISOLATION:	Mylar or polyester tape.
CABLE SHIELD:	Aluminized mylar or polyester tape and tinned copper drain wire.
CABLE JACKET:	Chlorosulfonated polyethylene "Hypalon" (ICEA S-82-552 Part 4, Para. 4.2); or chlorinated polyethylene "CPE" (ICEA S-82-552 Part 4, Para. 4.2).
IDENTIFICATION:	Surface printing on the cable shall show manufacturer's name, insulation type, jacket type, number of pairs, size of conductors, voltage rating, and numbered footage markers.

SPECIFIC REQUIREMENTS:

TEMP. RATING:	Cable shall be suitable for operation under the following maximum conductor temperature: 90°C --- Continuous, wet or dry locations
CONDUCTOR SIZE:	#16 AWG.
INSULATION THICKNESS:	All conductors to have 20 mils nominal insulation as per ICEA S-82-552 Table 3-1.
SHIELD ISOLATION:	Each pair of multi-pair assemblies shall have a shield isolation tape applied over the pair shield to ensure isolation of each individual pair shield.
JACKET THICKNESS:	Jacket thickness shall be in accordance with ICEA S-82-552 Table 4-1.
CABLING:	Pairs twisted with 2 inch lay.
FACTORY TESTS:	1. All cable shall be tested in accordance with requirements of ICEA S-82-552. 2. All cable and singles of multi-conductor cables supplied shall meet the flame test requirements of IEEE 383 using a gas burner flame source. Flame tests shall be performed on 1 pair 2/C-16 AWG and certified test reports shall be submitted to the Engineer in triplicate.
CERTIFICATION:	Cables shall be certified to be in conformance with all applicable requirements of ICEA S-82-552.

SECTION 260551 - ALTERNATING CURRENT ELECTRIC MOTORS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes alternating current electric motors required to drive the equipment furnished under this Contract.

B. Related Work Specified Elsewhere:

1. Valve and gate motor operators are specified in SECTIONS 409125.
2. Except as otherwise specified in the driven equipment Divisions, all alternating current motors other than (valve and gate motor operators) shall be as specified in this Section.

1.02 REFERENCES:

A. Design, fabricate, assemble, and test Equipment and Materials to conform to the following codes and standards:

1. American Bearing Manufacturers Association (ABMA):
   a. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   b. 11 - Load Ratings and Fatigue Life for Roller Bearings.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43 - Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   b. 112 - Standard Test Procedure for Polyphase Induction Motors and Generators.
3. National Electrical Manufacturers Association (NEMA):
   a. MG 1 - Motors and Generators.
   b. MG 2 - Safety Standard for Construction, and Guide for Selection, Installation, and Use of Electric Motors and Generators.
   c. 1004 - Standard for Electric Motors.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 1.

B. Submittals required include, but are not limited to, the following items:

1. Outline drawing for each group of identical motors.
2. Nameplate data for each group of identical motors rated 460 volts and below, including the following data:
   a. Manufacturer's name and serial number.
   b. Manufacturer's type and frame designation.
   c. Horsepower output.
   d. Time rating.
   e. Maximum ambient temperature for which motor is designed.
   f. Insulation system designation.
   g. Temperature rise and method of measurement.
   h. RPM at rated load.
   i. Frequency.
   j. Number of phases.
   k. Rated-load amperes.
   l. Voltage.
   m. Code letter for locked-rotor kVA.
   n. Design letter for polyphase integral-horsepower motors.
   o. Nominal efficiency for motors rated 1 through 199 horsepower.
   p. Service factor.
   q. For motors equipped with thermal protectors, the words "thermally protected."

3. Additional data for each group of identical motors rated above 100 horsepower:
   a. Acceleration time with connected load.
   b. Allowable locked rotor time.
   c. Starting capabilities.
   d. Thermal limit curve, superimposed on time-current curves during acceleration of the driven equipment at rated voltage and at minimum specified starting voltage.
4. If requested by Engineer for 460-volt motors rated 1 through 199 horsepower, copies of test reports of efficiency and power factor tests performed on electrically duplicate motors.
5. Torque and speed curves.
6. For each 460-volt motor rated 200 horsepower and larger, certificate of completion of factory tests.

C. Perform the following factory tests on each motor rated 460 volts and below in conformance with NEMA MG 1 and IEEE 112:
   1. No-load current and speed at normal voltage and frequency.
   2. High potential test.
   3. Other standard factory tests.

D. Tests to confirm guaranteed sound pressure levels may be required at Owner's option and expense.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Motors rated 460 volts and below shall be as manufactured by one or more of the following:
   1. Reference Appendix 011101-B.

2.02 GENERAL DESIGN AND CONSTRUCTION REQUIREMENTS:

A. Motors shall be continuous-duty powerhouse type suitable for a powerhouse environment where moderately abrasive conductive dusts and high humidity are present.
B. Motors shall be self-ventilated.
C. Motors shall be designed for full voltage starting.
D. Motors shall be suitable for operation at site altitudes as indicated in Appendix 011101-A.
E. Indoor motors shall be suitable for continuous operation at an ambient temperature of 50 °C.
F. Outdoor motors shall be suitable for continuous operation at any ambient temperature from minus 23°F to plus 50°C.
G. Motors shall include tropicalization package.
H. All motors shall have squirrel-cage rotors.
I. The nameplate horsepower rating of each motor at 1.0 service factor shall equal or exceed the horsepower required to drive the connected equipment under the design conditions specified and within normal operating ranges. For each motor furnished, the nameplate horsepower rating multiplied by the service factor shall equal or exceed the horsepower required to drive the connected equipment under any operating condition.

2.03 MOTORS RATED 1/2-HORSEPOWER AND SMALLER:

A. Rated 115 volts, single phase, 60 hertz.
B. Service factor of 1.0.

C. The torque characteristics of each motor at all voltages from 90 to 110% rated voltage shall be as required to accelerate the motor and driven equipment to full speed without damage to the motor or the driven equipment.
D. All windings shall be copper. Aluminum windings will not be accepted.
E. Insulation shall be Class B or Class F, with Class B temperature rise in accordance with NEMA MG 1.
F. Enclosures shall be fabricated of steel.
G. Horizontal motors shall be mounted on a common baseplate with the driven equipment.
H. Manual reset thermal overload protection shall be furnished integral to each motor.
I. Enclosures shall be totally enclosed nonventilated.

2.04 MOTORS RATED 3/4- THROUGH 199 HORSEPOWER:

A. Rated 460 volts, 3 phase, 60 hertz.
B. Service factor of 1.15 for all enclosures except for explosion-proof or dust ignition-proof enclosures which shall have a service factor of 1.0.
C. Enclosures shall be fabricated of cast iron or steel.
D. Enclosures shall be totally enclosed nonventilated or totally enclosed fan cooled.
E. Bearings shall be antifriction type, and shall have an ABMA L-10 rating life of not less than 80,000 hours at rated speed, and under the radial and/or thrust loadings encountered within normal operating ranges. The thrust loading corresponding to an ABMA L-10 rating life of 5,000 hours at rated speed shall not be exceeded under any operating condition of the motor or the driven equipment.
F. Bearings shall be insulated when required to prevent bearing or shaft damage due to stray shaft currents.
G. Each horizontal motor shall be mounted on a common baseplate with the driven equipment, or shall be furnished with separate sole plates and subsole plates to permit removal of the motor without disturbing the alignment of the driven equipment.
H. Furnish space heaters for all outdoor motors rated 25 horsepower and above. Space heaters shall be rated 120 volts, single phase, 60 hertz.
I. The torque characteristics of each motor at all voltages from 90 to 110% rated voltage shall be as required to accelerate the motor and driven equipment to full speed without damage to the motor or the driven equipment.
J. Insulation shall be Class F, with Class B temperature rise at rated horsepower in accordance with NEMA MG 1.
K. Where combined motor and driven equipment sound levels are specified for items of equipment, systems, or areas, motor sound levels shall be coordinated with driven equipment sound levels to meet the overall sound levels specified. The motor "A" weighted sound pressure level shall not in any event exceed 90 dB when measured at a reference distance of 1 meter per IEEE 85.
    1. Motors shall be of special high efficiency and high power factor design, including the following design features:
        a. Low loss lamination steel.
        b. Increased stator and rotor length.
        c. Increased winding cross section.
        d. High efficiency cooling fan design.
        e. Optimized slot configuration and air gap.
    2. Unless otherwise specified, the efficiency of each motor shall meet or exceed all NEMA Premium Requirements for energy efficiency, with efficiency values certified by NEMA MG1.12.53, both A and B Standards.

3. Information submitted with the proposal for each motor shall include minimum guaranteed efficiency based on tests performed in accordance with IEEE 112, Method B, with accuracy improvement by segregated loss determination including stray load loss measurement. Information submitted with the proposal shall include percent efficiency and percent power factor at full load, 3/4-load, and 1/2-load.

PART 3 - EXECUTION - Not Applicable.

END OF SECTION 260551

SECTION 262400 - PANELBOARDS, SWITCHBOARDS AND TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes panelboards, switchboards and dry-type transformers for low-voltage power and lighting systems applications.

B. Furnish and install quantities and types as specified or as indicated.

C. Related Work Specified Elsewhere:

1. SECTION 133423 – POWER CONTROL MODULE.
2. SECTION 260100 – REQUIREMENTS FOR SKID MOUNTED EQUIPMENT.
3. SECTION 262419 – 480-VOLT MOTOR CONTROL CENTER EQUIPMENT.

1.02 REFERENCES:

A. Applicable Standards:

1. American National Standards Institute (ANSI):
   a. C57 Series - Transformers, Regulators, and Reactors.
   b. C37.20 - IEEE Standard for Switchgear Assemblies Including Metal-Enclosed Bus.
2. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code (NEC).
3. National Electrical Manufacturers Association (NEMA):
   a. AB1 - Molded Case Circuit Breakers and Molded Case Switches.
   b. ICS1 - Industrial Control and Systems.
   c. ICS2 - Industrial Control Devices, Controllers and Assemblies.
   d. ICS4 - Terminal Blocks for Industrial Use.
   e. PB1 - Panelboards.
   f. PB2 - Deadfront Distribution Switchboards.
   g. ST1 - Specialty Transformers (Except General-Purpose Type).
   h. 250 - Enclosures for Electrical Equipment (1000V Maximum).
4. Underwriters' Laboratories, Inc. (UL):
   a. 50 - Enclosures for Electrical Equipment.
   b. 67 - Panelboards.
   c. 506 - Specialty Transformers.
   d. 508 - Industrial Control Equipment.
   e. 891 - Dead-Front Switchboards.
5. Federal Specifications:
   a. FED-STD-595B - Colors Used in Government Procurement.
   b. W-P-115C - Panel, Power Distribution.
   c. W-C-375 - Circuit Breakers, Molded Case, Branch Circuit and Service, Type I, Series Trip, Three Pole (10 through 100 Amperes).

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 1.

B. Includes, but not limited to, the following:

1. General arrangement and outline information.
2. Schematic power diagrams.
3. Wiring diagrams.
4. Bills of material.
5. Nameplate information.
6. Protective device coordination curves.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Panelboards and Switchboards:
   1. Reference Appendix 011101-B Approved Suppliers.

B. Transformers:
   1. Reference 011101 Appendix-B Approved Suppliers.

2.02 PANELBOARDS AND SWITCHBOARDS:

A. General:
   1. Heavy-duty type with voltage and ampere ratings as indicated.
   2. Enclosures of the following types:
      a. NEMA 1 - General Purpose for indoor nonhazardous locations.
   3. Panelboards in code gage, hot-dipped galvanized sheet metal boxes with code gage steel trim and finished with a rust inhibiting primer and light gray paint (formerly ANSI Z55.1.61 No. 61).
   4. Switchboards constructed of sheet steel for floor mounting and finished with a rust inhibiting primer and light gray paint (formerly ANSI Z55.1.61 No. 61).
   5. Hinged door with lock and catch combination in the front trim of all panelboards.
   6. Phenolic nameplate on front of panel engraved with the panelboard or switchboard designation, and above each breaker operating handle on switchboards. Nameplates shall be as specified in SECTION 260100.
   7. Minimum of 42 poles.
   8. Include 20% spare breakers of each type required by the system.
   9. Copper main buses.
   10. The short circuit current rating of the assembled panelboard or switchboard shall be equal to or greater than the interrupting capacity of the highest rated branch breaker.

B. 480/277V Panelboards:
   1. Rated 600Vac, 3-phase, 4-wire, solid neutral, with main breaker.
   2. Provide 100-ampere frame size bolt-on thermal-magnetic breakers with noninterchangeable trip units as required.
   3. Provide 225-ampere frame size bolt-on thermal-magnetic breakers with interchangeable trip units as required.
   4. Breakers shall have a minimum interrupting capacity 65,000 rms amperes symmetrical at 480V.
   5. Breakers as specified for all lighting supplied by this Contract as specified in SECTION 260100.
   6. General Electric Type CCB.

C. 120/208V Panelboards:
   1. Rated 240Vac, 3-phase, 4 wire, solid neutral, with main breaker.
   2. Provide 100-ampere frame size bolt-on thermal-magnetic breakers with noninterchangeable trip units.
   3. Breakers shall have a minimum interrupting capacity of 10,000 rms amperes symmetrical at 240Vac.
   4. Breakers as required for all exit and emergency lighting, receptacles and skid equipment supplied by this Contract as specified in SECTION 260100.
   5. General Electric Type AQ.
   6. All breakers for receptacles shall be ground fault interrupter (GFI) type set at 5 mA trip for personnel protection.

7. All breakers for heat trace shall be ground fault interrupter (GFI) type set at 30 mA trip for equipment protection.

2.03 TRANSFORMERS:

A. Dry type with kVA rating as required by load with a minimum of 20% additional capacity.
B. Suitable for indoor or outdoor installation. Transformers installed outside of the PCM shall be NEMA 4X.
C. Noise level not to exceed NEMA ST1 standards as follows:
   1. 0-9 kVA - 40 dB.
   2. 10-50 kVA - 45 dB.
   3. 51-150 kVA - 50 dB.
   4. 151-300 kVA - 55 dB.
   5. 301-500 kVA - 60 dB.
D. Class H insulation with 115°C maximum temperature rise in 40°C ambient under continuous full load operation.
E. 480-120/208V, 3-phase, 60-hertz, delta-wye connected with taps as follows:
   1. Minimum of four 2-1/2% full-capacity taps, 2 above (FCAN) and 2 below (FCBN) 480V.
   2. General Electric Type ML for 3-15 kVA and Type QL for 30 kVA and larger or Engineer approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General:
   1. Install panelboards and transformers inside PCM building including all necessary mounting and supporting materials. If required, install transformers inside silos as required.
   2. Locate and arrange with proper clearances from other equipment and material to obtain good accessibility for operation and maintenance.
   3. Space away from walls or columns at least 1/4-inch to prevent surface moisture from rusting the enclosure.
   4. Clean all welds, scars, and abrasions and remove metal splatter, rust and foreign material and apply organic zinc-rich coating.
      a. Carboline - Carbozinc 859.
      b. International - Interzinc 52 HS.
      c. Tnemec - Tnemezinc 90-97.
B. Panelboards:
   1. Surface mount.
   2. Install with top of panelboard approximately 6 feet above floor.
   3. Provide typed circuit directory in each panelboard indicating branch circuit loads.
C. Transformers:
   1. Floor mount wherever possible.
   2. Provide flexible conduit connections to minimize vibration and noise.

END OF SECTION 262400

SECTION 262419 - 480-VOLT MOTOR CONTROL CENTER EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:

A. Work in this Section includes furnishing the following:
   1. The following assemblies of 480-volt motor control center Equipment as specified.
      a. Unit 1 480-volt MCC
      b. Unit 2 480-volt MCC
   2. Maintenance equipment and spare parts as specified.
   3. Field Services as specified.

B. Contractor shall not proceed with design or fabrication of any motor control center until that motor control center is released by Engineer for construction.

C. The Equipment specified in this Section shall also conform to the requirements of SECTION 260100.

D. The Equipment shall be suitable for operation on a 480-volt, 3-phase, solidly grounded system.

E. Furnish Equipment with all auxiliary items, except those specified as furnished by Owner, required for complete motor control center Equipment systems as specified.

F. Related Work Specified Elsewhere:
   1. SECTION 133423 – POWER CONTROL MODULE.
   2. SECTION 260100 – REQUIREMENTS FOR SKID MOUNTED EQUIPMENT.
   3. SECTION 262400 – PANELBOARDS, SWITCHBOARDS AND TRANSFORMERS.

1.02 REFERENCES:

A. Applicable Codes and Standards: Design, fabricate, assemble, and test all Equipment furnished to conform to the following codes and standards:
   1. National Fire Protection Association (NFPA):
      a. National Electrical Code (NEC).
      b. National Electrical Safety Code (NESC).
   2. National Electrical Manufacturer's Association (NEMA):
      a. AB1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
      b. CC 1 - Electric Power Connection for Substations.
      c. ICS 1 - Industrial Control and Systems: General Requirements.
      d. ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
      e. ST 1 - Specialty Transformers.
   3. Underwriters' Laboratories, Inc. (UL):
      a. 508 - Industrial Control Equipment.
      b. 845 - Motor Control Centers.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 1.

B. Includes, but not limited to, the following:
   1. Arrangement and outline drawings.
   2. Bills of Material.
   3. Installation drawings.
   4. Wiring diagrams.
   5. Schematic diagrams.
   6. Instrument transformer performance curves and data.

7. Instruction books.

C. In addition to other Submittal requirements, final drawings shall be submitted as indicated in Division 1.

1.04 QUALITY ASSURANCE:

A. Factory Tests:
1. Reports of production tests performed on the Equipment furnished under this Section shall be available for review if requested by Engineer or Owner.
2. All Equipment shall be tested in accordance with applicable standards.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. 480-Volt Motor Control Center:
1. Reference Appendix 011101-B.

2.02 MOTOR CONTROL CENTER ASSEMBLY:

A. Assemblies shall conform to UL 845, NEMA ICS1, ICS2.

B. Ratings under altitude and ambient temperature conditions specified:
1. 480 volts line-to-line, 3-phase, 60-hertz.
2. Continuous current rating of main horizontal bus as specified.
3. Vertical buses to which main or tie sources are connected shall have continuous current rating equal to main horizontal bus. All other vertical buses rated 300 amperes continuous or as required by connected loads, whichever is greater.
4. 65,000 Amps RMS symmetrical short-circuit rating.

C. Stationary Structure:
1. Consist of an assembly of vertical metal enclosed sections, each nominally 20 inches wide, 20 inches deep, and 90 inches high, joined together to form a totally-enclosed freestanding unit designed to permit easy addition or removal of sections in the field.
2. Construction:
a. Indoor: NEMA 1, neoprene gasketed.
3. NEMA ICS 2-322 Class I, Type B, wiring construction.
4. Number of vertical sections as required to contain the number and type of Equipment items provided by this Contract and as specified.
5. Isolated main power bus and isolated vertical power bus in each vertical section.
6. Starter units, feeder tap units, and other Equipment in separate compartments isolated by steel barriers.
7. Ground bus, with 2 NEMA sized and spaced holes for connection of 250-MCM copper ground cable at each end of assembly.
8. Provision for entrance of connecting power and control circuits from top.
9. Horizontal wiring tray at the top and bottom of each vertical section, and vertical wireway from top to bottom in each vertical section. The vertical wireway door for each vertical section shall be separate from the starter and feeder tap unit doors. Face of horizontal wireways shall be a minimum of 5 inches high and the full width of each section of the MCC. Face of vertical wireways shall be a minimum of 4 inches wide and the full height of the MCC.
10. Complete accessibility from the front to all buses, starters, control devices, and all other components for wiring and maintenance.

11. Guide rails, separator bars, cover plates, and other provisions necessary for installation of a future starter unit in all future spaces and blank spaces remaining in the units after all required components are installed.
12. Standard control schemes for each starter size shall be designed by the manufacturer and approved by Engineer and Owner.
13. Permanent base leveling sills having closure strip at each end of units.
14. All spare auxiliary contacts wired to external connection terminal blocks.
15. Control Terminal Blocks:
    a. Use heavy-duty terminal blocks rated at least 20 amperes, 600 volts.
    b. Terminal blocks shall be pull-apart type to permit removal of motor starters without disconnecting external control cables.
    c. Identify each terminal on each block by stamping or marking the terminal designation permanently on the block.
    d. Provide number of terminals necessary for Contractor's design.
16. Power leads shall be terminated directly on the overload device.
17. Provide engraved laminated plastic nameplates for each motor control center assembly, each breaker, each motor starter, each instrument and each control device mounted on the Equipment.

D. Starters shall be of the following type and design:
1. Built-in interchangeable type 12-inch or larger vertical modular height plug-in units with hinged doors.
2. Drawout type.
3. Unless otherwise specified, starters shall be circuit breaker combination, full-voltage magnetic type, 3-pole, with three overload relays and external manual reset. Fused manual switches in lieu of automatic circuit breakers are not acceptable.
4. Contain fused, individual control transformer for supplying 120-volt ac control power to each motor starter coil, and its associated equipment. Both primary leads to each transformer shall be fused; one secondary lead shall be fused, and the other secondary lead shall be grounded. Rating of control power transformer shall not be less than indicated.
    a. Size 1-2 Starter – 150VA
    b. Size 3 Starter – 200VA
    c. Size 4-6 Starter – 300VA
5. Starters size 3 and larger shall be furnished with interposing relays for the low voltage control.
6. Starters size 5 and larger shall be furnished with 460 volt holding coils and interposing relays for low voltage control.
7. Provide with external lockable handles and interlocks to prevent opening door or drawing out the starter unless breaker is open.
8. Include solid-state adjustable motor overload devices sized for the actual horsepower of the motors being protected.
9. Provide auxiliary contacts for control and spares as required.

E. Feeder circuit breakers shall be of the following type and design:
1. Rated 600 volts ac.
2. Molded case, manually operated, and trip-free from the handle.

3. Breakers used in combination motor starters shall be adjustable instantaneous only, coordinated to provide short-circuit protection for both the motor circuit and the thermal overload relays in the magnetic starter. All other breakers shall contain inverse-time thermal overload protection and instantaneous magnetic short-circuit protection. Combination motor starter circuit breakers shall have a symmetrical interrupting capacity at 480 volts when used in conjunction with the associated contactor and overload relay not less than the motor control center short-circuit rating. All other breakers shall have a component interrupting capacity at 480 volts not less than the motor control center short-circuit ratings.
4. The Equipment supplied shall not require the use of current-limiting fuses to achieve the short-circuit ratings specified.
5. Include external handle which clearly indicates when breaker is "on," "off," or "tripped." Handle shall be lockable in the "off" position.
6. Ambient compensated to 50°C.
7. Furnish frame sizes 225-ampere and larger with interchangeable trip units.

F. Control and interposing relays shall be of the following type and design:
1. Industrial, heavy-duty type control relays.
2. Rated 300 volts with contacts rated at least 10 amperes. Relays connected to 480-volt primary circuits shall be rated 600 volts.
3. Timers and time delay relays to have snap action contacts, and be Agastat time delay relays Series 7000, or Engineer-approved equal.

G. Miscellaneous Equipment shall be of the following type and design:
1. Instrument transformers shall have proper ratio and suitable mechanical, thermal, and accuracy ratings for the service intended.
2. Ammeters and voltmeters shall be 4-1/2-inch switchboard type, 1% accuracy, General Electric Type AB40 or Engineer-approved equal.
3. Ammeter and voltmeter switches shall be rotary type, Electroswitch Series 24 or Engineer-approved equal.
4. Panel-mounted digital metering package may be furnished in lieu of separate analog instruments.

2.03 LIST OF COMPONENT EQUIPMENT:

A. Green Station Unit 1 480-Volt MCC:
1. Main bus continuous current rating: minimum of 600 amperes.
2. Short circuit rating: 65,000 amperes RMS symmetrical.
3. 3-phase, 3 wire.
4. Main source: Cables entering from above.
5. FVNR starters as required for Contractor's equipment and an additional 20% spare. Provide a starter in each MCC for redundant feeds for the compressed air system provided by this contract.
6. Breakers as per Contractor's design, subject to Owner and Engineer approval. In addition, provide the following breakers:
   a. Four (4) additional 60A breakers for spare silo disconnects.
   b. Two (2) breakers for lighting and receptacle panels specified in SECTION 133423.
   c. 20% spare breakers.
7. Physical orientation as per Contractor's design, subject to Owner and Engineer approval.
8. Located inside PCM.

B. Green Station Unit 2 480-Volt MCC:
1. Main bus continuous current rating: minimum of 600 amperes.

2. Short circuit rating: 65,000 amperes RMS symmetrical.
3. 3-phase, 3 wire.
4. Main source: Cables entering from above.
5. FVNR starters as required for Contractor's equipment and an additional 20% spare.
6. Breakers as per Contractor's design, subject to Owner and Engineer approval. In addition provide the following breakers:
   a. Four (4) additional 60A breakers for spare silo disconnects.
   b. Two (2) breakers for silo lighting and receptacle panels specified in SECTION 133423.
   c. 20% spare breakers.
7. Physical orientation as per Contractor's design, subject to Owner and Engineer approval.
8. Located inside PCM.

2.04 MAINTENANCE EQUIPMENT AND SPARE PARTS:

A. Furnish the following:
   1. Twenty-five percent replacement but not less than six spare fuses of each voltage and current rating, for both primary and secondary fuses, used in the motor control centers.
   2. Two (2) spare coils of each size and type used.
   3. Other parts normally furnished by manufacturer and listed in Contractor's Proposal.
   4. One (1) solid-state breaker testing unit for main breakers.

PART 3 - EXECUTION

3.01 FIELD SERVICES:

A. Contract Price shall include 5 man-days and round trips necessary to perform the specified Field Services. The Contract Price will be adjusted up or down for the actual services used.
B. Motor Starters Tests and Checks:
   1. Expedite delivery of overload relays to the Project upon receipt of motor nameplate data from Resident Project Representative.
   2. Megger each pole of each starter for freedom from grounds.
   3. Check all fuses and air circuit breakers for proper rating. Expedite replacement if required.
C. Motor Control Center Assembly Tests and Checks:
   1. Check all safety interlock mechanisms for proper lubrication, adjustment and operation.
   2. Megger all power buses with a 1,000-volt megger. Grounded ac circuits, instruments, and fuses should not be meggered.
   3. Inspect all buses and insulators for condition and cleanliness.
   4. Check all fuses.
   5. Check all internal control and metering circuits for conformance with the Contract Drawings and Specifications.
   6. Owner will perform other field testing under a separate contract, including:
      a. Field high-potential test of motor control center buses.
      b. Check and measure Equipment grounds.
      c. Check operation of heaters in motor control centers.

END OF SECTION 262419

SECTION 262421 - 480-VOLT VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes individually enclosed, variable frequency drives (VFDs) and associated equipment.

B. Work in this Section includes furnishing the following:
   1. One (1) 480Vac VFD per rotary feeder or as required by Contractor's design.

C. Every variable frequency drive system shall consist of all system components required to meet the performance, protection, safety, testing, and certification criteria of this specification.

D. The VFD system must:
   1. Represent a fully integrated package. Any components not manufactured by the VFD manufacturer shall be purchased by the VFD manufacturer and supplied with the VFD.
   2. Include all material and labor necessary to interconnect any VFD system elements, even if shipped separately (excluding input harmonic filters).

E. Any modifications to a standard product provided to meet this specification shall be performed by the VFD manufacturer only.

F. The VFD system shall be completely factory pre-wired, assembled and then tested as a complete package by the VFD manufacturer, to assure a properly coordinated, fully integrated drive system.

G. Any third party certification, safety or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.

H. The Equipment specified in this Section shall also conform to the requirements of SECTION 260100.

1.02 CODES AND STANDARDS:

A. Provide equipment in full accordance with the latest applicable rules, regulations, and standards of:
   1. National Electric Code (NEC).
   2. Underwriters' Laboratories (UL).
   3. American National Standards Institute (ANSI).
   4. National Electrical Manufacturers Association (NEMA).
   5. Institute of Electrical and Electronics Engineers (IEEE).
   6. Federal Communications Commission (FCC).

B. VFDs shall be manufactured, assembled, tested and provided with a UL label.

C. Quality Standards: Variable frequency drives shall be manufactured by the VFD supplier at its own facility which has a quality assurance program.

D. Experience:
   1. It is the intention of this specification to purchase dependable and reliable equipment offering the best performance available from currently proven technology. All equipment furnished under this contract must, therefore, have documentation showing proof of actual operation for a minimum of three years in similar service. New components or design technologies that have less than three years of actual operating experience will not be accepted.
   2. The VFD manufacturer shall be able to demonstrate at least ten years of experience in manufacturing VFDs to demonstrate their capability to provide parts and service support.

1.03 DOCUMENTATION:

A. Submittals:
   1. Submit as specified in SECTION 013301.
   2. Submittals shall be custom prepared by the VFD system manufacturer for this specific application.
   3. Submittal information shall include, but not be limited to:
      a. Equipment dimensions, including cable entry locations, shipping splits and shipping weights.
      b. Block diagram showing the basic control and protection systems specifying the protection, control, trip and alarm functions at the different locations, the reference signals and commands and the auxiliary supplies.
      c. Electrical one-line diagram showing main and auxiliary circuitry, including main power input, VFD, system earthing and auxiliary supplies.
      d. Wiring diagrams, including external connection terminals.
      e. Product data sheets.
      f. Spare parts list.
      g. Certifications.
      h. Warranty.
      i. Efficiency and power factor values.
      j. Provide documentation on communication system interface along with a complete list of all available parameters and associated addresses.
      k. Provide paper documentation of the programmable logic controller program.

B. Final:
   1. Final documentation shall include the following:
      a. Start-up and commissioning instructions and data.
      b. Certified "as-built" drawings of all equipment with information listed above.
      c. Factory test report.
      d. Operation and maintenance manual.
      e. Manufacturer's service and repair support during and after warranty.
      f. Spare parts lists with supplier names and part numbers.
      g. Provide paper and electronic copy of programmable logic controller program.

C. In addition to other Submittal requirements, final drawings shall be furnished on CD-ROM in AutoCAD, .tiff, and Adobe *PDF formats.

1.04 DELIVERY:

A. VFD systems shall be installed in the PCM.

B. Complete instructions for handling and storage shall be provided prior to delivery of the equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. 480-Volt Variable Frequency Drives:
   1. Reference Appendix 011101-B.

2.02 VARIABLE FREQUENCY DRIVES:

A. General Requirements:
1. VFD shall be microprocessor based and utilize Pulse Width Modulation (PWM) for speed control of an induction motor.
2. The VFD shall utilize Insulated Gate Bipolar Transistors (IGBT's).
3. The VFD's shall be sized to operate the specified motors.
4. The VFD shall be capable of producing a variable AC voltage/frequency output to provide continuous operation of a standard induction motor over a 5-100% speed range.
5. As a commissioning and troubleshooting feature, the VFD power circuit shall be capable of operating without a motor connected to the VFD output.
6. VFD's rated for variable torque loads shall be capable of a momentary overload of 110% for one minute.

B. Input Protection:
1. The VFD shall be provided with an input circuit breaker.
2. The circuit breaker shall have a minimum 65,000 –AIC rms symmetrical minimum rating.
3. The circuit breaker shall be equipped with a door interlocked external operator and have provisions to be locked in the off position.

C. Motor Compatibility:
1. Motor life expectancy shall not be compromised in any way by operation with the VFD system. The VFD shall provide motor overload protection in any operating condition.
2. VFD output waveform shall be suitable for operating a squirrel cage induction motor without derating or requiring additional service factor.
3. The system design shall not have any inherent output harmonic resonance in the operating speed range.
4. The VFD output shall produce no electrically induced pulsating torque to the output shaft of the mechanical system eliminating the possibility of exciting a resonance caused by VFD induced torque pulsations.
5. VFD shall protect motor from high-voltage $\delta v/\delta t$ stress which would cause insulation breakdown of an "inverter ready" motor. If the VFD requires an output filter to meet this requirement, it shall be an integral part of the VFD system and included within the VFD enclosure.
6. Output filters shall be provided if required by VFD supplier.

D. VFD System Efficiency:
Nominal VFD system efficiency shall be a minimum 96% at 100% speed and 100% load and minimum 95% at 80% speed and 50% load.

E. System Input Power Factor: VFD system shall maintain a 96% minimum true power factor from 30% to 100% of rated speed.

F. Speed Regulation: VFD speed regulation shall be ±0.5% without encoder or tachometer feedback.

G. Sound Level: Maximum allowable audible noise from the VFD system will be 85 dB(A) at a distance of one meter (3.3 ft) at any speed or load condition. VFD systems with audible noise in excess of this limit shall be provided with sufficient noise abatement treatment to reduce the sound pressure level below 85 dB(A).

2.03 AVAILABILITY AND RELIABILITY:

A. Firing Signals: All internal firing signals, and other communications (which link operational controls with power components such as status and diagnostic signals) shall meet noise immunity and safety requirements as defined by applicable IEEE Standards.

B. Power Sag Ride-Through: The VFD system shall be capable of continuous operation with a 20% voltage sag on the input power line.

C. "Catch-A-Spinning-Load" Capability: The VFD system shall be able to catch and take control of a spinning load if started while rotating equipment is already spinning. Appropriate safeguards shall be included in this operation to prevent damaging torque(s), voltages or currents from impacting any of the equipment. The user shall have the option of employing this feature or disabling it.

D. Auto-Restart Capability: The VFD system shall be capable of automatically restarting in the event of a power failure or drive trip. The VFD system shall provide the user with the choice of automatically restarting or not. The user shall be able to selectively apply this feature to some (but not necessarily all) conditions as determined by the user to be appropriate for the specific application.

E. Ground Fault Withstand: In the event of a ground fault, the VFD shall annunciate the ground fault condition and trip offline to clear the fault. The cause of the shutdown shall be logged to the fault history and be available at the keypad. There shall be no risk of fire or electric shock as a result of the ground fault. The VFD's will be installed on a 480V, 3-wire, solidly ground system.

2.04 SERVICEABILITY/MAINTAINABILITY:

A. Front Access: VFD system shall be designed for front access only.

B. Power Component Accessibility: All power components in the converter sections shall be designed for easy removal and accessibility to minimize repair downtime.

C. Marking/Labeling: Sleeve type wire marker tags or other acceptable means of permanent identification shall be applied to power and control wiring. Individual nameplates shall be provided for all major components of the VFD system.

2.05 PHYSICAL REQUIREMENTS:

A. Environmental Requirements: VFD system shall be capable of continuous operation at site conditions, without derating.

B. Heat Dissipation/Cooling System:
   1. VFD system shall be air-cooled.

C. Enclosure: VFD and auxiliary components shall be housed in a NEMA 12 enclosure.

D. Installation/Cabling: All VFD system wiring (power, control and protection) shall be located internally within the VFD system enclosure. If special requirements of the project require that one or more VFD system components must utilize external cabling or connections to complete the VFD system (excluding separately mounted input harmonic filter), this cabling and connecting shall be entirely supplied and/or contracted by the VFD system supplier, and approved by the Engineer. All external power conductors shall be insulated. Power wiring shall be isolated by voltage class. Control and instrument wiring shall be isolated from power wiring.

E. Control Power:
   1. Provide a suitable sized 480 volt to 120 volt single phase control power transformer to power all cooling fans and auxiliary devices if necessary and control power for digital inputs.

2.06 PROTECTIVE DEVICES/DIAGNOSTICS:

A. Protective Features and Circuits:
   1. The controller shall include the following alarms and protective features:
      a. Static instantaneous over-current and over-voltage trip.

b. Under-voltage and power loss protection.
c. Over-temperature protection.
d. Electronic motor inverse time overload protection.
e. When power is restored after a complete power outage, the VFD shall be capable of catching the motor while it is still spinning and restoring it to proper operating speed without the use of an encoder.

2. The VFD system shall be protected from damage due to the following, without requiring an output contactor:
   a. Single-phase fault or three-phase short circuit on VFD system output terminals.
   b. Losses of input power due to opening of VFD input disconnect device or utility power failure during VFD operation.
   c. Loss of one (1) phase of input power.
   d. Motor regeneration due to backspin or loss of VFD input power.
3. The VFD shall be able to withstand the following fault conditions without damage to the power circuit components:
   a. Failure to connect a motor to the VFD output.
   b. VFD output open circuit that may occur during operation.

B. Data Displays:
1. A door-mounted LCD display shall be furnished, capable of displaying the VFD operational status and drive parameters. The digital display shall present all diagnostic message and parameter values in English engineering units when accessed, without the use of codes.
2. As a minimum, the following door mounted digital indications shall be supplied:
   a. Speed demand in percent.
   b. Output current in amperes.
   c. Output Frequency in hertz.
   d. Output voltage.
   e. Total 3-phase kW output.
   f. Kilowatt hour meter.
   g. Elapsed time running meter.
   h. Run status.
   i. Fault status.
   j. Actual speed in RPM.
   k. Power available.
   l. Drive On or Drive Off.
   m. Drive in Remote or drive in Local.

C. Diagnostics and Fault Recording:
1. The control logic section shall be fully digital and not require analog adjustment pots or fixed selector resistors.
2. Fault log data shall be stored in nonvolatile memory.
3. The VFD shall include a comprehensive microprocessor based digital diagnostic system which monitors its own control functions and displays faults and operating conditions.
4. A "FAULT LOG" shall record, store, and display upon demand, a minimum of the last four fault events.

2.07 PROGRAMMING AND COMMUNICATIONS:

A. User Input/Keypad:
1. The door of each power unit shall include a mode selector switch marked "Local/Off/Remote," LED indication lights, and pushbuttons.

2. A door-mounted keypad with integral digital LCD display shall be furnished, capable of controlling the VFD and setting drive parameters. The display shall present all diagnostic message and parameter values in standard engineering units when accessed, without the use of codes. The keypad shall allow the operator to enter exact numerical settings in standard engineering units. A plain English user menu (rather than codes) shall be provided in software as a guide to parameter setting.
3. Drive parameters shall be factory set in non-volatile EEPROM registers and re-settable in the field through the keypad. Password security shall be available to protect drive parameters from unauthorized personnel. The EEPROM stored drive variables shall be able to be transferred for programming of new or spare boards.
4. The keypad module shall contain a "self-test" software program that can be activated to verify proper keypad operations.
5. The VFD system shall have the user selectable option of programming up to three speed avoidance bands. This gives the user the ability to block out and prevent operation at any undesirable speed, such as one that may be coincident with a mechanical resonance condition.

B. Hard-Wired I/O and Control Devices:
1. The VFD shall include programmable I/O for application specific configuration. The drive shall be configurable to operate in a local and remote mode. The drive shall provide for the following programmable input/output points to be associated with the control functions:
   a. Digital Inputs:
      (1) Provide a minimum of 6 fully programmable inputs configured for Owner's use.
   b. Digital Outputs, Form C Relay (Dry Contact rated a minimum of 2 Amps at 120 Vac and 0.2A at 125Vdc);
      (1) Provide a minimum of 4 fully programmable outputs configured for Owner's use.
      (2) One output shall be used to control 120VAC power to the motor space heater if applicable.
   c. Analog Input:
      (1) One 4-20 mA isolated input to control drive output (motor speed).
   d. Analog Output:
      (1) One 4-20 mA isolated output signal representing drive speed and scaled 0-100%.
2. All programming shall be done at the factory and tested at the factory.
3. Provide terminal blocks, pushbuttons, indicating lights and control relays to provide control, indication, and isolation of field-mounted devices.
4. The VFD shall be capable of implementing a speed control PID loop to maintain a level setpoint.

C. Serial Communication and Protocols:
1. VFD shall be capable of direct communication to an IBM or compatible computer for serial link setup of parameters, fault diagnostics, trending and diagnostic log downloading. Provide software required.

2.08 COMPONENT REQUIREMENTS:

A. Printed Circuit Boards: All printed circuit boards shall be new. They shall be conformably coated for moisture and chemical resistance, in addition to any dielectric coating properties. All boards shall be tested as specified.

B. Wiring:
   1. All control wiring shall be physically separated from the power wiring. Low and high voltage cables shall be physically isolated from each other. The VFD system shall be pre-wired within the enclosure. Spade type connectors are not acceptable. No soldering shall be used in connection with any wiring. Wiring shall be adequately supported to avoid tension on conductors and terminations. All wiring shall be run in surface mounted conduit or wire-ways. Any section of wiring outside of conduit or wire-way shall be securely tied with cable ties at intervals not exceeding 6 inches. No cables shall be tied off to or in any way supported from power busses. Wherever wiring passes metal edges or through holes, suitable guards or grommets shall be provided to prevent cutting or chafing of the insulation.
   2. All terminal blocks shall have at least 20% spares. No more than two wires shall be terminated on one terminal.
   3. All wiring shall be tagged with permanent labels at each termination, junction box, and device.
   4. Ground Connection: Corrosion resistant grounding pads or terminals shall be provided in each power cubicle. A copper ground bus shall be provided for grounding of control circuits.

C. Input Power Terminations: Input and output power connections shall be made to isolated, supported and plated bus strap connections or terminal blocks. Sufficient space shall be provided for termination connections from the top or the bottom of the VFD cubicle.

D. All VFD devices shall be supported from the cabinet structure, not from current carrying components.

2.09 FACTORY TESTING:

A. Subassembly Tests:
   1. Printed circuit boards shall be visually inspected and functionally tested. All boards shall be tested individually prior to assembly to minimize any impact faulty boards may have on delivery schedules and system reliability. Each board shall be load and temperature cycled during the manufacture's standard burn-in test. Any boards that exhibit drift during the test shall be replaced with boards that have successfully completed the burn-in without drift.
   2. Power assemblies shall be visually inspected and tested. Complete diagnostics and logic shall be tested. The complete power conversion circuit shall be thoroughly tested at 100% load for a minimum of one hour and then tested for one minute at momentary overload rating, to reduce potential problems in advance of final system testing.

B. System Level Tests:
   1. The system shall be given preliminary checks including verification of electrical connections including ground connections, power and control wiring shall be resistance checked point-to-point. E-prom and EE-prom shall be checked for correct revision level. Visual check shall be performed to verify: degree of protection for cabinets, input isolation is lockable in the off-position, marking of terminals and wiring, space availability for cable termination, accessibility of components and ease of maintenance and repair. The VFD system shall be fully checked against the approved drawings for compliance and correct physical dimensions.
   2. All control voltage levels are to be checked and verified.
   3. A no load test is to be performed on the system. Drive is to be connected to an unloaded motor and feed back signals shall be verified. Output voltage shall be calibrated. All logic and interlocks including customer logic and instrumentation shall be tested.

2.10 SPARE PARTS:

A. A list of manufacturer's suggested spare parts and associated costs shall be provided with the submittal. As a minimum, the following spare parts shall be provided:
   1. Three of each type of power and control fuse supplied.
   2. Three of each type of indicating light bulb supplied.
   3. One each printed circuit board supplied, including communication and I/O modules.

B. All parts supplied with the equipment shall be properly labeled for ease of identification and to permit the shortest possible time to repair. Any parts that come from a sub-supplier shall be labeled with that manufacturer's name and part number. Manufacturer shall state closest point where spare parts are stocked and where service can be obtained. Manufacturer shall warrant that all parts shall be available for a minimum of ten years.

PART 3 - EXECUTION

3.01 FIELD SERVICES:

A. The field services commissioning will be performed by others. If requested, the Contractor shall furnish service personnel to supervise as required.

B. The field services commissioning of the VFD shall include at a minimum the following:
   1. VFD unit inspection.
   2. Coupled run of feeder and motor.
   3. Set up of integral controller.
   4. Loop check of DCS controls.

C. Contractor shall provide time in the bid price to allow for all commissioning and start up activities under the conditions described above.

D. Field services time shall not be used to correct manufacturing defects or warranty work.

END OF SECTION 262421

DIVISION 40 - PROCESS INTEGRATION

SECTION 409125 – MEASUREMENT AND CONTROL INSTRUMENTATION FOR PACKAGED SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the requirements for instrumentation and control Work by this Contract. Furnish instrumentation and control devices required for a complete operational package. In general, Work includes, but is not limited to, the following:
   1. Furnish packaged equipment and devices with instrumentation and controls as specified.
   2. Furnish all instruments, meters, gauges, switches, controllers, thermometers, indicators, and transmitters as required for a complete system.
   3. Furnish instrumentation as required to properly monitor and control the equipment supplied by this Contract in a fully automatic mode. Include instrumentation for all equipment operation including startup, normal and shutdown modes.
   4. Design, shop install, and test all skid-mounted instruments.

B. Furnish all Materials for complete installation of shipped-loose instrumentation. Coordinate the physical arrangement and mechanical connections with Equipment and structures also furnished by this Contract.

C. Related Work Specified Elsewhere:
   1. SECTION 011101 – SUMMARY OF WORK.
   2. SECTION 013301 – SUBMITTALS.

1.02 REFERENCES:

D. Design, fabricate, assemble, test and install Equipment and Materials in accordance with the manufacturer's recommended procedures and to the applicable provisions of the following codes and standards:
   1. American Society of Mechanical Engineers (ASME):
      a. Power Piping - Code for Pressure Piping, B31.1.
      b. Thermowells – Performance Test Code, PTC 19.3 TW.
   2. ASTM International (ASTM, formerly known as American Society for Testing and Materials):
      a. A182/A182M - Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      b. A213/A213M - Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes.
      c. A1016/A1016M General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes.
   3. American Welding Society (AWS).

1.03 DEFINITIONS:

A. Blowback Valves: 4-way selector ball valves located in the sensing line between the instrument shutoff valve and the root valve. Used to clear the sensing line by applying air pressure toward the process connection, while constantly isolating the instrument from the air supply and venting the sensing line before returning the instrument to service.

B. Instrument Blowdown Valves: Located on the dirt leg in the process sensing line at or near the instrument. Used to clear the sensing line of accumulated dirt, liquid, scale or other debris by using the process fluid.
C. Instrument Manifold Valves: Located in the process sensing lines at, near, or directly bolted to a differential pressure instrument. Used to isolate the instrument for normal maintenance or calibration. These valves are separate from and in addition to the Root Valve.
D. Instrument Shutoff Valves: Located in the sensing line and air supply lines at or near the instrument. Used to isolate the instrument for normal maintenance or calibration. These valves are separate from and in addition to the Root Valve.
E. Root Valves: Located at the take-off connection of the process piping or equipment. Used only for maintenance of the sensing line or associated valves. These devices are separate from and in addition to Instrument Manifold Valve or Instrument Shutoff Valve.
F. Instrument Stand: Generic term used to refer to either Instrument Horns to mount one or two instruments or Instrument Racks that can mount up to six instruments. Used as a mounting means for instruments and their accessories.

1.04 SUBMITTALS:

A. For Equipment and Material submit as specified in SECTION 013301 including appendices:

1.05 QUALITY ASSURANCE:

A. Qualifications:
1. All Equipment and Materials shall have an acceptable history of satisfactory reliable service in similar use for a period of at least three years at comparable pressure, temperature, voltage and design stress level.
2. Equivalent newly developed equipment with less than three years actual service will be considered, from established manufacturers, if it has been adequately tested, meets the requirements of this Contract, and is approved by the Engineer.
B. Factory Tests:
1. Notify Engineer when factory tests are to be made, with sufficient notice such that a representative may be present, if desired.
2. Perform all manufacturer's standard factory tests on instruments.
3. Perform all tests required by the applicable codes and standards.
4. Submit certificates of completion of factory tests as compliance Submittals.
C. Welding Procedures and Qualifications:
1. Prepare welding procedures as follows:
a. Include certified copies of the qualification test records as evidence that the procedures have been qualified in accordance with the latest revisions of the following codes:
(1) Power Piping Code.
b. Submit in a form similar to the "Recommended Forms of Procedure Specifications" outlined in the above codes.
2. Qualify all welders and welding operators in accordance with the following:
a. Qualify in strict compliance with the following codes:
(1) Power Piping Code.
b. Qualify for each welding procedure to be used.
3. Submit welding qualification test records.

1.06 DELIVERY, HANDLING, AND STORAGE:

A. Protect all instruments, including shipped-loose or installed in-place, during shipment from ambient temperature, moisture and physical abuse which may cause:
   1. Damage to delicate meter movements, mechanisms, or electronics.
   2. Corrosion.
   3. Reduced normal operating life.
B. Protect all finished instrument and controls process and electrical connections with suitable end covers to prevent entrance of foreign material.
C. Protect instrument threads and stems from damage.
D. Tag all Equipment and Material according to this Section, PART 2 – DEVICE TAGGING, before shipping to site.
E. Ship Equipment and Material assembled as complete as possible.

PART 2 - PRODUCTS

2.01 GENERAL:

A. All instrumentation and mounting hardware shall be suitable for the temperature, pressure, voltage, ambient conditions and stress levels per the system design.
B. Maximum design pressure and temperature shall be as defined in Power Piping - Code for Pressure Piping, B31.1.
C. All instruments shall meet the requirements of the approved vendor list included in APPENDIX 011101-B.
D. Where possible the same manufacturer and model numbers shall be furnished for individual applications to reduce the overall number of spare parts the Owner will need to store and maintain.
E. All instruments shall be installed per manufacturer's recommendations.
F. All skid mounted instrumentation shall be accessible from a standing position from a floor or platform.
G. All locally mounted indicating instruments shall face toward the normal operating area and shall be within reading distance.
H. All instruments shall be mounted so that the enclosure for terminations or maintenance is easily accessible.
I. All skid mounted instrumentation enclosures shall be supplied with NEMA 4X or IP65 enclosures unless installed in an electrically classified hazardous area. If installation location is in an electrically classified hazardous area as defined by the NEC, the enclosure shall meet the requirements of the electrical classification.
J. Furnish with all necessary auxiliary systems required for a complete overall workable mechanical system conforming to the intent of this Contract.
K. Furnish instrumentation for performance testing and performance monitoring.
L. Furnish complete, coordinating the physical arrangement and mechanical connections with equipment and structures also furnished by this Contract.
M. Furnish all portable interface communication devices to allow for setup, calibration, and diagnostics, of Equipment and Materials furnished by this Contract. Where more than one type of portable device is required to interface with the various Equipment and Materials, furnish at least one of each type of communication device.
N. Furnish all power supplies, transformers, rectifiers, or other devices required to interface with the DCS.

O. Requirements for Instrument Material:
   1. Use new, unused, first-quality materials free of defects.
   2. Use materials suitable for their application, and for the temperature, pressure, voltage, ambient conditions and stress levels per the system design.
   3. Furnish as required for complete installation ready for operation.

P. Instruments, control devices and accessories furnished by this Contract shall not contain mercury.

2.02 DEVICE TAGGING:

A. Furnish 316 stainless steel minimum 0.040 inch thickness with correct Engineer's tag number and service description stamped, engraved, or laser etched clearly into the metal.
B. Device tags minimum dimensions for each tag shall be 1-inch tall by 2-inches wide.
C. Device tags shall be permanently attached with minimum 18 gauge stainless steel wire to the stem or case of each device, use of string or tape is unacceptable.
D. The Owner reserves the right to change tag numbers that are initially submitted by Engineer or sub-vendors in order to maintain continuity of the Owner's tagging scheme.
E. Furnish and attach a device tag to all devices shipped to site by this Contract, whether furnished by this Contractor or by others.

2.03 TRANSMITTERS:

A. Unless specifically specified or indicated otherwise, transmitters shall satisfy the following:
   1. Each transmitter shall be selected and adjusted for the maximum design conditions.
   2. Furnish transmitters with local indication of the measured parameter in engineering units.
   3. Devices shall be designed to operate continuously under the conditions specified.
   4. For all pressure transmitters with instrument shutoff valves, furnish mounting brackets to mount the transmitter. Transmitter shall be mounted to pipe stand, instrument rack, or other specified rigid device.
   5. For all pressure or differential pressure transmitters with instrument manifold valves, furnish mounting brackets to mount the instrument manifold valve, not the transmitter. Manifold shall be mounted to pipe stand, instrument rack, or other specified rigid device.
   6. Transmitter ranges shall be selected such that the normal operating conditions are within 50 to 85 percent of calibrated range. Ranges shall be used for factory calibration.
   7. Furnish calibration certificates for all transmitters furnished as part of this Contract, whether the instruments are furnished by this Contractor or others.
   8. Furnish pressure and differential pressure transmitters with diaphragm seals, where necessary, to protect sensitive components from corrosive process fluids. Diaphragm seal material shall be designed for long-term service in the process environment it is placed. Process connection for transmitters supplied with diaphragm seals shall be a 1/2" threaded, for dirty water service or heat trace purposes and 2" flanged to prevent plugging in slurry or similar services with high potential for plugging.

2.04 PROCESS SWITCHES:

A. The use of process switches shall be avoided, unless specifically approved otherwise by Owner. Transmitters shall be used for all control applications including but not limited to permissives and interlocks. Switch elements:
   1. Interrupting Rating: 120VAC, 5 amperes or 125Vdc, 5-ampere.

2. Enclosure shall be NEMA 4X unless otherwise specified or indicated. With threaded conduit connection, 1/2-inch or 3/4-inch size.

B. All switches shall be DPDT if available based on manufacturer's standard instrument design.

C. To the extent that switch setpoints are known, instrument ranges shall be such that the setpoint is between 1/3 and 2/3 of the total adjustment range.

D. Switch setpoints shall be field-adjustable. However, the adjustment means shall be enclosed or otherwise made tamper resistant.

E. Wetted materials shall be suitable for the application.

F. Switch dead band shall not exceed 5% of the adjustment range.

G. Gage and differential pressure switches:
1. Electro-mechanical type, where switch elements are actuated or de-actuated by mechanical link to a diaphragm which is influenced by the monitored pressure.
2. Install with plugged test connections between the instrument and its isolation valves.
3. Furnish gage pressure switches with instrument isolation valves.
4. Furnish differential pressure switches with instrument manifold valves.
5. Furnish pulsation dampeners as specified or required.
6. Factory-adjust each switch to the setting specified or required before shipment to the jobsite. Indicate the factory setting on the device tag.

H. Temperature switches:
1. Electro-mechanical type where temperature is detected indirectly as the vapor pressure of a fluid sealed inside a bulb and capillary system. Vapor pressure actuates or de-actuates the switch elements via a sensing diaphragm.
2. Sensing elements:
   a. Capillary shall be stainless-steel interlocked spiral armor or stainless steel tubing on capillary.
   b. Bulb shall be straight unless otherwise specified or indicated, sized for capillary length furnished, union-connected to well.
   c. Well shall be furnishing for each switch, as specified or required.
3. Factory-adjust each switch to the setting specified or indicated before shipment to the jobsite. Indicate the factory setting on the device tag.

2.05 FLOW MEASUREMENT

A. Size and install flow elements in strict accordance with the manufacturer's recommendations, taking into account line size, expected flow rates, flow media characteristics, upstream and downstream pipe requirements.

B. Maximum pressure drop across the sensing element shall be subject to Engineer approval.

C. Flow elements which are easily accessible or have designed maintenance access shall have direct-mount transmitters. For all other flow elements the transmitters shall have remote mount transmitters located to facilitate accessibility and maintenance access.

D. Furnish calibration certificates with all flow elements.

E. Air mass flow:
1. Thermal dispersion flow transmitter.
2. With 120 VAC power requirements.
3. With 4–20 mA HART output.
4. With RS-232 cabling and all software required to connect and use vendor propriety software to Owner's laptop.
5. Set the instrument K-factor for the operating design conditions.

F. Differential pressure flow measurement in accordance with the following, as applicable:
   1. Flow elements and installation shall meet the requirements of ASME MFC-3M.
   2. Beta ratio of the flow element shall be greater than 0.5 and less than 0.75.
   3. Furnish orifice plate, venturi and flow nozzle flow rate calculation sheets.
   4. Furnish and calibrate flow transmitters for square-rooting of the flow signal to be performed in the DCS.

2.06 LEVEL MEASUREMENT:

A. Design level measurement such that the technology is appropriate for tank geometry and equipment layout, so that filling, mixing, or other operations shall not interfere with accurate and continuous measurements.
B. Level transmitters shall be 4-20 mA devices, capable of HART communication.
C. Furnish one Rosemount 475 communicator for Owner maintenance.
D. Radar non-contact:
   1. May be used in most liquid or bulk solid level applications, except where freezing process fluid interferes with the signal back to the DCS.
   2. Transmitters shall have local LCD indication of the measured parameter in English engineering units.
   3. Include built-in temperature sensor for temperature compensation.
   4. Transducer surfaces exposed to tank contents shall be Teflon or Owner approved equal.
   5. Transmitter shall be 120 VAC field powered.
   6. Accuracy shall be better than 0.5% of range.
E. Guided Wave Radar level transmitter:
   1. With Owner approval may be used in all liquid, foaming liquid or bulk solid level applications.
   2. Each transmitter shall be selected and adjusted for the service and operating conditions required and shall be designed to operate at the maximum conditions expected.
   3. Transmitters shall have local LCD indication of the measured parameter in English engineering units.

2.07 THERMOCOUPLES AND RESISTANCE TEMPERATURE DETECTORS:

A. Thermocouple and RTD temperature measurements shall be directly wired to the DCS and therefore do not require temperature transmitters or a 4-20mA signal.
B. Bearing thermocouples shall be as follows unless otherwise specified.
   1. Dual Type E. No. 20 AWG ungrounded chromel-constantan wires with compacted ceramic insulation in 316L stainless steel sheath. Sheath mounted spring loaded.
   2. Universal type head with screwed cover and chain and terminal connectors.
   3. Three inch extension union nipple made of 304 stainless steel.
C. Pipe Thermocouples shall be as follows:
   1. Dual Type E No. 16 AWG ungrounded chromel-constantan wires with compacted ceramic insulation in 304 stainless steel sheath. Sheath mounted spring loaded.
   2. Universal head type with screwed cover and chain and terminal connector.
   3. Three inch extension union nipple made of 304 stainless steel.
   4. Thermowell as specified this Section, PART 2 - ACCESSORIES.
D. Motor winding RTD over temperature sensors shall be general purpose RTDs with armored leads as follows:
   1. 10 Ohm Copper, 3-wire element.

2. 1/8-inch OD, 316 SS sheath.
3. Temperature range from -180 to 250 C.
4. Fiberglass insulated lead wiring with flexible SS armored tubing, wires with bare ends.
5. Mounting on tube fittings.

E. RTDs for other applications shall be general purpose RTDs:
1. 100 ohm, platinum, 3-wire element.
2. 1/8-inch to 1/4-inch OD, 306 SS sheath.
3. Temperature Range from -180 to 250 C up to -180 to 500 C.
4. Fiberglass Lead Wiring insulated with flexible SS armored tubing, wires with bare ends.
5. Mounting on tube fittings.

2.08 PRESSURE MEASUREMENT:

A. Gage and differential pressure transmitters shall have at least the following specifications:
1. Model transmitter shall be in the highest accuracy performance class offered by that manufacturer.
2. Housing shall be aluminum with manufacturer standard coating.
3. Diaphragm and wetted materials shall be 316 SS.
4. With LCD Display.
5. Pressure transmitters shall be 4-20 mA devices, capable of Honeywell DE communication.
a. Furnish Honeywell STS 103 Communicator for Owner maintenance.

B. Pressure Gauges:
1. Select scale range so that normal operating pressure is between 1/3 and 2/3 of full scale and design pressure is less than 3/4 full scale.
2. Element shall be Bourdon tube or bourdon coil.
3. Bourdon tube and socket materials shall be 316L SS.
4. Phenolic case with solid-front, blow out back protection.
5. 4-1/2 inch dial size, weatherproof.

2.09 THERMOMETERS:

A. Bimetal:
1. 5-inch dial size.
2. Furnish all welded stainless steel case and stem. Materials of construction for wetted parts shall conform to the material of the line or equipment into which installed.
3. Straight stem, length as required by thermowell dimensions.
4. Bottom connection type.

2.10 LOAD CELLS

A. Load cells shall be sealed to prevent moisture and be pressure insensitive.
B. Load cells shall be shaded from the sun.
C. Load cells for a given silo shall all wire back to a single transmitter with 4-20mA signal back to the Owner's DCS.

2.11 ZERO SPEED SWITCHES

A. Zero speed switches may be furnished in place of underspeed switches.
B. Flexible couplings shall be either non-lubricated or permanently lubricated.

2.12 UNDERSPEED SWITCHES:

A. Underspeed switches may be furnished in place of zero speed switches.
B. One per mechanical device, direct connected, flex-coupled, non-contacting proximity sensor on the shaft.
C. Furnish with speed increasers where necessary.
D. Flexible couplings shall be either non-lubricated or permanently lubricated.

2.13 ACCESSORIES:

A. Accessories for pressure-sensing devices shall be as follows:
   1. Pulsation dampeners shall be furnished for direct mount pressure gauges in fluctuating pressure service.
B. Thermowells:
   1. Furnish a thermowell for each temperature sensing element unless otherwise specified or indicated.
   2. Insertion length shall insure thermowell is into flow path, not to exceed maximum length to maintain resonant frequency of the thermowell below break-point per ASME PTC 19.3 TW.
   3. Lagging extension shall be as required to insure thermowell wrench flats extend ¼ inch past insulation.
   4. Furnish thermocouples assembled with thermowells, handle as one assembly.
   5. Wells shall be step-less tapered constructed in accordance with ASME PTC 19.3 2010.
   6. Material shall be 316 stainless steel or as specified for the line or equipment into which the thermocouple assembly is installed, unless otherwise specified, indicated or approved by Engineer.

2.14 MISCELLANEOUS INSTALLATION MATERIALS:

A. Tubing:
   1. Tubing and piping materials shall be as specified, and shall meet the requirements of ASME Power Piping - Code for Pressure Piping, B31.1.
   2. Tubing shall be ASTM A213 seamless, grade TP316 stainless steel, min wall, fully annealed and suitable for bending. Hardness not greater than Rockwell B90:
      a. Minimum allowable wall thickness:

Outside Diameter (inches)	Min. Wall Thickness (inches)
1/2	0.049

B. Fittings:
   1. Grip-type flareless tubing fittings shall be Swagelok, 4-piece type.
   2. Do not apply thread lubricant to grip-type tubing fittings.
   3. Socket weld-type tubing fittings shall be Swagelok.
C. Flexible Instrument Tubing:
   1. Flexible instrument tubing shall be nylon or corrugated hose braided and reinforced, with permanently attached male pipe thread ends.
   2. Braid: 316 or 321 stainless steel.
   3. Fittings: As specified or indicated for service.
   4. Length: As specified or indicated for service.

D. Tubing Supports:
   1. Tubing support material shall include structural angles, channels, clips, rods, anchors, turnbuckles, modular support systems, as required in ASME Power Piping - Code for Pressure Piping, B31.1, Paragraphs 121 and 122.3 for the tubing as specified.
   2. Support materials shall be compatible with the tubing materials. Furnish all insulators or other accessories to protect dissimilar metals from each other as required by the manufacturer.
   3. Furnish approved vibration isolating materials as required by the Engineer to prevent tube surface damage due to rubbing on supports or other tubes.

E. Heat-traced tubing bundle:
   1. Heat-traced tubing bundle and heated instrument enclosures shall be furnished for all tubing located outdoors and contains steam, water, moist air, or moist gas. The purpose of the heat-traced tubing bundle is freeze protection.
   2. Instrument heat-traced tubing bundle shall be integrally packaged tubing, insulation, heating cable and protective jacket.
   3. Process tubing shall meet this Section, PART 2 – MISCELLANEOUS INSTALLATION MATERIALS: Piping & Tubing specified above.
   4. Single tube for gauge pressure applications.
   5. Dual tube for differential pressure applications.
   6. Jacket material shall be thermoplastic polyether urethane (TPU) elastomer.
   7. Insulation shall be nonhygroscopic glass fiber.
   8. Heater cable shall be sized for the following criteria:
      a. Power source of 120VAC.
      b. Maintain at least a 50 Deg F maintenance temperature of the process fluid.
   9. Jacket temperature shall not exceed 140 Deg F.
   10. Self-regulating with intermittent exposure blowdown temperatures below 185 Deg F bundle jacket color shall be blue.
   11. Furnish tubing bundles assembled to heated instrument enclosures, such that the complete instrument installation can be feed from a single power feed.

F. Heated Instrument Enclosures:
   1. Heated instrument enclosures shall be furnished for all instruments located outdoors that require freeze protection. The purpose of the enclosure is freeze protection.
   2. Enclosures shall be constructed of rigid insulating polyurethane or urethane, conforming to IP65 rating for watertight and weatherproof enclosures. Soft case, flexible instrument enclosures shall not be allowed.
   3. Enclosure shall have a fully gasketed diagonal opening with lid support.
   4. Enclosure shall include window for viewing instruments which have gauges, indicators, faces, or displays without opening the enclosure.
   5. Install all instrument enclosure internals including the instrument valving, tubing, fittings, mounting materials, and enclosure heaters inside the enclosure.
   6. Latches and hinges shall be stainless steel.
   7. Drains shall be installed to prevent liquid accumulation in the enclosure.
   8. Blowout discs shall be installed to prevent over-pressurization in the enclosure.
   9. Furnish a stainless steel nameplate for each enclosure. The nameplate shall include the instrument stand tag number and the instrument tag numbers of each instrument installed in the enclosure. The nameplate shall have the tag numbers stamped on it and shall be permanently attached to the front exterior of the enclosure.

10. Include a 110 VAC electric heater with thermostat. Heater shall be sized to maintain a 50oF interior temperature based on the site ambient conditions as specified in SECTION 011101.
11. For each heat-traced tubing bundle entry use bulkhead fittings.
12. Attach to all heated enclosures an external Stainless Steel NEMA 4X terminal box containing a fixed terminal strip for all heat trace power connections.
13. The power supply for the heat-traced tubing bundle and the enclosure heater shall be integrated into a single location at the enclosure.
14. Blowdown valves shall be mounted inside the enclosure to allow devices to be blown down. Install with adequate access for all enclosure internals.
15. Instrument enclosure manufacturer shall be the same manufacturer for the heat-traced tubing bundle specified in this Section, PART 2 – HEAT-TRACED TUBING BUNDLE.

2.15 INSTRUMENT BLOWBACK VALVES:

A. Valves shall be installed and tubed to prevent high-pressure air from being transmitted to the instrument, either from the air source directly or from a plugged sensing line that fails to clear.
B. Construction:
   1. Body: 4-way ball valve, all bar stock.
   2. End Connections:
      a. Tubing Systems: Use integral tube fittings or adapter tubing fittings.
      b. Piping Systems: As specified or indicated.
   3. Rotation: 270 degrees.
   4. Include three-position factory-engraved nameplate. Engravings shall read "INSTRUMENT-VENT-BLOWBACK."
C. Blowback valves shall be compliant with ASME Power Piping - Code for Pressure Piping, B31.1.

2.16 INSTRUMENT MANIFOLD VALVES:

A. Manifolds shall be installed to allow operators to test or vent each process sensing line for instrument calibration without removing or disconnecting instrument manifold valve.
B. Shop or field fabrication of instrument manifold valves using individual instrument valves and tubing or piping is not acceptable.
C. Construction:
   1. Body: 2500-pound ANSI class 316 SS.
   2. Packing: Grafoil®.
   3. Trim: 316 SS.
   4. Seats: metal-to-metal seats.
D. Manifold valves shall be compliant with of ASME Power Piping - Code for Pressure Piping, B31.1.

2.17 INSTRUMENT SHUTOFF VALVES:

A. Instrument shutoff valves shall be used for either:
   1. Air Isolation: Installed to isolate the instrument air system from individual air users.
      a. Construction:
         (1) Body: Shutoff valve shall be rated at least 400 psig at 150 Deg F, bronze.
         (2) Packing: Reinforced Teflon.

(3) Seats: Reinforced Teflon.
(4) Trim: 316 stainless steel ball and stem.
(5) End connections:
(a) Tubing systems: Use integral tubing fittings or use adapter tubing fittings.
(b) Piping systems: As specified or indicated.

2. Process Fluid Isolation: Installed to allow operators to test or vent the process sensing line for instrument calibration without removing or disconnecting instrument shutoff valve.
a. Construction:
(1) Body: 2500-pound ANSI class 316 SS.
(2) Packing: Grafoil®.
(3) Seats: Metal-to-metal.
(4) Trim: 316 stainless steel.
(5) Valve Orifice: 0.174 inch minimum.
(6) End connections:
(a) Tubing systems: Use integral tubing fittings or use adapter tubing fittings.
(b) Piping systems: As specified or indicated.
b. Instrument shutoff shall be compliant with ASME Power Piping - Code for Pressure Piping, B31.1.

B. Shop or field fabrication of instrument shutoff valve using individual instrument valves and tubing or piping is not acceptable.

2.18 POSITIONERS FOR CONTROL VALVES AND DRIVES:

A. Pneumatic operators shall be as follows:
1. All pneumatic operators shall be spring-opposed diaphragm operators or linear spring cylinder actuators unless specified otherwise.
2. Size selection shall result in stable operation under maximum pressure drop conditions with 60 psig to 90 psig air supply pressure to positioner or controllers, as applicable to each particular valve.
3. Actuator shall be sized to open or close the valve against 120 percent of the maximum differential pressure.
4. Actuator sizing shall take into account, dynamic unbalanced forces including flow and stem friction.
5. Diaphragms shall be nylon reinforced neoprene or Buna-N and diaphragm housing shall be of pressed steel construction.
6. Include stem travel indicator with generated scale on yoke.
7. Include top-mounted hand jack on each valve. Hand jack shall be arranged to move the stem against the spring action and limit the stem travel on loss of air pressure.

B. Pneumatic positioners for Open-Close control:
1. Include solenoid pilot valves with manual override.
2. Include adjustable limit switches for both open and closed positions, factory mounted on drives with proximity type limit switches.

C. Pneumatic positioners for Modulating Control:
   1. Furnish pneumatic I/P positioner for modulating control. Positioners shall be equipped with output gauge. Positioner shall be capable of characterizing the output to establish desired relationship between input signal and drive position. Positioners shall be hard-wired 4-20mA type capable of HART communication protocol.
   2. Include 4-20mA position feedback signal to the Owner's DCS for all modulating control applications.

D. Electric Control Drives for Open-Close Control:
   1. Operator shall be Limitorque or approved equal.
   2. Gear case on valve shall be totally enclosed.
   3. Actuator shall be hardwired type.
   4. Motor operators shall develop adequate torque to fully stroke the valve at a speed adequate for the application.
   5. Include stem indicator with graduated scale on yoke.
   6. Constructed to Stainless Steel NEMA 4X weatherproof class as a minimum for all enclosures including motors.
   7. Equipped with 120VAC, single-phase, 60 Hertz, space heater in both limit switch and motor compartments.
   8. All limit switch contacts shall be wire to field terminal strips for external connection.
   9. All limit switch and control switch contacts shall be rated for 3 amps at 120VAC. All lights shall be rated for 120VAC.
   10. Include integral-reversing starter complete with control-power transformer. Transformer shall be sized to operate starter, two local indicating lights, motor space heater, and limit switch compartment heater, and sized for 50V-amperes of control power for external loads.
   11. Operator controls shall be internally wired to terminal board complete for Owner's external connections.
   12. Integral push button control station and indicating light shall be furnished.
   13. Have two integral or close-coupled indicating lights. One red light shall indicate valve is open, and one green light shall indicate valve is closed. Both lights shall be on, in mid-travel.
   14. Have opening and closing torque switches wired to trip motor if excessive torque is generated in either direction of travel. Closing torque switch shall be wired to trip motor when a predetermined torque is reached which corresponds to required seating thrusts for wedge gate or globe valves as determined by the valve manufacturer. Torque switches shall be wired to field terminal strips.
   15. Operator shall require a continuous open or close command from the Owner's DCS for opening or closing operation, valves shall fail in place on loss of signal.
   16. Operator shall be capable of complete manual valve actuation whenever motor drive is not energized even in the event that motor is fused or otherwise fails. However, simultaneous manual and motor operation shall not be possible. Manual operation shall not require more than 80 pounds of rim pull effort at maximum torque required to operate the valve.
   17. Have self-locking wormset gearing.
   18. Equipped with a direct position readout at the valve by means of a mechanical dial-position indicator showing percent of valve opening.

19. Motor operators shall have complete internal wiring to terminals and have motor leads brought into the limit switch compartment directly to the terminal board without use of external conduit.
20. Oil bath or grease lubricated.
21. Have lost-motion hammerblow mechanism for unseating valves in both motor drive and manual operation modes.
22. Equipped with thrust compensator or Belleville-spring mechanism as required and as recommended by the actuator manufacturer for the specified service in high-speed or high-temperature applications.
23. Limit switch make up sequences shall be subject to approval.

E. Electric Control Drives for Modulating Control:
   1. For 120 VAC, 60 hz applications:
      a. Operator shall be Harold Beck & Sons or approved equal.
      b. Include noncoasting motor braking.
      c. Drive shall be capable of continuous modulation without causing overheating or premature failure of the motor or damage to the gearing mechanism. Gearing shall be capable of withstanding a stalled condition for up to 12 hours without damage to either gearing or motor.
      d. Drive response to control signal loss shall be capable of fail in place, fully open or fully closed as specified or indicated for each drive.
      e. Drive shall have an integral switch for electro-mechanical manual override operation of the drive at the drive.
      f. Drive shall have adjustable, mechanical travel stops to prevent overtravel during manual or automatic operation.
      g. Drive shall have internal, integral limit switches for use only in the motor control circuit to limit travel.
      h. Limit Switches in addition to those specified elsewhere:
         (1) At least two internal SPST, adjustable, auxiliary limit switches for NO or NC action for both open and closed positions.
         (2) Contactless position sensor for continuous hardwired signal feedback of drive position for either visual indication or control loop purposes. Signal shall be 4-20 mA type.
      i. Drive shall be totally enclosed, weatherproof construction for outdoor mounting, Stainless Steel, NEMA 4X, or better.
   2. For 480 VAC, 60 hz applications:
      a. Operator shall be Limitorque or approved equal.
      b. Include noncoasting motor braking.
      c. Drive shall be capable of continuous modulation without causing overheating or premature failure of the motor or damage to the gearing mechanism. Gearing shall be capable of withstanding a stalled condition for up to 12 hours without damage to either gearing or motor.
      d. Drive response to control signal loss shall be capable of fail in place, fully open or fully closed as specified or indicated for each drive.
      e. Drive shall have an integral switch for electro-mechanical manual override operation of the drive at the drive.
      f. Drive shall have adjustable, mechanical travel stops to prevent overtravel during manual or automatic operation.

g. Drive shall have internal, integral limit switches for use only in the motor control circuit to limit travel.
h. Limit Switches in addition to those specified elsewhere:
   (1) At least two internal SPST, adjustable, auxiliary limit switches for NO or NC action for both open and closed positions.
   (2) Contactless position sensor for continuous hardwired signal feedback of drive position for either visual indication or control loop purposes. Signal shall be 4-20 mA type.
i. Drive shall be totally enclosed, weatherproof construction for outdoor mounting, Stainless Steel, NEMA 4X, or better.

2.19 INSTRUMENT AIR:

A. Instrument air headers shall be 2" for main headers and 1 ½ " for other headers.
B. Several instruments may be supplied from one root valve off an instrument air header, establishing instrument air subheaders as follows:
   1. Air supply for up to five devices: ½" or larger.
   2. Air supply for up to ten devices: ¾" or larger.
C. The air supply to each air user shall include:
   1. Instrument blowdown valves upstream of individual air isolation valves.
   2. Instrument air isolation valves upstream of any filters or regulators.
   3. Combination filter Pressure Regulating Valve (PRV) shall be self-contained, spring-loaded diaphragm type combination filter-regulator with integral relief valve, outlet pressure gauge and drain cock.
   4. If carbon steel piping is used in the air system, an additional instrument air line filter shall be installed directly upstream of the PRV, suitable for oil and liquid removal. Minimum rated air flow handled at 100 psig shall be 11 scfm. Filtration efficiency shall be 99.99% or greater at .6 microns.

PART 3 - EXECUTION

3.01 TESTING:

A. Test all instrumentation to ensure satisfactory operation before any Equipment or Materials are shipped to Site.
B. All Equipment and Materials shall be tested thoroughly to ensure the total system operates as specified.
C. Calibrate all instruments as specified in this Section, PART 3 – DEVICE CALIBRATION.

3.02 DEVICE CALIBRATION:

A. General:
   1. Industry standards and manufacturers' recommendations shall be followed in the execution of this Work.
   2. Provide all test instruments, calibration standards, and devices required to perform calibration and testing procedures
   3. Notify Owner of the instrument calibration start and finish dates so that instrument calibration can be witnessed by the Owner or any other person assigned by the Owner if they chose.

4. Calibrate in strict accordance with manufacturers' recommendations.
5. Allow manufacturer's recommended warm-up time prior to start of calibration of device. Use of portable power supplies or batteries to power transmitters for Device Calibration is not allowed.
6. If the instrument is of the "smart" family, verify the internal configuration data includes the instrument tag number.
7. Immediately after Device Calibration, attach a calibration label or self-adhesive calibration sticker to the device with the name of the person performing the calibration and date of calibration.

B. Pressure or differential pressure devices:
1. All pressure devices shall be calibrated to read the pressure at the process root valve.
2. If pressure device does not have a factory calibration certification:
   a. Use certified dead weight tester, manometer or Wallace and Tiernan pneumatic calibration unit to validate all certified calibration pressure gauges used in the calibration of all other non-calibrated devices.
   b. Adjust zero and span of device to read the pressure at the process root valve.
   c. Use a vacuum or pressure hand pump and certified calibration pressure gauge to verify and record device pressure output readings at 0, 25, 50, 75, and 100% of input value.
   d. Record alarm point and failed sensor values.
   e. Record device hysteresis.
   f. Remove test equipment and verify that the instrument output reads the correct pressure.
3. If pressure device has a factory calibration certification and is in service with a static water leg, calibrate the device with the procedure outline above to compensate for the static water leg.

C. Temperature devices:
1. Thermocouples and extension lead wire shall be checked for proper type polarity and grounding. The temperature element shall be checked with an ohm meter for continuity. Record the resistance
2. RTD wiring shall be checked for proper type polarity and grounding. The temperature element shall be checked with an ohm meter for continuity. Record the resistance.
3. Temperature switches shall be checked by immersion in a temperature regulated oven or bath. Record actuation point and any dead band.

D. Level controllers and liquid level switches:
1. Fill the float chamber with water and observe the operation of the device.
2. Record direction of response of controller or switch points of liquid level switches.

E. Switches, other than liquid level:
1. All switch positioning shall account for dimensional changes that may occur when the equipment is placed in service.
2. Apply process input and adjust switch actuation points to specified value.
3. Record if switches make and break with an electrical continuity check.
4. Adjust dead band if applicable.
5. Verify repeatability of switch actuation points after adjustments are completed.

F. Other transmitters and signal converters:
1. Apply power, input signal, and process input, as applicable.
2. Adjust zero and span.
3. Calibrate per manufacturer instructions for the applicable process measurement.

G. Pneumatic operated valves:
   1. Adjust air supply PRV on valve to output pressure desired.
   2. Apply power to positioner or solenoid.
   3. Record readings or output of device at 0, 25, 50, 75, and 100% of input value.
   4. Place valve at 50 percent open and remove air supply to verify proper failure mode of the valve. Restore air then place valve at 50% open and lift signal cable. Record all results.
      a. Fail Closed - Valve closes on loss of power or air.
      b. Fail Open - Valve opens on loss of power or air.
      c. Fail Last - Valve remains in the last position it was in on loss of power or air.
   5. Record device hysteresis.
   6. Adjust limit switches to actuate at values indicated. Confirm switches make or break with an electrical continuity check.
   7. Apply power to the position transmitter and adjust zero and span to represent 0 to 100% open position of the control valve.

H. Motor operated valves:
   1. Apply power to the motor.
   2. Use the DCS to stroke the valve.
   3. Record valve for proper direction of response; for example, increasing signal to positioner increases valve opening.
   4. Record readings or output of device at 0, 25, 50, 75, and 100% of input value.
   5. Record device hysteresis.
   6. Adjust limit switches to actuate at values indicated. Confirm switches make or break with an electrical continuity check.
   7. Apply power to the position transmitter and adjust zero and span to represent 0 to 100% open position of the control valve.

I. Remotely operated dampers:
   1. Adjust air supply PRV on drive to output pressure desired.
   2. Apply power to control drive.
   3. Record damper for proper fail action. Energize and de-energize solenoid valves to verify proper switching of the instrument air power source and to prove the failure mode of the control drive.
      a. Fail Closed - Damper closes on loss of power or air.
      b. Fail Open - Damper opens on loss of power or air.
      c. Fail Last - Damper remains in the last position it was in on loss of power or air.
   4. Record damper for proper direction of response; for example, increasing signal to control drive increases damper opening.
   5. Record damper position at 0, 25, 50, 75, and 100% of input value.
   6. Record device hysteresis.
   7. Adjust limit switches to actuate at values indicated. Confirm switches make or break with an electrical continuity check.
   8. Apply power to the position transmitter and adjust zero and span to represent 0 to 100% open position of the damper.

END OF SECTION 409125

SECTION 485249 – ACTIVATED CARBON INJECTION

PART 1 - GENERAL

1.01 SUMMARY:

A. The Activated Carbon Injection (ACI) Systems will be used to reduce mercury (Hg) levels from two Big Rivers Electric Corporation (BREC) coal fired units: Green Unit 1, and Green Unit 2. The Hg levels shall be reduced to 1.0 lb./TBtu at each unit's precipitator outlet.

B. Contractor shall provide one ACI system per unit as specified herein with all accessories and appurtenances including, but not limited to, the following:
   1. Activated carbon silos.
   2. Bin-vent filters, complete with fans and motors.
   3. Manual silo isolation valves.
   4. Rotary feeder/air locks.
   5. Cutoff valves.
   6. Diverter valves (if provided).
   7. Weigh Bins.
   8. Screw Feeders.
   9. Blowers complete with filters, inlet and outlet silencers, and sound attenuation enclosures.
   10. Eductors.
   11. Piping, valves, couplings, hangers, and pipe support systems.
   12. Target boxes.
   13. Compressed Air System.
   14. Instrumentation and Controls
   15. Local control panels.
   16. Monorails and hoists.
   17. Piping and hoses.
   18. Injection Lances.
   19. Distribution assemblies.
   20. Access required for operation and maintenance of the ACI system including stairs, ladders, cages, platforms, and other safety devices as required.
   21. All special tools required for operation and maintenance, calibration, and disassembly of the equipment provided.
   22. Painting.
   23. Lighting.
   24. Field services for technical direction during installation and start-up.

C. Related Work Specified Elsewhere:
   1. SECTION 011101 – SUMMARY OF WORK.
   2. SECTION 051200 – STEEL.
   3. Finishes (Coatings): DIVISION 9 – FINISHES (COATINGS).
   4. SECTION 133423 – POWER CONTROL MODULE.
   5. SECTION 133425 – EQUIPMENT ENCLOSURE.
   6. DIVISION 26 – ELECTRICAL EQUIPMENT.
   7. SECTION 260100 – REQUIREMENTS FOR SKID MOUNTED EQUIPMENT.
   8. SECTION 260551 – ALTERNATING CURRENT ELECTRIC MOTORS.
   9. SECTION 409125 – MEASUREMENT AND CONTROL INSTRUMENTATION FOR PACKAGED SYSTEMS.
   10. SECTION 485250 – DRY SORBENT INJECTION.

1.02 REFERENCES:

A. Design, fabricate, assemble, and test Equipment and Materials to conform to the following Codes and Standards:
   1. American Institute of Steel Construction (AISC).
      a. Manual of Steel Construction.
      b. Quality Criteria and Construction Standards.
   2. American Society for Testing and Materials (ASTM):
      a. A36 - Carbon Structural Steel.
      b. A53 - Welded and Seamless Steel Pipe.
   3. American Bearing Manufacturer's Association (ABMA).
      a. 9-1990 Load Ratings and Fatigue Life of Ball Bearings.
      b. 11-1990 Load Ratings and Fatigue Life of Roller Bearings.
   4. American Society of Mechanical Engineers (ASME).
      a. Boiler and Pressure Vessel Code, Section VIII.
   5. National Fire Protection Association (NFPA).
      a. 68 - Standard on Explosion Protection by Deflagration Venting
   6. American National Standards Institute (ANSI).
   7. American Welding Society (AWS)
   8. Instrument Society of Automation (ISA)
   9. National Electrical Code (NEC)
   10. Underwriters laboratory (UL)

B. Factory Reports and Tests:
   1. Provide as specified in DIVISION 1.
   2. Notify Engineer at least two weeks prior to factory tests so that Owner and Engineer may be present if desired.

1.03 SYSTEM DESCRIPTION:

A. The ACI systems will be supplied with halogenated Powdered Activated Carbon (PAC) delivered by bulk transport trucks. The carbon will be pneumatically conveyed using onboard truck unloading blowers to bulk storage silos, one per unit. The carbon shall then be fed from the bulk silos to the conveying piping using a redundant feeder system, consisting of weigh bins and screw feeders, before being pneumatically conveyed with positive pressure blowers and an eductor system to each unit's injection nozzles located downstream of the unit air preheaters. Each unit has two air preheaters and therefore two injection locations. The ACI system shall be of "heavy-duty" design consistent with a plant life of 30 years with minimal maintenance. The system will feed activated carbon based on an output from the Owner's DCS. The output will be generated using steam flow as a feed forward and a periodic mercury signal as a PID controller trim. Automated start and stop sequences will be implemented so the system requires minimal operator attendance.

1.04 MODEL TESTS:

A. Contractor shall perform both a computational fluid dynamic (CFD) and a physical flow model study.

B. Reference SECTION 488030.

1.05 SUBMITTALS:

A. For each subassembly shipped submit as specified in DIVISION 1.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Prepare the ACI system shop-fabricated to the greatest extent possible, recognizing shipping limits.

B. Match mark all subassemblies.

C. Furnish all temporary bracing/shoring required for shipping, handling and temporary storage at the Site.

1.07 QUALITY ASSURANCE:

A. Contractor must have previous experience with systems of this type and with material handled. Contractor shall submit experience record prior to Submittal drawings if requested.

B. Contractor shall meet NFPA 68, Standard on Explosion Protection by Deflagration Venting. ~~Contact carbon supplier for range of possible product deflagration constants.~~

1. The design of the vents shall be based on a deflagration constant of Kst=120 bar-m/s.

1.08 OPERATING CONDITIONS:

A. Reference Appendix 011101-A.

1.09 PROJECT SITE CONDITIONS:

A. Reference DIVISION 1.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Acceptable Suppliers:

1. Reference APPENDIX 011101-B.

2.02 ACTIVATED CARBON SILOS:

A. General Design:

1. Furnish activated carbon silos complete with access, dust collectors, slide gates, and instruments.
2. The silos shall be a vertical cylinder with conical bottom and a sloped top cover of all welded steel, dust tight, and weather tight construction. Each silo shall have a minimum of ~~two~~ one silo discharge locations. Silos shall be of one-piece, shop fabricated construction. If this is not possible the silos shall be of two-piece, shop fabricated construction designed with one circumferential field weld required.
3. Silos shall be coated as specified in SECTION 099000.
4. Silos shall include ~~an automatic fluidization system~~ bin activators to ensure PAC flow out of the silo to the feeder systems with no need for external flow assistance. The bin activators shall be in accordance with the following: ~~Fluidization system shall include all necessary components for a fully automatic system such as fluidization pads, nozzles, pressure regulators, pipe, valves, instrumentation, etc. Provide fluidizers near all outlets of silo to prevent arching or bridging and to maintain material in fluid conditions so that it will flow from the silo. Contractor shall supply fluidizing air with a new compressed air system.~~

a. Fabrication:

(1) Fabricate pressure cone with replaceable ~~stainless~~carbon steel liners or fabricate completely with ~~stainless~~carbon steel.

(2) Cone shall be coated in accordance with Section 099000.

(3) Support bin dischargers with not less than eight hanger arm assemblies.

(4) Provide flexible inlet connections for bin dischargers to prevent vibration of bin and downstream rotary feeder.
(5) Install all flexible connections and skirts using double beads with draw bands.
(6) All skirting and flexible connections shall be suitable for material being handled.
(7) Construct bin dischargers to withstand loading applied by the material above the discharger.

b. Electrical:
(1) Motors shall be vibrating-duty type meeting the requirements of SECTION 260551.
(2) All Electrical components shall conform to SECTION 260100.

c. Protective Coatings: Apply protective coatings to all carbon steel surfaces in accordance with the following:
(1) Coating systems for ferrous metal surfaces shall consist of an organic zinc rich prime coat and a polyurethane finish coat.

5. All plate material required for fabrication shall be ASTM A36 steel.
6. Design stresses under all static and dynamic loads shall not exceed those permissible per the AISC code and specifications.
7. Silos shall be designed for 5-day storage at the design full load injection rate. Silo structure design loads shall include potential wind and snow loads as per Appendix 011101-A and shall allow for loads associated with equipment, catwalks, and platforms.
8. Silos shall include any penetrations and supports necessary for installation of conduit, piping, and any equipment external to the silo.
9. Silo roofs shall include a jib crane.
   a. Crane capacity shall be sufficient to safely handle the largest single piece of equipment at each location, or a minimum of ½ - ton. Capacity shall be permanently marked on the crane.
   b. Hoist capacity shall be sufficient to lift from grade or silo interior bottom slab to silo roof with sufficient safety wraps left on hoist drum.
   c. Boom length shall allow sufficient reach beyond silo side to lower largest equipment to grade.
10. Steel platforms shall be supplied in the silo skirt as necessary to allow for equipment access.
11. Provide silos with two ground level mounted personnel and equipment access door 3' x 6'-8" or larger if required to allow removal of components. Additionally, each silo shall include one mandoor for access to the second level. Second level access shall be provided by stairs.
12. Furnish expansion joints and flexible connections as necessary to prevent transmission of loads and vibration from the hopper connections to the unloading equipment.
13. Silos shall include insulation and lagging per manufacturer's standard.
14. Silo shall be heated and ventilated to maintain indoor temperature requirements specified in Appendix 011101-A. Any heating required shall be supplied by electric unit heater(s) with unit mounted thermostats. Provide an operable ventilation air inlet louver. Louver shall be aluminum construction with insect screen and weather hood. Provide an exhaust fan with operable discharge louver and weather hood. Ventilation fans and louvers shall include local unit mounted starters. Ventilation fans and intake louvers shall be interlocked with space mounted thermostats. Ventilation system shall be operated via on-off-auto selectors switch. Size fan for a minimum of 15 skirt volume air changes per

hour. Heating calculations shall assume no electrical load in space and a minimum 2 air changes of infiltration.

15. Silos shall include factory installed internal lighting and ground fault interrupting convenience outlets. External lighting shall be shipped loose to be installed by others.
16. Provide one roof mounted, 24-inch diameter combination manway and pressure/vacuum relief valve per silo.
17. Provide roof deck with perimeter handrail with toeplate in accordance with OSHA requirements.
18. Each subassembly shall have a single terminal box for all electrical and instrumentation wiring.
19. Provide two conduit/cable tray openings in each silo skirt.

B. Silo Access:
   1. Furnish one stair tower between the activated carbon silos and the DSI silos as shown in the conceptual general arrangement drawings.
   2. Furnish access platforms and catwalks as necessary to access each silo's roof and equipment areas.
   3. Furnish a caged ladder for each silo as a secondary mean of egress.
   4. Stairs shall meet OSHA standards and shall be 36" wide.
   5. Stairs shall include handrails and toeplates on both the inside and outside of the stairs.

2.03 INSTRUMENTATION:

A. Instrumentation shall be as specified in SECTION 409125.
B. Skid mounted instruments shall be wired to a skid terminal box by this Contract as specified in SECTION 260100.
C. Instruments will be wired back to the Owner's Distributed Control System (DCS) by others.
D. Provide all instrumentation for an automated system as specified in this SECTION, PART 1 - SYSTEM DESCRIPTION.
E. Provide all instrumentation to detect abnormal system operation.
F. At a minimum provide:
   1. Continuous silo level transmitter.
   2. Three silo level switches: high, low, and low-low.
   3. Weigh feeder load cells with summing box and transmitter.
   4. Differential pressure transmitters for all strainers or filters.
   5. Instrument air and transport blower header pressure transmitters.
   6. Pressure gauges on the discharge of all blowers.
   7. Motor bearing and winding temps.
   8. Motor zero speed or under speed switches.

2.04 BIN VENT FILTERS:

A. Furnish each silo with a self-contained open-bottom flanged fabric type bin vent dust collector with a motor driven exhaust fan.
B. Dust collectors shall be capable of outlet emissions not exceeding 0.005 grains per dry standard cubic foot.
C. Bin Vent Filters shall be designed for outdoor installation.
D. Filter Cleaning Mechanism:
   1. Air jet cleaning system shall be suitable for the continuous cleaning of filter bags while the dust collector is in operation. Back-blowing shall be accomplished with compressed air, at the necessary pressure determined by Contractor, directed through venturi sections into the open, clean air end of the bags.

2. Compressed air flow shall be controlled by solenoid valves. A solenoid valve shall be furnished for each blow tube of filter bags. Solenoid valves shall be designed such that upon failure of the valve operating mechanism or drive, the valve will return to, or remain in, the closed position.

E. All vent filters and other dust collectors with the activated carbon injection systems shall be equipped with permanent vent stacks that are designed and configured to allow particulate emissions testing in accordance with U.S. EPA Methods 1 through 5.

2.05 MANUAL SILO DISCHARGE ISOLATION VALVES:

A. Provide manual cutoff knife gate valve at each discharger outlet.
B. Carbon steel or cast iron construction with hand screw operator.
C. Approved Manufacturers:
1. Reference Appendix 011101-B.

2.06 ROTARY AIRLOCK FEEDERS:

A. Heavy-duty, fall-through, closed-end rotor type designed for abrasion resistance.
B. Cast-iron housings with all wear replaceable parts cast in an abrasion-resistant metal.
C. Abrasion-resistant Ni-Hard rotors and seal shoe. Air seal must be between rotor tips and seal shoe, not to feeder housing.
D. Rotor support bearings shall be outboard, anti-friction, permanently sealed and rated for a minimum 50,000 hours ABMA B-10 life.
E. Shaft seals shall have packing rings with air purge from the outside. Air purge hardware shall be provided and shop mounted to the feeder. This hardware shall include air line filter, pressure regulator, pressure gauge, solenoid valve, stainless steel tubing, and fittings.
F. Driven by a constant-speed, right-angle, gear-head motor. Drive motors shall be as specified in SECTION 260551. Maximum rotor speed shall be 10 rpm. Drives shall be reversible.
G. Size using a pocket-filling efficiency of 50 percent.
H. Furnish with zero speed switches or under speed switches.
I. Furnish with wye-type inlet vent hoppers and intake tees.
J. Approved Manufacturers:
1. Reference Appendix 011101-B.

2.07 CUTOFF VALVES:

A. Provide pneumatically operated automatic slide-gate valves on the discharge of each rotary air lock feeder.
B. Carbon steel and/or cast iron with hand wheel operators as manufactured by Fabri-Valve, DeZurik or Fuller.
C. Valves shall have flanged inlets and outlets.
D. Cylinder-operated, automatic slide-gate valves shall be manufactured by DeZurik or Fabri-Valve.

2.08 DIVERTER VALVES:

A. Provide as required.
B. Air-operated, swing disc-type design.
C. Cast-iron construction with flanged ends. Flexible metal hose shall have wear-resistant liner.
D. Shall be capable of switching while material is being conveyed through them.
E. Provide two position-limit switches as specified in SECTION 409125 for each diverter valve.
F. Manufacturer shall be Delta or Fuller SK.

2.09 WEIGH BINS:

A. Supply two weigh bins for each ACI silo.
B. Weigh bins shall include features to prevent arching or bridging over the feeder and to prevent segregation of materials entering the feeder.
C. Weigh bins shall be sized so that there will be a minimum of 30 minutes between product unloading.

2.10 SCREW FEEDERS:

A. Supply two screw feeders for each ACI silo with local control panels as specified in SECTION 260100.
B. ~~Screw conveyors shall have sectional or helical flights of a minimum 9-inch outside diameter.~~ Screw flights shall be 1/4-inch carbon steel or 14-gage stainless steel minimum.
C. Construct troughs with 1/4-inch carbon steel or 14-gage stainless steel.
D. Trough covers shall be flanged type, minimum 10-gage, same material as trough.
E. Provide self-lubricating composite material intermediate support bearings.
F. Support tail shaft with a flanged type roller bearing with a felt type plate seal.
G. Screw feeders shall be furnished with local control panels which shall control off an analog feed rate signal from the DCS. Control panels shall include all abnormal condition digital feedback signals and an analog screw feeder speed feedback signal. Feedback conditions shall include over-maximum flow rate, under-minimum flow rate, VFD malfunction, and hopper fill malfunctions. Local control panels shall meet the requirements specified in SECTION 260100.
H. Screw feeders shall be furnished with variable frequency AC motors.
I. Feeders shall be dust tight. Contractor's design shall include a means of venting air without exceeding 0.005 grains per dry standard cubic foot.

2.11 BLOWERS:

A. Furnish two 100% blowers for PAC transfer for each unit. Each blower shall be sized to individually meet each unit's system capacity requirements.
B. Blowers shall be designed for outdoor installation. If Contractor's design requires indoor installation, blowers may be installed within the silo skirt if accessibility allows. If Contractor prefers, one weatherproof enclosure, shop-fabricated to the greatest extent possible, as specified in SECTION 133425 shall be supplied for indoor installation of blowers.. If Contractor's design requires indoor installation in a weatherproof enclosure the ACI and DSI conveying equipment shall be installed in a common enclosure, if practical. Maximum area available for equipment installation is shown on the general arrangement drawings and is 20' x 97'.
C. Furnish with each blower at least the following:
    1. Motor.
    2. V-belt drive with guards.
    3. Inlet and discharge silencers.
    4. Inlet filter.
    5. All connecting piping, both rigid and flexible.
    6. Expansion joints.
    7. Pressure relief, check and cutoff valves.
    8. Pressure regulation, if required.
    9. Fabricated steel base for all the above items.
D. Blowers:
    1. Rotary lobe, positive-displacement type, belt driven.

2. Approved Manufacturers:
   a. Reference Appendix 011101-B.
3. Lubrication shall be force-feed or splash.
   a. Forced-feed lubricator systems shall have shaft-mounted oil pumps and an auxiliary ac motor-driven oil pump for starting and emergency use.
   b. Cooling of lubrication system, if required, shall be by self-contained air cooling system provided with blowers.
4. Bearings:
   a. Oil lubricated and designed for any radial or thrust loads which will be imposed upon them.
   b. Bearings shall limit the maximum horizontal shaft deflection at any point on the shaft to 0.002-inch at the design conditions.
   c. Bearing shall be rated for a minimum 50,000 hours ABMA B-10 life.
5. Seals shall be stainless-steel, labyrinth or mechanical type.

E. Inlet Filters:
1. Dry-type replaceable element suction filter for each blower capable of 98% efficiency with three micron particles or greater filtering.
2. Have no more than 0.25-inch W.G. drop when clean. Design system for a 1.0-inch W.G. drop before filters need to be replaced.

F. Silencers:
1. Furnish inlet and discharge silencers for each set of blowers.
2. Each silencer shall have a minimum of two baffles.

G. Sound pressure level for each set of blowers shall be as specified in SECTION 011101.
H. Motors shall be as specified in SECTION 260551.
I. Arrange blowers to permit ease of access for maintenance.
J. Interconnect blowers so that any blower may pressurize any of the conveying lines for each respective unit.

2.12 TARGET BOXES:
A. Material shall terminate at target boxes.
B. Target boxes shall be the manufacturer's standard design; however, the outlet shall be at least twice the inlet diameter.

2.13 TRUCK UNLOADING:
A. Furnish a 4-inch truck unloading line for each bulk storage silo.
B. Furnish a truck unloading panel which meets requirements as specified in SECTION 260100, for each bulk storage silo.
C. Unloading panels shall have the following lights and buttons:
1. Ready to unload pushbutton
2. Silo Level High alarm light
3. Unloading permitted green light
4. Silo Trouble

D. Truck unloading lines shall transport material to target boxes.
E. Furnish all piping and supports to route truck unloading line from four feet above grade to target box on top of silo.
F. Furnish a ¼" mesh debris screen in the truck unloading line located as necessary to allow access for cleaning.
G. Furnish Kamlock fitting with dust cap on each truck unloading line suitable for connection to truck discharge.

2.14 MONORAILS AND HOISTS:

A. Cranes or monorails and trolleys with hoists shall be furnished where necessary or specified to permit equipment removal and lowering to grade.

B. Trolley and hoists shall be electric with hoists being wire rope and single-speed lift unless otherwise specified.

C. Monorails may be curved but must conform to hoist manufacturer's recommendation on minimum curvature.

D. Monorails must be vertically spaced to allow adequate head room for trolley and hoist to lift and remove the piece of equipment and allow a minimum of 6-inch clear space between top of monorail and bottom of floor or roof beams to allow installation of Owner conduit and piping.

E. Monorail beams to be American Standard "I" beams. Furnish removable trolley stops at each end of monorails.

2.15 PIPING, COUPLINGS, VALVES AND ADAPTERS:

A. Conveying and Air (Low-Pressure) Piping:

1. Furnish all piping for the ACI system.
2. Piping shall be Schedule 40, carbon steel ASTM A53, Grade B.
3. ~~3.~~ All conveying bends shall be suitable for the intended service and designed for a minimum life expectancy of 5 years. ~~a minimum of 2 foot radius and have replaceable ceramic backs with compression fittings.~~
4. Piping shall be shop fabricated to the greatest extent possible and finish coated. Piping shall be fabricated in accordance with SECTION 485935.

B. Couplings:

1. Furnish couplings for all in-line devices such as fabricated laterals, discharge adapters and bends, etc.
2. Compression type.
3. Approved Manufacturer:
   a. Reference Appendix 011101-B.

C. Valves:

1. Furnish all valves necessary for the operation and maintenance of the ACI system. These shall include, but not be limited to, the following:
   a. Gate valves.
   b. Ball valves.
   c. Check valves.
   d. Solenoid valves.
   e. Pressure/vacuum relief valves.
   f. Regulator valves.
2. Furnish a manually operated gate type, isolation valve at the discharge of each set of blowers.
3. Furnish a ball valve ahead of each compressed air operated device.
4. Furnish a check valve at the discharge of each blower.
5. Furnish a pressure/vacuum relief valve at the top of each bulk storage silo and at the discharge of each blower.
6. Furnish motor operators for valves as specified in SECTION 409125.
7. Valve locations shall be designed in such a manner they can be operated from floors or platforms without the use of ladders. Valves, which are inaccessible from a platform or floor, shall be furnished with chain operators to the nearest platform or floor below the valve.

D. Piping Specials:

1. Furnish piping specials including emergency eyewash stations as specified in SECTION 485715. Emergency eyewash stations shall be furnished for each truck unloading location, as well as on the unloading floor of each silo. Eyewashes shall be either Haws or Bradley portable heated eyewashes.

2.16 HANGERS AND PIPING SUPPORT SYSTEM:

A. Reference Section 485940 – Hangers, Supports, and Anchors.

2.17 INJECTION LANCES:

A. Injection lances shall be designed for optimal PAC distribution in accordance with the results of the physical flow model and CFD model.
B. Injection lances shall be designed for minimal wear and maintenance.
C. Injection lances shall be designed with the capability of online removal for periodic maintenance.
D. Injection lances shall be design to minimize pluggage.
E. Injection lances shall be furnished with a means to monitor pluggage and to alarm when plugging occurs.
F. Injection lances shall have a manually valved compressed air system for cleaning of plugged lances.
G. Distribution assemblies, or splitters shall be located directly upstream of injection lances to distribute activated carbon from the primary transport line to individual ports.
H. Provide local temperature or pressure measurement of each lance for means of locally determining a lance is plugged.

2.18 PROTECTIVE COATINGS:

A. Paint all carbon steel surfaces in accordance with SECTION 099000.

2.19 LIGHTING:

A. All lighting circuits will be fed from lighting panels located inside the PCM as specified in SECTION 133423.
B. Exterior lighting shall be controlled by a photocell and H-O-A switch furnished by this Contract.
C. Lighting shall be 277Vac.

D. Reference Appendix 011101-B Approved Suppliers List.

2.20 EQUIPMENT I/O

A. The system shall be designed to run on loss of signal from the DCS, running signals shall be latched in the MCCs.
B. At a minimum all equipment shall have start command, stop command, running feedback, stopped feedback and power available signals to communicate with the Owner's DCS.
C. All variable speed or frequency feeders will have hardwired interlock to the plant MFT relay.
D. All variable speed or frequency feeders shall have at least one 4-20 mA speed feedback and a separate 4-20 mA current feedback hardwired to the Owner's DCS.

2.21 INSULATION

A. Contractor shall specify and indicate on drawings insulation purpose, type, and thickness required for equipment, piping, or piping components.

B. Personnel protection insulation shall be calculated based on a maximum surface temperature of 140 °F with an ambient temperature of 75 °F, lagging emissivity of 0.09 and 2 mph airflow velocity.
C. Thermal insulation shall be calculated based on the use of mineral wool, calcium silicate or Engineer approved alternate.

PART 3 - EXECUTION

3.01 NOT APPLICABLE:

END OF SECTION 485429

SECTION 485250 - DRY SORBENT INJECTION

PART 1 - GENERAL

1.01 SUMMARY:

A. The Dry Sorbent Injection (DSI) Systems will be used to reduce SO_3 levels from two Big Rivers Electric Corporation (BREC) coal fired units: Green Unit1, and Green Unit 2. The SO_3 levels shall be reduced to a concentration decided by Contractor in order to reduce the consumption of activated carbon and minimize overall project operating costs.

B. Contractor shall provide one dry sorbent injection (DSI) system per unit as specified herein with all accessories and appurtenances including, but not limited to, the following:
   1. Hydrated lime silos.
   2. Bin-vent filters, complete with fans and motors.
   3. Manual silo isolation valves.
   4. Rotary feeders/air locks.
   5. Cutoff valves.
   6. Diverter valves (if provided).
   7. Weigh Bins.
   8. Screw Feeders.
   9. Blowers complete with filters, dehumidification system, inlet and outlet silencers, and sound attenuation enclosures.
   10. Piping, valves, couplings, hangers, and pipe support systems.
   11. Target boxes.
   12. Compressed Air Systems.
   13. Instrumentation and Controls
   14. Local control panels.
   15. Monorails and hoists.
   16. Piping and hoses.
   17. Injection Lances.
   18. Distribution assemblies.
   19. Access required for operation and maintenance of the DSI system including stairs, ladders, cages, platforms, and other safety devices as required.
   20. All special tools required for operation and maintenance, calibration, and disassembly of the equipment provided.
   21. Painting.
   22. Lighting.
   23. Field services for technical direction during installation and start-up.

C. Related Work Specified Elsewhere:
   1. SECTION 011101 – SUMMARY OF WORK.
   2. SECTION 051200 – STEEL.
   3. Finishes (Coatings): DIVISION 9 – FINISHES (COATINGS).
   4. SECTION 133423 – POWER CONTROL MODULE.
   5. SECTION 133425 – EQUIPMENT ENCLOSURE.
   6. DIVISION 26 – ELECTRICAL EQUIPMENT.
   7. SECTION 260100 – REQUIREMENTS FOR SKID MOUNTED EQUIPMENT.
   8. SECTION 260551 – ALTERNATING CURRENT ELECTRIC MOTORS.
   9. SECTION 409125 – MEASUREMENT AND CONTROL INSTRUMENTATION FOR PACKAGED SYSTEMS.
   10. SECTION 485249 – ACTIVATED CARBON INJECTION.

1.02 REFERENCES:

A. Design, fabricate, assemble, and test Equipment and Materials to conform to the following Codes and Standards:
   1. American Institute of Steel Construction (AISC).
      a. Manual of Steel Construction.
      b. Quality Criteria and Construction Standards.
   2. American Society for Testing and Materials (ASTM):
      a. A36 - Carbon Structural Steel.
      b. A53 - Welded and Seamless Steel Pipe.
   3. American Bearing Manufacturer's Association (ABMA).
      a. 9-1990 Load Ratings and Fatigue Life of Ball Bearings.
      b. 11-1990 Load Ratings and Fatigue Life of Roller Bearings.
   4. American Society of Mechanical Engineers (ASME).
      a. Power Piping - Code for Pressure Piping, B31.1.
   5. National Fire Protection Association (NFPA).
   6. American National Standards Institute (ANSI).
   7. American Welding Society (AWS)
   8. Instrument Society of Automation (ISA)
   9. National Electrical Code (NEC)
   10. Underwriters laboratory (UL)

B. Factory Reports and Tests:
   1. Provide as specified in DIVISION 1.
   2. Notify Engineer at least two weeks prior to factory tests so that Owner and Engineer may be present if desired.

1.03 SYSTEM DESCRIPTION:

A. The DSI systems will be supplied with hydrated lime delivered by bulk transport trucks. The lime will be pneumatically conveyed using onboard truck unloading blowers to the hydrated lime silos, one per unit. The lime shall then be fed from the bulk silos to the conveying piping using a redundant feeder system, consisting of weigh bins and screw feeders, before being pneumatically conveyed with positive pressure blowers to each unit's injection nozzles located upstream of the unit air preheaters. Each unit has two air preheaters and therefore two injection locations. The conveying air downstream of the blowers shall be conditioned prior to contact with the lime. The DSI system shall be of "heavy-duty" design consistent with a plant life of 30 years with minimal maintenance. The system shall feed dry sorbent based on an output from the Owner's DCS. The output will be generated using a function of steam flow and allow an operator to bias the output, plus or minus 10% based on the current blend of fuel for the unit. Automated start and stop sequences will be implemented so the system requires minimal operator attendance. For an option bid, design shall allow for future use of trona as well as hydrated lime and include any additional Equipment and Materials required for a complete system.

1.04 MODEL TESTS:

A. Contractor shall perform both a computational fluid dynamic (CFD) and a physical flow model study.

B. Reference SECTION 488030.

1.05 SUBMITTALS:
- A. For each subassembly shipped submit as specified in DIVISION 1.

1.06 DELIVERY, STORAGE, AND HANDLING:
- A. Prepare the DSI system shop-fabricated to the greatest extent possible, recognizing shipping limits.
- B. Match mark all subassemblies.
- C. Furnish all temporary bracing/shoring required for shipping, handling and temporary storage at the Project Site.

1.07 QUALITY ASSURANCE:
- A. Contractor must have previous experience with systems of this type and with material handled. Contractor shall submit experience record prior to Submittal drawings if requested.

1.08 OPERATING CONDITIONS:
- A. Reference APPENDIX 011101-A.

1.09 PROJECT SITE CONDITIONS:
- A. Reference DIVISION 1.

PART 2 - PRODUCTS

2.01 GENERAL:
- A. Acceptable Suppliers:
  1. Reference APPENDIX 011101-B.

2.02 HYDRATED LIME SILOS:
- A. General Design:
  1. Base Bid:
     - a. Furnish hydrated lime silos complete with access, dust collectors, slide gates, and instruments.
     - b. The silos shall be a vertical cylinder with conical bottom and a sloped top cover of all welded steel, dust-tight, and weather-tight construction. Each silo shall have a minimum of ~~two~~one silo discharge locations. Silos shall be of one-piece, shop fabricated construction. If this is not possible the silos shall be of two-piece, shop fabricated construction designed with one circumferential field weld required.
     - c. Silos shall be coated as specified in SECTION 099000.
     - d. Silos shall be furnished with an automatic fluidization system to ensure dry sorbent flow out of the silo to the feeder systems with no need for external flow assistance. Fluidization system shall include all necessary components for a fully automatic system such as fluidization pads, nozzles, pressure regulators, pipe, valves, instrumentation, etc. Provide fluidizers near all outlets of silo to prevent arching or bridging and to maintain material in fluid conditions so that it will flow from the silo. Contractor shall supply fluidizing air with a new compressed air system.
     - e. All plate material required for fabrication shall be ASTM A36 steel.
     - f. Design stresses under all static and dynamic loads shall not exceed those permissible per the AISC code and specifications.
     - g. Silos shall be 14' diameter and shall be designed for 5-day storage at the design full load injection rate. Silo structure design loads shall include potential wind and

snow loads as per Appendix 011101-A and shall allow for loads associated with equipment, catwalks, and platforms.

h. Silos shall include any penetrations and supports necessary for installation of conduit, piping, and any equipment external to the silo.

i. Silo roofs shall include a jib crane.
   (1) Crane capacity shall be sufficient to safely handle the largest single piece of equipment at each location, or a minimum of ½ - ton. Capacity shall be permanently marked on the crane.
   (2) Hoist capacity shall be sufficient to lift from grade or silo interior bottom slab to silo roof with sufficient safety wraps left on hoist drum.
   (3) Boom length shall allow sufficient reach beyond silo side to lower largest equipment to grade.

j. Steel platforms shall be supplied in the silo skirt as necessary to allow for equipment access.

k. Provide silos with two ground level mounted personnel and equipment access doors 3' x 6'-8" or larger if required to allow removal of components. Additionally, each silo shall include one mandoor for access to the second level.

l. Furnish expansion joints and flexible connections as necessary to prevent transmission of loads and vibration from the hopper connections to the unloading equipment.

m. Silos shall include insulation and lagging per manufacturer's standard.

n. Silo shall be heated and ventilated to maintain indoor temperature requirements specified in Appendix 011101-A. Any heating required shall be supplied by electric unit heater(s) with unit mounted thermostats. Provide an operable ventilation air inlet louver. Louver shall be aluminum construction with insect screen and weather hood. Provide an exhaust fan with operable discharge louver and weather hood. Ventilation fans and louvers shall include local unit mounted starters. Ventilation fans and intake louvers shall be interlocked with space mounted thermostats. Ventilation system shall be operated via on-off-auto selector switch. Size fan for a minimum of 15 skirt volume air changes per hour. Heating calculations shall assume no electrical load in space and a minimum 2 air changes of infiltration.

o. Silos shall include factory installed internal lighting and ground fault interrupting convenience outlets. External lighting shall be shipped loose to be installed by others.

p. Provide one roof mounted, 24-inch diameter combination manway and pressure vacuum relief valve per silo.

q. Provide roof deck with perimeter handrail with toeplate in accordance with OSHA requirements.

r. Each subassembly shall have a single terminal box for all electrical and instrumentation wiring.

s. Provide two conduit/cable tray openings in each silo skirt.

2. Option Bid:
   a. All base bid requirement remain the same except for the following:
      (1) The silos shall be a vertical cylinder with conical bottom and a sloped top cover of all welded steel, dusttight, and weathertight construction. Each silo shall have a minimum of two silo discharge locations. Silos shall be shop-assembled to the greatest extent possible with any remaining materials shipped separately.

(2) Silos shall be 20' diameter and shall be designed for 5-day storage at the design full load injection rate. Silo structure design loads shall include potential wind and snow loads as per Appendix 011101-A and shall allow for loads associated with equipment, catwalks, and platforms.

B. Silo Access:
1. Furnish one stair tower between the DSI and activated carbon silos as shown in the conceptual general arrangement drawings.
2. Furnish access platforms and catwalks as necessary to access each silo's roof and equipment areas.
3. Furnish a caged ladder for each silo as a secondary mean of egress.
4. Stairs shall meet OSHA standards and shall be 36" wide.
5. Stairs shall include handrails and toeplates on both the inside and outside of the stairs.

2.03 INSTRUMENTATION:

A. Instrumentation shall be as specified in SECTION 409125
B. Skid mounted instruments shall be wired to a skid terminal box by this Contract as specified in SECTION 260100.
C. Instruments will be wired back to the Owner's DCS by others.
D. Provide all instrumentation for an automated system as specified in this SECTION, PART 1 - SYSTEM DESCRIPTION.
E. Provide all instrumentation to detect abnormal system operation.
F. At a minimum provide:
1. Continuous silo level transmitter.
2. Three silo level switches: high, low, and low-low.
3. Weigh feeder load cells with summing box and transmitter.
4. Differential pressure transmitters for all strainers or filters.
5. Instrument air and transport blower header pressure transmitters.
6. Pressure gauges on the discharge of all blowers.
7. Motor bearing and winding temps.
8. Motor zero speed or under speed switches.

2.04 BIN VENT FILTERS:

A. Furnish each silo with a self-contained open-bottom flanged fabric type bin vent dust collector with a motor driven exhaust fan.
B. Dust collectors shall be capable of outlet emissions not exceeding 0.005 grains per dry standard cubic foot.
C. Bin Vent Filters shall be designed for outdoor installation.
D. Filter Cleaning Mechanism:
1. Air jet cleaning system shall be suitable for the continuous cleaning of filter bags while the dust collector is in operation. Back-blowing shall be accomplished with compressed air, at the necessary pressure determined by Contractor, directed through venturi sections into the open, clean air end of the bags.
E. Compressed air flow shall be controlled by solenoid valves. A solenoid valve shall be furnished for each blow tube of filter bags. Solenoid valves shall be designed such that upon failure of the valve operating mechanism or drive, the valve will return to, or remain in, the closed position.

2.05 MANUAL SILO DISCHARGE ISOLATION VALVES:

A. Provide manual cutoff knife gate valve at each discharger outlet.

B. Carbon steel or cast iron construction with hand screw operator.
C. Approved Manufacturers:
   1. Reference Appendix 011101-B.

2.06 ROTARY AIRLOCK FEEDERS:
A. Heavy-duty, fall-through, closed-end rotor type designed for abrasion resistance.
B. Cast-iron housings with all wear replaceable parts cast in an abrasion-resistant metal.
C. Abrasion-resistant Ni-Hard rotors and seal shoe. Air seal must be between rotor tips and seal shoe, not to feeder housing.
D. Rotor support bearings shall be outboard, anti-friction, permanently sealed and rated for a minimum 50,000 hours ABMA B-10 life.
E. Shaft seals shall have packing rings with air purge from the outside. Air purge hardware shall be provided and shop mounted to the feeder. This hardware shall include air line filter, pressure regulator, pressure gauge, solenoid valve, stainless steel tubing, and fittings.
F. Driven by a constant-speed, right-angle, gear-head motor. Drive motors shall be as specified in SECTION 260551. Maximum rotor speed shall be 10 rpm. Drives shall be reversible.
G. Size using a pocket-filling efficiency of 50 percent.
H. Furnish with zero speed switches or under speed switches.
I. Furnish with wye-type inlet vent hoppers and intake tees.
J. Approved Manufacturers:
   1. Reference Appendix 011101-B.

2.07 CUTOFF VALVES:
A. Provide pneumatically operated automatic slide-gate valves on the discharge of each rotary air lock feeder.
B. Carbon steel and/or cast iron with hand wheel operators as manufactured by Fabri-Valve, DeZurik or Fuller.
C. Valves shall have flanged inlets and outlets.
D. Cylinder-operated, automatic slide-gate valves shall be manufactured by DeZurik or Fabri-Valve.

2.08 DIVERTER VALVES:
A. Provide as required.
B. Air-operated, swing disc-type design.
C. Cast-iron construction with flanged ends. Flexible metal hose shall have wear-resistant liner.
D. Shall be capable of switching while material is being conveyed through them.
E. Provide two position-limit switches as specified in SECTION 409125 for each diverter valve.
F. Manufacturer shall be Delta or Fuller SK.

2.09 WEIGH BINS:
A. Provide two weigh bins for each DSI silo.
B. Weigh bins shall include features to prevent arching or bridging over the feeder and to prevent segregation of materials entering the feeder.
C. Weigh bins shall be sized so that there will be a minimum of 30 minutes between product unloading.

2.10 SCREW FEEDERS:
A. Supply two screw feeders for each DSI silo with local control panels as specified in SECTION 260100.

B. ~~Screw conveyors shall have sectional or helical flights of a minimum 9-inch outside diameter.~~ Screw flights shall be 1/4-inch carbon steel or 14-gage stainless steel minimum.
C. Construct troughs with 1/4-inch carbon steel or 14-gage stainless steel.
D. Trough covers shall be flanged type, minimum 10-gage, same material as trough.
E. Provide self-lubricating composite material intermediate support bearings.
F. Support tail shaft with a flanged type roller bearing with a felt type plate seal.
G. Screw feeders shall be furnished with local control panels which shall control off an analog feed rate signal from the DCS. Control panels shall include all abnormal condition digital feedback signals and an analog screw feeder speed feedback signal. Feedback conditions shall include over-maximum flow rate, under-minimum flow rate, VFD malfunction, and hopper fill malfunctions. Local control panels shall meet the requirements specified in SECTION 260100.
H. Screw feeders shall be furnished with variable frequency AC motors.
I. Feeders shall be dust tight. Contractor's design shall include a means of venting air without exceeding 0.005 grains per dry standard cubic foot.

2.11 BLOWERS:

A. Furnish two 100 % blowers for lime transfer per unit. Each blower shall be sized to individually meet each unit's system capacity requirements.
B. Blowers shall be designed for outdoor installation. If Contractor's design requires indoor installation, blowers may be installed within the silo skirt if accessibility allows. If Contractor prefers, one weatherproof enclosure, shop-fabricated to the greatest extent possible, as specified in SECTION 133425 shall be supplied for indoor installation of blowers. If Contractor's design requires indoor installation the ACI and DSI conveying equipment shall be installed in a common enclosure, if practical. Maximum area available for equipment installation is shown on the general arrangement drawings and is 20' x 97'.
C. Furnish with each blower at least the following:
    1. Motor.
    2. V-belt drive with guards.
    3. Inlet and discharge silencers.
    4. Inlet filter.
    5. Dehumidification System (one per set of blower).
    6. Air-to-Air Heat Exchangers.
    7. All connecting piping, both rigid and flexible.
    8. Expansion joints.
    9. Pressure relief, check and cutoff valves.
    10. Pressure regulation, if required.
    11. Fabricated steel base for all the above items.
D. Blowers:
    1. Rotary lobe, positive-displacement type, belt driven.
    2. Approved Manufacturers:
        a. Reference Appendix 011101-B.
    3. Lubrication shall be force-feed or splash.
        a. Forced-feed lubricator systems shall have shaft-mounted oil pumps and an auxiliary ac motor-driven oil pump for starting and emergency use.
        b. Cooling of lubrication system, if required, shall be by self-contained air cooling system provided with blowers.

4. Bearings:
   a. Oil lubricated and designed for any radial or thrust loads which will be imposed upon them.
   b. Bearings shall limit the maximum horizontal shaft deflection at any point on the shaft to 0.002-inch at the design conditions.
   c. Bearing shall be rated for a minimum 50,000 hours ABMA B-10 life.
5. Seals shall be stainless-steel, labyrinth or mechanical type.

E. Inlet Filters:
1. Dry-type replaceable element suction filter for each blower capable of 98% efficiency with three micron particles or greater filtering.
2. Have no more than 0.25-inch W.G. drop when clean. Design system for a 1.0-inch W.G. drop before filters need to be replaced.

F. Dehumidification System:
1. Dehumidification system shall consist of one, factory-assembled and tested, regenerative desiccant wheel style dehumidifier per set of blowers.
2. Dehumidification systems shall include the following accessories and components.
   a. Electric heater.
   b. Cooling package consisting of compressors, condenser coil, and evaporator coil.
   c. Energy-recovery heat exchangers.
   d. Reactivation-air pretreatment heat exchanger.
   e. Reactivation-air heater.

G. Air-to-Air Heat Exchangers:
1. Furnish one air-to-air heat exchanger downstream of each blower.
2. Heat exchangers shall maintain conveying air at a maximum of 10°F above ambient, or per lime supplier recommendations.

H. Silencers:
1. Furnish inlet and discharge silencers for each set of blowers.
2. Each silo shall have a minimum of two baffles.

I. Sound pressure level for each set of blowers shall be as specified in SECTION 011101.

J. Motors shall be as specified in SECTION 260551.

K. Arrange blowers to permit ease of access for maintenance.

L. Interconnect blowers so that any blower may pressurize any of the conveying lines for each respective unit.

2.12 TARGET BOXES:

A. Material shall terminate at target boxes.

B. Target boxes shall be the manufacturer's standard design; however, the outlet shall be at least twice the inlet diameter.

2.13 TRUCK UNLOADING:

A. Furnish a 4-inch truck unloading line for each bulk storage silo.

B. Furnish a truck unloading local control panel which meets requirements as specified in SECTION 260100.

C. Unloading panels shall have the following lights and buttons:
1. Ready to unload pushbutton
2. Silo Level High alarm light
3. Unloading permitted green light
4. Silo Trouble

D. Truck unloading lines shall transport material to target boxes.
E. Furnish all piping and supports to route truck unloading line from four feet above grade to target box on top of silo.
F. Furnish a ¼" mesh debris screen in the truck unloading line located as necessary to allow access for cleaning.
G. Furnish Kamlock fitting with dust cap on each truck unloading line suitable for connection to truck discharge.

2.14 MONORAILS AND HOISTS:

A. Cranes or monorails and trolleys with hoists shall be furnished where necessary or specified to permit equipment removal and lowering to grade.
B. Trolley and hoists furnished shall be electric with hoists being wire rope and single-speed lift unless otherwise specified.
C. Monorails may be curved but must conform to hoist manufacturer's recommendation on minimum curvature.
D. Monorails must be vertically spaced to allow adequate head room for trolley and hoist to lift and remove the piece of equipment and allow a minimum of 6-inch clear space between top of monorail and bottom of floor or roof beams to allow installation of Owner conduit and piping.
E. Monorail beams to be American Standard "I" beams. Furnish removable trolley stops at each end of monorails.

2.15 PIPING, COUPLINGS, VALVES AND ADAPTERS:

A. Conveying and Air (Low-Pressure) Piping:
   1. Furnish all interconnecting lines for the DSI system.
   2. Piping shall be Schedule 40, carbon steel ASTM A53, Grade B.
   3. All conveying bends shall be suitable for the intended service and designed for a minimum life expectancy of 5 years. ~~a minimum of 2 foot radius and have replaceable ceramic backs with compression fittings.~~
   4. Piping shall be shop-fabricated to the greatest extent possible and finish coated. Piping shall be fabricated in accordance with SECTION 485935.

B. Couplings:
   1. Furnish couplings for all in-line devices such as fabricated laterals, discharge adapters and bends, etc.
   2. Compression type.
   3. Approved Manufacturer:
      a. Reference Appendix 011101-B.

C. Valves:
   1. Furnish all valves necessary for the operation and maintenance of the DSI system. These shall include, but not be limited to, the following:
      a. Gate valves.
      b. Ball valves.
      c. Check valves.
      d. Solenoid valves.
      e. Pressure/vacuum relief valves.
      f. Regulator valves.
   2. Furnish a manually operated gate type, isolation valve at the discharge of each set of blowers.
   3. Furnish a ball valve ahead of each compressed air operated device.
   4. Furnish a check valve at the discharge of each blower.

5. Furnish a pressure/vacuum relief valve at the top of each bulk storage silo and at the discharge of each blower.
6. Furnish motor operators for valves as specified in SECTION 409125.
7. Valve locations shall be designed in such a manner they can be operated from floors or platforms without the use of ladders. Valves, which are inaccessible from a platform or floor, shall be furnished with chain operators to the nearest platform or floor below the valve.

D. Piping Specials:
1. Furnish piping specials including emergency eyewash stations as specified in SECTION 485715 – Piping Specials. Emergency eyewash stations shall be furnished for each truck unloading location, as well as on the unloading floor of each silo. Eyewashes shall be either Haws or Bradley portable heated eyewashes.

2.16 HANGERS AND PIPING SUPPORT SYSTEM:

A. Reference Section 485940 – Hangers, Supports, and Anchors.

2.17 INJECTION LANCES:

A. Injection lances shall be designed for optimal hydrated lime distribution in accordance with the results of the physical flow model and CFD model.
B. Injection lances shall be designed for minimal wear and maintenance.
C. Injection lances shall be designed with the capability of online removal for periodic maintenance.
D. Injection lances shall be design to minimize pluggage.
E. Injection lances shall be furnished with a means to monitor pluggage and to alarm when plugging occurs.
F. Injection lances shall have a manually valved compressed air system for cleaning of plugged lances.
G. Distribution assemblies, or splitters shall be located directly upstream of injection lances to distribute hydrated lime from the primary transport line to individual ports.
H. Provide local temperature or pressure measurement of each lance for means of locally determining a lance is plugged.

2.18 PROTECTIVE COATINGS:

A. Paint all carbon steel surfaces in accordance with SECTION 099000.

2.19 LIGHTING:

A. All lighting circuits will be fed from lighting panels located inside the PCM as specified in SECTION 133423.
B. Exterior lighting shall be controlled by a photocell and H-O-A switch furnished by this Contract.
C. Lighting shall be 277Vac.
D. Reference Appendix 011101-B Approved Suppliers List.

2.20 EQUIPMENT I/O

A. The system shall be designed to run on loss of signal from the DCS, running signals shall be latched in the MCCs.
B. At a minimum all equipment shall have start command, stop command, running feedback, stopped feedback and power available signals to communicate with the Owner's DCS.
C. All variable speed or frequency feeders will have hardwired interlock to the plant MFT relay.

D. All variable speed or frequency feeders shall have at least one 4-20 mA speed feedback and a separate 4-20 mA current feedback hardwired to the Owner's DCS.

2.21 INSULATION

A. Contractor shall specify and indicate on drawings insulation purpose, type, and thickness required for equipment, piping, or piping components.
B. Personnel protection insulation shall be calculated based on a maximum surface temperature of 140 °F with an ambient temperature of 75 °F, lagging emissivity of 0.09 and 2 mph airflow velocity.
C. Thermal insulation shall be calculated based on the use of mineral wool, calcium silicate or Engineer approved alternate.

PART 3 - EXECUTION

3.01 NOT APPLICABLE:

END OF SECTION 485250

SECTION 485502 – COMPRESSED AIR EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:

A. Furnish a two (2) x 100% compressed air system to supply the instrument, service, and fluidization air for the DSI ~~and ACI~~ systems for both units.
B. Furnish all compressor components specified herein.
C. Provide services of technical personnel in the field to direct the installation and placing of compressors in operation.

1.02 REFERENCES:

A. Applicable Codes and Standards:
   1. Design, fabricate, assemble, and test Equipment and Materials so that upon installation in accordance with the manufacturer's recommended procedures for this application, the Equipment will conform to the applicable provisions of:
      a. American Gear Manufacturers Association (AGMA):
         (1) 6011 - Specification for High Speed Helical Gear Units.
      b. American National Standards Institute (ANSI):
         (1) B31.1 - Power Piping.
         (2) C2 - National Electrical Safety Code.
      c. American Society for Testing and Materials (ASTM):
         (1) A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
         (2) F1554 - Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.
      d. American Society of Mechanical Engineers (ASME):
         (1) Section VIII. Code for Unfired Pressure Vessels.
         (2) B31.1 - Power Piping.
      e. Institute of Electrical and Electronics Engineers (IEEE):
      f. Heat Exchange Institute (HEI).
      g. National Electrical Manufacturers Association (NEMA).

1.03 QUALITY ASSURANCE:

A. Factory Tests:
   1. Include all manufacturers' standard factory tests on Equipment and Materials.
   2. Test the compressors in the shop as follows:
      a. Test each impeller for integrity by either the Magna-Flux or Zyglo process.
      b. Dynamically balance and test impellers at 115% of operating speed.
      c. Hydrostatically test casings at 150% of the operating pressure.
      d. Completely assemble and run each compressor at the factory to confirm satisfactory operation with regard to the following:
         (1) Dynamic balance.
         (2) Vibration (certify 0.5-mill peak to peak maximum on impeller shafts).
         (3) Mechanical operation.
         (4) Capacity and pressure performance.
         (5) Gear tooth contact.
         (6) Lubrication system operation.
   3. Perform all manufacturers' standard tests to determine the performance of the motors.

B. Sound Pressure:
   1. Equipment furnished shall not exceed a 85-dBa sound pressure level measured at 5 feet above the assembly support elevation and 3 feet horizontally in any direction from the Equipment perimeter.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Furnish a two (2) x 100% compressed air system to provide the instrument and fluidization air for the DSI and activated carbon injection systems.
B. Furnish compressor unit complete and packaged to the maximum consistent with the overall design and Specifications. Ship all major components mounted on the base plate assembly, with no major Equipment assembly other than cooler mounting required in the field.
C. Compressors shall be air-cooled.
D. The compressed air system shall include two (2) x 100% skid-mounted, completely factory-assembled, electric-heat or heatless reactivated, fully automatic regenerative dryers. Dryers shall be capable of producing instrument quality air at a dewpoint of -40 °C. Each compressed air system and dryer shall be sized for 120% of the maximum demand for Units 1&2 combined. A cross-tie shall be provided downstream of the dryer to allow either compressor to feed both Units. One compressed air system shall be powered by Unit 1 and the other shall be powered by Unit 2.
E. A compressed air receiver tank shall be furnished for each DSI and ACI silo. It shall be sized to supply fluidizing air (if applicable), instrument air, air requirements of the bin vent filter, service air, and any other user furnished with the DSI or ACI systems.
F. Air receiver shall be designed and stamped in accordance with ASME BPVC Section VIII.
G. At a minimum the following shall be furnished with the air receivers:
   1. Inlet and outlet flanged connections.
   2. Pressure gauge
   3. Automatic moisture drain valves
   4. Manway per ASME Section VIII
   5. Safety relief valve
H. System shall be sized to supply air at the user pressure requirement at the maximum air usage.
I. Furnish all interconnecting piping from the compressors to each compressed air user.
   1. Compressed air piping used for instrument air shall be minimum Schedule 40S seamless stainless steel ASTM A312/A312M Grade TP304. Piping used for service air shall be minimum Schedule 80 seamless carbon steel ASTM A53 Grade B.
   2. Furnish in-line filters, valves and pressure regulators (if required) ahead of each pneumatic device. Materials of components shall match the piping system in which they are used.
   3. Furnish flexible connections where required.
   4. Pipe shall be shop-fabricated and coated to the greatest extent possible.
J. Provide moisture or drain traps for each intercooler, aftercooler, water separator, and required low points in interstage air piping of all Equipment furnished under this Contract.
   1. Drain traps shall be automatic type.
K. Compressors shall supply oil-free air.
L. Furnish a lubrication oil system including all necessary Equipment and accessories, including pumps, dual changeable filters, dual coolers, reservoir, sight flow indicators, valves, pressure

relief valves, pressure switches, necessary instrumentation, and all integral piping and other appurtenances required to form a complete lubrication system.

1. Furnish all oil piping required to complete the system.

M. Furnish all necessary compressed air instrumentation, including the following:
   1. Low pressure indicating transmitter for air receivers.
   2. Pressure regulators, solenoid valves, and receiver pressure gauges.

END OF SECTION 485502

SECTION 485715 - PIPING SPECIALS

PART 1 - GENERAL

1.01 SUMMARY:

A. Furnish all piping specials in accordance with the Specifications and the following:
   1. Furnish and test all specials complete and ready for operation.
   2. Furnish complete with all necessary miscellaneous pipe, valves, unions, fittings, auxiliaries, and isolating valves whether indicated on the drawings or not, but required.
   3. Furnish accessories such as gauge glasses, pressure gauges, and other instruments of equal quality to those similar items which are specified hereinafter.
   4. Provide design of all necessary supports, foundations, and equipment pads.
   5. Support all piping connected to the specials with necessary hanger material conforming to SECTION 485940. Support the pipe to provide forces and moments which are acceptable to the specials manufacturer.

B. Piping specials are designated as shown below:

USSS-BXXXX-A-PP-I-VVVVZ

U =	Unit Number
SSS =	System Code (2 or 3 characters)
B=	Special Tag
XXX =	Sequential Line Number
A =	Nominal Pipe Size
PP =	Piping System Identifier.
I =	Insulation class designation.
VVVV=	Special Number
Z=	Special Number Suffix

These designations are used in the Specifications and only the last four tag items are used on the Drawings.

1.02 REFERENCES:

A. Applicable Codes and Standards:
   1. Design, fabricate, assemble, install, and test Equipment and Materials in accordance with, but not limited to, the following codes and standards:
      a. American Society of Mechanical Engineers (ASME):
         (1) B31.1 - Code for Pressure Piping - Power Piping.
         (2) ASME Boiler and Pressure Vessel Code.
      b. American National Standards Institute (ANSI):
         (1) B16.25 – Butt-Welding Ends.
         (2) B16.34 – Valves, Flanged and Butt-Welding End.
         (3) B16.5 – Pipe Flanges and Flanged Fittings.
         (4) B31.1 – Code for Pressure Piping – Power Piping.
         (5) S1.4 – Specifications for Sound Level Meters.
         (6) ANSI/FCI 70-2 – Control Valve Seat Leakage.
      c. American Society for Testing and Materials (ASTM):
         (1) A216 – Carbon Steel Castings Suitable for Fusion Welding for High-Temperature Service.
         (2) A217 – Martensitic Stainless Steel and Alloy Steel Castings for Pressure Containing Parts Suitable for High Temperature Service.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 1.

B. Submittals required shall include the following:

1. A list of all piping specials by special number showing the manufacturer and the manufacturer's model or figure number as applicable.
2. Detail drawings and manufacturer's descriptions for each piping special as follows:
   a. Drawings showing general arrangement detail dimensions and all clearances required for installation, operation, and maintenance.
   b. Details of all external connections which must be made.
   c. Electrical connection drawings for all Equipment requiring electrical connections complete with schematic diagrams of internal wiring.
   d. Static and dynamic loadings.
   e. Certificates of completion of factory tests.
   f. Operation and maintenance data.
   g. An 8-1/2 x 11-inch drawing of the nameplate.
   h. Instruction books.
   i. Storage and installation instructions.

1.04 QUALITY ASSURANCE:

A. Experience:

1. All Equipment and Materials furnished shall have an acceptable history of satisfactory reliable service for a period of at least three years at comparable temperature, pressure and design stress levels.
2. Newly developed equipment with less than three years' actual service will be considered from established manufacturers if it has been adequately tested, meets the requirements of this Contract, and is approved by the Engineer.

B. Factory Tests:

1. Conduct all standard factory tests and all tests required by the applicable codes and standards.
2. Submit certificates of completion of factory tests as Submittals.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Suitably protect all Equipment and Materials for storage at the jobsite. Seal all openings and do not remove until Equipment is ready for connection.

B. Tag all piping specials, including all components shipped loose, with the special number.

C. Where spare, replacement, or additional parts are required for the piping specials, these items shall be delivered to Owner immediately upon receipt at the jobsite. Parts shall be packaged and sealed for long-term storage and be securely and visibly labeled as to part, function, and name of Equipment to which they apply.

PART 2 - PRODUCTS

2.01 LIST AND DESCRIPTION OF PIPING SPECIALS:

A. Piping Specials List:

Special No.	Item Description
S-1	Y-Type Strainers
S-5	Air Coalescing Filters
S-10	Expansion Joints (Rubber)
S-11	Expansion Joints (Metal - S.S. Bellows)
S-13	Flexible Metal Hoses
S-14	Flexible Rubber Hoses
S-15	Truck Hoses
S-18	Sight Flow Indicators
S-19	Lube Oil Sight Overflow
S-25	Flanged Restricting Orifices
S-26	Orifice Flanges
S-31	Air Cocks
S-32	Water Hose Bibs
S-34	Safety Eyewash
S-44	Safety and Relief Valves (Pressure)
S-45	Safety and Relief Valves (Vacuum)
S-51	Pressure-Regulating Valves

2.02 S-1 Y-TYPE STRAINERS:

A. Manufacturers:
   1. Reference Appendix 011101-B
B. Special Features Required:
   1. Provide two baskets per strainer.
   2. Provide 1/2-inch NPT connections in the inlet and outlet for differential pressure gauge.
   3. Provide 1-inch minimum blowdown connection with valves and piping the same size.
   4. Provide 1-inch NPT plugged drain connection.
C. Installation Requirements:
   1. Install as indicated and per manufacturer's recommendations.
   2. Strainers shall be installed with blowdown valves piped to a safe discharge point.

2.03 S-5 AIR COALESCING FILTERS:

A. Manufacturers:
   1. Reference Appendix 011101-B.
B. Special Features Required:
   1. Air coalescing filters shall have 1/2-inch NPT connections on inlet and outlet for pressure gauge connections.
   2. Provide 1-inch NPT drain connection with valve.
   3. Furnish with sufficient spare filters to refill each filter three times.
   4. 5 psi maximum pressure drop at the rated capacity.
   5. Air discharged from filter in normal operation shall contain a maximum of 0.1 ppm of oil by weight.
C. Installation Requirements:
   1. Install as indicated and per manufacturer's recommendations.

2.04 S-10 EXPANSION JOINTS (RUBBER):

A. Manufacturers:
   1. Reference Appendix 011101-B.

B. Special Features Required:
   1. Control units where piping cannot be properly anchored. Units shall be complete with all required hardware to assure maximum axial movements are not exceeded.
   2. Internal sleeve with purge connection for abrasive service.
   3. Flanges shall be sized and drilled as required by corresponding piping system.
   4. Provide backing plates.

C. Installation Requirements:
   1. Length of space in pipeline shall equal design installation length of expansion joint.
   2. Install as shown on Drawings with all mating piping properly anchored and guided in accordance with the manufacturer's recommendations.
   3. The two sections of pipe which attach to either end of the expansion joint shall be in alignment with each other.

2.05 S-11 EXPANSION JOINTS (METAL) STAINLESS BELLOWS:

A. Manufacturers:
   1. Reference Appendix 011101-B.

B. Special Features Required:
   1. Control units where piping cannot be properly anchored. Units shall be complete with all required hardware to assure maximum axial movements are not exceeded.
   2. Internal sleeve with purge connection for abrasive service.
   3. Weld end preparations shall be machined and flanges shall be sized and drilled as required by corresponding Piping System.
   4. 304 stainless steel corrugations with stainless steel liners.
   5. Single-unit construction suitable for full vacuum to the design pressure listed in the schedule below. Multi-ply joints are not acceptable.

C. Installation Requirements:
   1. Length of space in pipeline must equal design installation length of expansion joint.
   2. The two sections of pipe which attach to either end of the expansion joint must be in alignment with each other.
   3. Install as shown on the Drawings with all mating piping properly anchored and guided in accordance with the manufacturer's recommendations.

2.06 S-13 FLEXIBLE METAL HOSES:

A. Manufacturers:
   1. Reference Appendix 011101-B.

B. Special Features Required:
   1. Flexible hose shall be annular 304 stainless steel corrugated metal hose with braided stainless steel wire covering.
   2. Provide with flanged connections. Flange shall match corresponding Piping System.

C. Installation Requirements:
   1. Install metal hose with piping anchored and guided according to the manufacturer's recommendations.
   2. Installing in a tight bend is discouraged.

2.07 S-14 FLEXIBLE RUBBER HOSES:

A. Manufacturers:
   1. Reference Appendix 011101-B.

B. Special Features Required:
   1. Type and material of hose shall be as required for the service.

2. Provide end fittings and hose clamps as required.

C. Installation Requirements:
1. Install hose as detailed on Drawing.
2. Install hose with piping anchored and guided according to the manufacturer's recommendations.

2.08 S-15 TRUCK HOSES:

A. Manufacturers:
1. Reference Appendix 011101-B.

B. Special Features Required:
1. Furnish two carbon steel, quick-disconnect couplers with hose shanks.
2. Furnish couplers with dust plugs.

C. Installation Requirements:
1. Install hose with piping anchored and guided according to the manufacturer's recommendations.
2. Clamp hose couplers to hose using two double-bolt heavy-duty clamps.

2.09 S-18 SIGHT FLOW INDICATOR:

A. Manufacturers:
1. Reference Appendix 011101-B.

B. Special Features Required:
1. The body material shall be the same as the valves in the respective Piping System.
2. Indicator shall have tempered glass windows.
3. The rotating wheel type shall be used for pressures up to 150 psig.
4. The sight flow indicator shall have rotor for positive identification of flow.
5. The sight flow indicator shall have teflon envelope seal material.

C. Installation Requirements:
1. Install as indicated and per manufacturer's recommendations.
2. Flow indicators shall be installed in a horizontal pipe run such that the indicator is visible from the top or the bottom.

2.10 S-19 LUBE OIL SIGHT OVERFLOW:

A. Manufacturers:
1. Reference Appendix 011101-B.

B. Special Features Required:
1. Cast-iron body with enamel finishes.
2. 1/2-inch NPT top vent connection.
3. Pyrex glass sight.

C. Installation Requirements:
1. Install as indicated and per manufacturer's recommendations.

2.11 S-25 FLANGED RESTRICTING ORIFICES:

A. Manufacturer:
1. Reference Appendix 011101-B.

B. Special Features Required:
1. Flanged restricting orifices shall be provided with flanges conforming to the Piping System of the line in which they are installed.
2. Provided flanges with jacking bolts.

3. Orifice plates shall be square-edged stainless steel with identifying tab showing the orifice size and tag number projecting beyond the flanges.
4. Orifice plates shall be drilled to the orifice size listed in the schedule. Provide two extra blank plates for each restricting orifice in addition to the one drilled plate.

C. Installation Requirements:
1. Install as indicated and per manufacturer's recommendations.

2.12 S-26 ORIFICE FLANGES:

A. Manufacturer:
1. Reference Appendix 011101-B.

B. Special Features Required:
1. Orifice flanges shall conform to the Piping System for the line in which they are installed, except they shall be minimum Class 300 B16.5 rated.
2. Instrument connections on orifice flanges on horizontal pipe runs shall be located on side of pipe in the horizontal plane.
3. Flange taps for instrument connection shall be NPT and plugged for shipment.
4. Provide flanges with jacking bolts.
5. Provide spacer ring to be installed in the line when orifice is removed. Inside diameter of spacer ring to be the same as pipe inside diameter.

C. Installation Requirements:
1. Install as indicated and per manufacturer's recommendations.
2. Bore inside of the pipe and flanges smooth and concentric to ensure smooth flow.

2.13 S-31 AIR COCKS:

A. Manufacturers:
1. Reference Appendix 011101-B.

B. Special Features Required:
1. Air cocks shall be 3/4-inch malleable iron couplings attached to 3/4-inch bronze ball valves.
2. Provide coupling half on each valve.
3. Air cocks shall be 3/4-inch quick-change coupling with integral shutoff valve which automatically closes when coupling is not in use.
4. Coupling shall have Model C-91858Y nipple with 3/4-inch male pipe threads.

2.14 PORTABLE SAFETY EYEWASH:

A. Manufacturers:
1. Bradley (Model S19-921HR: portable heated eyewash)
2. Haws (Model 7500EB: portable heated eyewash)

2.15 S-44 SAFETY AND RELIEF VALVES (PRESSURE):

A. Manufacturers:
1. Reference Appendix 011101-B.

B. Special Features Required:
1. Drill and face flanges to match the Piping System.
2. Provide adaptors if required.
3. Valves shall pass full flow at 25% overpressure for liquid service and 10% overpressure for steam, air, and gas service.
4. Provide valves with closed bonnets to completely enclose spring.
5. Provide drain connections.

6. Provide internal bonnet vents or pipe external vent to exhaust line.
7. Provide valve gags for each size of flanged valves.
8. Provide all valves with operating lifting gear.
9. Valves for water, glycol-water, oil, and air service between 0 and 400°F shall be provided with Viton "O-ring" seats.

C. Installation Requirements:
1. Install as indicated and per manufacturer's recommendations.

2.16 S-45 SAFETY AND RELIEF VALVES (VACUUM):

A. Manufacturers:
1. Reference Appendix 011101-B.

B. Special Features Required:
1. Applicable items listed under pressure relief valves.
2. Valves located outdoors should have weather hood provided.

C. Installation Requirements:
1. Install as indicated and per manufacturer's recommendations.

2.17 S-51 PRESSURE-REGULATING VALVES

A. Manufacturers:
1. Reference Appendix 011101-B.

B. Special Features Required:
1. Valve shall be designed to conform with the Piping System in which it is to be installed.
2. Pressure regulating valves shall be self-contained type.
3. Valves shall have replaceable seats and disc with adjustable handwheel or screw.
4. Supply with inlet and outlet pressure gauges with calibration taps.

C. Installation Requirements:
1. Install valves as indicated and per manufacturer's recommendations.

PART 3 - EXECUTION - Not Applicable.

END OF SECTION 485715

SECTION 485935 - PIPE WELDING AND FABRICATION

PART 1 - GENERAL

1.01 SUMMARY:

A. Provide all welding and fabrication required to complete the piping systems as specified.
B. The welding and fabrication required includes shop welding and shop fabrication.

1.02 REFERENCES:

A. Applicable Codes and Standards:
   1. American National Standards Institute (ANSI):
      a. B16.25 - Buttwelding Ends.
   2. American Society of Mechanical Engineers (ASME):
      a. B31.1 - Code for Pressure Piping - Power Piping.
      b. Boiler and Pressure Vessel Code.
      c. LOS-1M - Recommended Practices for Cleaning, Flushing and Purification of Steam and Gas Turbine Lubrication Systems.
   3. American Welding Society (AWS).
   4. Pipe Fabrication Institute (PFI):
      a. ES3 - Fabricating Tolerances.
      b. ES16 - Access Holes, Bosses and Plugs for Radiographic Inspection of Pipe Welds.
      c. ES21 - Internal Machining and Fit-up of GTAW Root Pass Circumferential Butt Welds.
      d. ES24 - Pipe Bending Methods, Tolerances, Process and Material Requirements.
   5. Society for Protective Coatings (SSPC):
      a. SP3 - Power Tool Cleaning.
      b. SP5 - White Metal Blast Cleaning.
      c. SP6 - Commercial Blast Cleaning.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 1.
B. Submittals required shall include the following:
   1. Isometric piping drawings in accordance with the following:
      a. Lay lengths, pipe spools, fittings, flanges, specials, valves, field welds, piece mark numbers, hanger locations, hanger attachments, instrument connections, drain and vent connections required shall be indicated on the isometric piping drawings for any piping to be provided by the Contractor and installed in the field by Others.
      b. Contractor shall clearly dimension all piping.
   2. Welding procedures as specified.
   3. Welders' qualification test records as specified.
   4. Weld radiograph reports as specified.
   5. Postheat treatment temperature records as specified.
   6. ASME manufacturer's data reports for piping as required by ASME B31.1 and the ASME Boiler and Pressure Vessel Code.

1.04 QUALITY ASSURANCE:

A. Welding Procedures and Qualifications:
   1. Prepare welding procedures designed for the conditions of this Contract and as follows:
      a. Include certified copies of the qualification test records as evidence that the procedures have been qualified in accordance with the latest revisions of the following codes:
         (1) ASME B31.1.
         (2) ASME Boiler and Pressure Vessel Code.
      b. Submit in a form similar to the "Recommended Forms of Procedure Specifications" outlined in the above codes.
   2. Qualify all welders and welding operators in accordance with the following:
      a. Qualify in strict compliance with the following codes:
         (1) ASME B31.1.
         (2) ASME Boiler and Pressure Vessel Code.
      b. Qualify for each welding procedure to be used.
      c. ~~Submit qualification test records for position 6G and c~~Certify each welder and welding operator on the job for each welding procedure they are to use before they do any welding.
   3. Submit welding procedures and qualification test records as Submittals. Welding procedures and welders' qualification test costs shall be at Contractor's expense.

B. Inspections and Stamping:
   1. Compliance with the requirements of the ASME B31.1 shall be verified by a recognized insurance or inspection company.
   2. Compliance with the requirements of the boiler and pressure vessel code shall be verified by an authorized code inspector.
   3. Owner shall retain the right to maintain one or more inspectors in the shop during fabrication and welding.
   4. Inspect welds in accordance with the following:
      a. Keep radiograph exposure records which show date, location, area, film number, serial number, film combination, time, source-film distance, angulation, and other pertinent information for each weld radiographed. Submit a summary of this record, and an expert interpretation, in report form for each weld as a Submittal.
      b. Imperfect welds, as outlined in the ASME Boiler and Pressure Vessel Code and in ASME B31.1 will be judged unacceptable and shall be repaired. Repaired welds shall then be reradiographed.
   5. Inspection stamps, code symbol stamps, and other required information shall be stamped on the pipe by using "low stress," round nose steel stamps, or other approved method.
   6. Contractor shall assume the expense for all inspections required.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Protect all pipe ends of fabricated sections with heavy metal pipe end protectors, tack welded to the pipe and sealed with at least three wraps of waterproof tape.
B. Protect all flanges with plywood or masonite covers sealed and bolted to the flange with not less than four bolts.
C. Protect threaded connections with thread protectors.
D. Protect small connections with plastic inserts pressed into the connection and sealed with at least three wraps of waterproof tape.
E. Separately store pipes made of different materials.

F. Identify each piece of fabrication with a piece mark number which is repeated on each end of the section and on each branch.
G. Stainless steel pipe and fittings shall be handled with nylon slings or other nonferrous devices.

PART 2 - PRODUCTS - NOT APPLICABLE.

PART 3 - EXECUTION

3.01 GENERAL:

A. Perform all welding and fabrication in accordance with the requirements of ASME B31.1, and in accordance with the ASME Boiler and Pressure Vessel Code if under the jurisdiction of that code.
B. Design, fabricate, and test Equipment and Materials in accordance with the manufacturer's recommended procedures and the Applicable Codes and Standards listed in ARTICLE 1.02, this Section.
C. Fabricate in a manner to keep field welds at a minimum.
D. Complete all welded connections true to line, facing, and position within the tolerances specified in PFI ES-3.
E. Plates, lugs, insulation saddles, and other attachments welded to pipe shall be of the same material as the pipe.
F. Do not use miter bends.

3.02 WELDING:

A. Processes and Procedures:
   1. Accomplish shop welding by one of the following processes or a combination of these processes:
      a. Shielded Metal Arc Welding (SMAW).
      b. Submerged Arc Welding (SAW).
      c. Gas Metal Arc Welding (GMAW) or (MIG).
      d. Gas Tungsten Arc Welding (GTAW) or (TIG).
   2. Clearly describe the welding processes and combinations of processes used in the welding procedures and qualify the processes as specified above.
   3. Butt weld end preparation on all pipe shall conform to ANSI/ASME B16.25, PFI ES-1 and PFI ES-21. Weld end preparation for field weld connections to Owner-furnished items are subject to Engineer's approval. Provide weld build-up on inside of pipe if required for machining to required "C" dimension.
   4. The use of backing rings shall not be permitted. The root pass shall be made by the gas metal arc welding process or the gas tungsten arc welding process. The shielding and/or purging shall be by an inert gas, and the gases to be used and the flow rates shall be specified in the welding procedure.
   5. Make tack welds as follows:
      a. Use the same welding procedure used for making the root pass.
      b. Make without consuming the insert where consumable inserts are used.
      c. Inspect and repair if necessary before making root pass.
      d. Fuse into the root pass if not removed.
   6. Accomplish weld cleaning as follows:
      a. Use wire brushing, grinding, pneumatic deslagging, or hand tools as necessary to remove oxidation, slag, and flux between passes and after final pass.

b. Remove all defects such as cracks, porosity, slag entrapment, and undercutting down to solid weld metal or base metal prior to applying subsequent passes.

7. Welding may be interrupted on 1% Cr, 1/2% Mo through 3-1/4% Cr, 1 percent Mo materials provided the following conditions are fulfilled:
   a. A minimum of at least 3/8-inch thickness of weld deposit or 25% of the welding groove is filled, whichever is greater.
   b. The weld is wrapped with adequate insulation to allow for slow cooling to room temperature.
   c. Welds must be at preheat temperature before welding is resumed.
8. Make welds to equipment connections in accordance with the equipment manufacturer's requirements or these Specifications, whichever method is more stringent.
9. Weld plates, lugs, insulation saddles, and other attachments to pipe in accordance with the procedures established for the pipe material.
10. Remove weld defects by chipping, grinding, or arc gouging. Reweld the area using the same welding procedure used originally.
11. Stamp all welds with the welder's or welding operator's number or symbol.

B. Materials:
1. Consumable insert rings, where used, shall be of the same material as the base metal.
2. Filler materials shall be compatible with the base metal and shall be specified and purchased by ASME or AWS classification and chemical composition.
3. Electrodes shall be compatible with the base metal, suitably shielded where applicable, and shall be specified and purchased by ASME or AWS classification and chemical composition.
4. Properly store welding electrodes and filler material to ensure that no damage occurs. Store electrodes in suitable enclosures which provide a regulated temperature if recommended by the electrode manufacturer. The use of wet or moist electrodes will not be permitted.

C. Heat Treatment:
1. Heat treat welded joints in accordance with the requirements of ASME B31.1, and in accordance with the ASME Boiler and Pressure Vessel Code if under the jurisdiction of that code.
2. Accomplish preheating by induction or resistance heating methods. Preheating with controlled flame heating is acceptable for shop fabrication with a method as approved by Engineer. Determine the preheat temperature by temperature indicating crayons or other approved method.
3. Accomplish postheat treatment by full furnace heat treatment or local induction or resistance heating. Postheat treatment with controlled flame heating is acceptable for shop fabrication with a method as approved by Engineer. Make a complete automatic recording temperature record of the postheat treatment cycle for all welds. Submit summary of records as Submittals.
4. Preheat and postheat treatment for welds attaching plates, lugs, insulation saddles, and clips to pipe shall be made in accordance with the heat treatment procedures established for the pipe material.
5. Preheat and postheat treatment for welds made to equipment connections shall be in accordance with the equipment manufacturer's requirements or these Specifications, whichever method is more stringent.

3.03 BENDING:

A. Make all pipe bends for nominal pipe sizes of 8 inches and larger by a hot bending process. Make pipe bends for nominal pipe sizes 6 inches and smaller by either a hot or a cold bending process.

B. Perform hot bending of pipe in accordance with the following:
   1. Fill pipe with firmly tamped sand.
   2. Uniformly heat pipe to at least 1950°F but not higher than 2250°F.
   3. Perform all bending at temperatures between 1650°F and 2000°F.

C. Perform cold bending of pipe using a cold bending machine with internal mandrel.

D. All bends shall be free from cracks, visible buckles and wrinkles, and surface defects in addition to the tolerances specified in PFI ES-24. The allowable flattening for all bends, as determined by the difference between the major and minor diameters, shall not be greater than 8% of the nominal pipe diameter.

E. Make bends so that circumferential buttwelds are not located within the bends. Circumferential buttwelds may be located within the tangent section on the holding or pulling ends.

F. Make bends so that the wall thickness prior to the bending operation is not less than the product of the specified minimum wall thickness and bend thinning allowance in accordance with the following:

Radius of Bend Nominal Pipe in Diameters	Bend Thinning Allowance
6D	1.06
5D	1.08
4D	1.14
3D	1.25

G. Bend electric-fusion-welded or electric-resistance-welded pipe so that longitudinal weld is located in the neutral axis of the bend.

H. Perform postheat treatment of bends in accordance with the following:
   1. Carbon steel piping which has been heated to 1650°F or higher for bending or forming does not require postheat treatment.
   2. Carbon steel piping having a wall thickness of 3/4-inch or greater and all carbon steel pipe having a nominal pipe size of 4 inches and larger, which has been subjected to cold bending or forming operations shall have a postheat treatment at the temperature and time cycle specified in ASME B31.1 for welded joints.
   3. All alloy steel pipe bends shall have a postheat treatment at the temperatures and time cycles specified for welded joints in ASME B31.1 or in the ASME Boiler and Pressure Vessel Code (depending on which code has jurisdiction).
   4. Make a complete automatic recording temperature record of the postheat treatment cycle for all hot-formed sections and bends. Submit summary of records as Submittals.

3.04 CONNECTIONS:

A. Branch Connections:
   1. Branch connections for compressed air piping shall be butt welding fittings, butt weldolets, or fabricated fittings.
      a. Butt weldolets may be used for tee connections smaller than are available using butt welding fittings.

b. Fabricated fittings shall be shop fabricated and reinforced in accordance with the requirements of ASME B31.1.

2. Bonney Forge Threadolets or Sockolets or Vogt forged steel Couplets, WFI threaded, or socketweld Pipets shall be used for tee connections 2 inches and smaller.
3. Socket weld or threaded tees shall be used for lines 2 inches and smaller as indicated on the Piping Design Table.

B. Instrument Connections:
1. Instrument connections shall be of the same design as the piping system to which they connect.
2. Instrument connections, except connections for temperature wells shall be as follows:
   a. Bonney Forge Sockolets or Vogt forged-steel socket weld Couplets.
   b. Size as required.
3. Connections for temperature wells shall be as follows:
   a. Bonney Forge Threadolets or Vogt forged-steel threaded Couplets.
   b. Size as required.
4. Provide instrument connections for all instruments, controls, and sample points indicated and as required.
5. Provide connections on the instrument air headers for air supplies to instruments installed by this Contract.
6. Contractor shall indicate instrument connection location on the isometric piping Drawings prior to submittal for review. The location of instrument connections is subject to Engineer's approval.

C. Drain Connections:
1. Drain connections shall be of the same design as the piping system to which they connect.
2. Drain connections shall be Bonney Forge Threadolets or Sockolets or Vogt forged-steel Couplets. Size of drain connections shall be in accordance with the following table unless otherwise indicated on the Drawings:

Pipe Line Size	Drain Connection Size
14" and larger pipe	2"
10" and 12" pipe	1-1/2"
4" to 8" pipe	1"
2" to 3" pipe	1/2"
1-1/2" and smaller pipe	1/2"

3. Provide drain connections at all low points and between all header sectionalizing valves and between all equipment sectionalizing valves on all piping systems.
4. Contractor shall indicate the drain connections on the isometric piping Drawings prior to submittal for review. The location of drain connections is subject to Engineer's approval.

D. Vent Connections:
1. Vent connections shall be of the same design as the piping system to which they connect.
2. Vent connections shall be Bonney Forge Threadolets or Sockolets, or Vogt forged-steel Couplets. Vent connection size shall be minimum 1/2-inch or shall be the same as the line size where line sizes are smaller than the specified vent size.
3. Provide vent connections at all the high points of all piping systems.
4. Contractor shall indicate the vent connections on the isometric piping Drawings prior to submittal for review. The location of vent connections is subject to Engineer's approval.

E. Radiograph Access Holes and Plugs:
   1. Access holes and plugs for radiographic inspection of pipe welds shall meet the design requirements of the piping system and shall be in accordance with PFI ES-16.
   2. Install access hole plugs in connections in the shop, but do not seal weld.
   3. If access holes and plugs are provided for radiographic inspection of shop welds, the access hole plugs shall be installed and seal welded in accordance with PFI ES-16 after the weld has been radiographed and accepted and before the piping is shipped to the field.

3.05 CLEANING AND PAINTING:

A. The interior and exterior surfaces of all piping shall be thoroughly cleaned of all mill scale, foreign materials, dirt, greases, and oils.

B. Clean all fabricated piping, parts, and appurtenances in accordance with PFI Standard ES-5, and the following:
   1. Exterior Surfaces:
      a. Remove all loosely adhering foreign material from the outside surfaces of all piping.
      b. Piping, parts, and appurtenances of uninsulated piping shall be shop prepared and shop coated in accordance with SECTION 099000

C. All weld end preparations for field welds on alloy steel and carbon steel piping shall be coated with a consumable coating to prevent surface corrosion prior to welding. The manufacturer's coating to be used shall be submitted to Engineer for approval prior to use.

D. Flange faces shall be given an application of a water soluble preservative coating. The manufacturer's coating to be used shall be submitted to Engineer for approval prior to use.

END OF SECTION 485935

SECTION 485940 - HANGERS, SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SUMMARY:

A. Design and Furnish all hangers, supports, restraints, supplemental steel and anchors required to adequately support the piping systems.

1.02 REFERENCES:

A. Applicable Codes and Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B31.1 - Power Piping.
      b. Boiler and Pressure Vessel Code.
   2. American Society of Testing and Materials (ASTM):
      a. A125 - Steel Springs, Helical, Heat-Treated.
      b. A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
      c. A194 - Carbon and Alloy Steel Nuts for Bolts for High Pressure or High-Temperature Service.
      d. A335 - Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service.
      e. A387 - Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
      a. SP58 - Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
   4. Society of Protective Coatings (SSPC) Surface Preparation Specifications:
      a. SP1 - Solvent Cleaning.
      b. SP3 - Power Tool Cleaning.
      c. SP5 - White Metal Blast Cleaning.
      d. SP6 - Commercial Blast Cleaning.
      e. SP10 - Near-White Blast Cleaning.
      f. SP11 - Power Tool Cleaning to Bare Metal.

1.03 SUBMITTALS:

A. Submit detail drawings as specified in DIVISION 1 for each piping system. Submit only a completed system set of drawings covering all the supports in a system on the first submittal. Contractor shall maintain a drawing list to be submitted upon request. The drawing list shall indicate support tag numbers, revision, number of sheets for each support drawing, and date issued of each support.

B. Submittals required shall include the following:
   I. Detail drawings of engineered hanger assemblies on 8-1/2"x11" sheets indicating the following:
      a. Illustrate each support in the installed position. Show each support correctly oriented with respect to piping and existing or new structure. Indicate in the plan view and elevation views the location of the support attachment to the building structure including the orientation, dimensions, and elevations of added supplementary steel and/or existing steel, and support attachment to the piping for each support. All field welds shall be shown and sized. Location of the support shall be by referencing the plant grid coordinate system and true elevation and additionally in plan view shall locate the hanger relative to the column grid numbering system.

b. Nominal pipe size, pipe schedule, pipe material, design temperature, insulation thickness, isometric drawing number, and stress analysis file name
c. Plan location of the piping in the design (D), cold (C), and erect (E) for cold spring, and hot (H) positions.
d. Plan location of the hanger attachment to the supplemental steel, existing steel, and concrete to the pipe.
e. Location and size of all supplementary steel.
f. Elevation location of the support steel.
g. Elevation location of the piping in the design (D), cold (C), and erect (E) for cold spring, and hot (H) positions.
h. Total hanger load including:
   (1) Operating load on the support during normal operating conditions of the piping system to which the support is attached.
   (2) Hydrostatic load on the support during hydrostatic test of the system.
   (3) Occasional load on the support during any special events such as, relief valve discharge, seismic, wind, or other causes of loads on the system during life of the plant.
   (4) Maximum load capacity of the support assembly
i. Submit as an additional sheet to the support drawing the magnitude and direction of the support loads at all attachment points to the existing supporting structure (whether main steel or concrete). The attachment loads shall be clearly identified by the design (D), cold (C), erect (E), Hydro (H), etc. as applicable
j. Complete bill of material referenced with part number to the hanger illustration.
k. Hanger tagging designations shall be in a manner as approved by Engineer.
l. Equipment connection reaction list.
m. Concrete pad (including reinforcing steel), grout, and foundation details including anchor bolt type and embedment depth.
n. Supports from (either applied to top or bottom of) suspended concrete slabs require Engineer review and approval.
o. Hanger drawings shall show all information required for installation and erection of the hanger. Include necessary construction information regarding field welded connections, piece weights for lifting and rigging, etc. In addition, hanger drawing shall show erection support brackets, lifting lugs, and the like as needed for unloading, erection, and installation of the Contractor's materials.
p. For supplemental support steel that supports more than 1 pipe (i.e. trapeze type supports), supplier shall provide total beam end reactions for all pipes supported in addition to individual pipe loads.

2. Hanger load calculations if requested.
3. Certified Material Test Reports (CMTR) for all alloy pipe hanger components.
4. Certificate of completion of factory tests.
5. The above items shall be submitted by Contractor concurrently. Revise and resubmit the above items as necessary to incorporate revised drawings and/or Contractor's revised hanger detail sheets.

1.04 QUALITY ASSURANCE:

A. Factory Tests:
   1. Conduct all standard factory tests and all tests required by the applicable codes and standards.
   2. For supports carrying large loads in excess of 40 kips and selected components such as riser clamps, bolts and studs under tensile load, rods, eyerods, rod clevises and portions of beams that will be stressed to one third of maximum allowable stress shall be shop inspected for freedom from cracks and defects. Inspection shall be in form of magnetic particle testing after parts have been fabricated and stress relieved.
   3. Submit certificates of completion of factory tests as Submittals.
   4. All pipe support fabrication shall present a neat appearance. All flame cut edges shall be ground smooth. Weld spatter shall be removed by grinding or wire brushing before painting.
   5. Each support shall be completely assembled in the shop to assure all parts fit property. Properly assembled support may be disassembled only to the extent that is required for shipment. Prior to disassembly pieces shall be match marked to aid in reassembly.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Ship hangers to the Site with each hanger assembly individually bundled and each bundle durably tagged with the hanger assembly number. Any loose support components shall be clearly tagged with its hanger assembly number and where practical mechanically attached to the main assembly. All materials shall be shipped in as large of piece as practical to minimize field labor for erection.
B. Lifting lugs shall be provided for variable and constant springs with a weight of 100 pounds or greater.
C. Coat threaded connections with a suitable rust preventive compound.
D. Cap ends of all threaded material to prevent damage during shipping.
E. Hanger rods shall not be allowed to bend at any point when stored or transported horizontally.
F. Delivery shall be as specified in DIVISION 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Pipe hangers and supports shall be designed and manufactured by the following:
   1. Reference Appendix 011101-B.

2.02 DESIGN:

A. Design, fabricate, and test Equipment and Materials in accordance with the manufacturer's recommended procedures and the applicable codes and standards listed in ARTICLE 1.02, this Section.
B. Pipe hanger assemblies, supports, restraints, and anchors shall be complete to include the following:
   1. Constant spring hangers, variable spring support hangers, rigid supports, floor supports, guides, sway braces, supplementary steel, and anchors as required to adequately support the piping systems for normal operating and occasional hydrostatic loads.

2. All necessary structural steel, brackets, angles, and clips which are not a part of the existing building or boiler structural steel, but which are required to properly support the piping system, including additional steel as required to limit stresses on the existing building or boiler structural steel to reasonable values as approved by Engineer.
   a. Added supplemental steel required for attachment of supports to building structure will be attached by means of clip angles. Clip angles shall conform to "Framed Beam Connections" as indicated in AISC Manual of Steel Construction. Supplementary beam clip angles shall be sized to match support beam strength. Clip angles shall be securely attached by bolting to the supplemental steel for shipping and installation ease. Bolting shall be through elongated holes in the clip angle. Permanent attachment of clip angles will be by field welding.
   b. Unstiffened column web connections shall not be permitted where structural attachment is to a column web of the existing steel. Stiffening plates shall be designed and provided opposite the structural attachment.
   c. When determined to be required by the Contractor, furnish beam or column web stiffeners to stiffen beam or column webs and flanges. Contractor's pipe hanger system design shall not include, consider, or allow pipe hanger system loads to be cantilevered from or apply torsion to any building or structure support system members.
   d. Contractor shall not connect pipe hangers or supplementary steel for pipe hangers to stair stringers, girts, purlins, vertical nor horizontal bracing members, monorail beams, nor other similar structural members.
   e. Pipe hanger support brackets shall not be cantilevered from building or boiler structural steel members.
   f. Contractor shall design, manufacture, fabricate and deliver pipe support structural steel assemblies in the largest pieces practical to accommodate installation with the goal of minimizing field labor and equipment installation time. Assemblies shall include provisions to consider construction tolerances and accommodate field fit up via the use of slotted holes, predrilled holes, erection bolts, erection seats, templates, etc.
   g. Contractor shall design, manufacture, fabricate and deliver pipe support structural steel and hanger assemblies to aid in the compliance of OSHA – 29 CFR 1926 Subpart R – Steel Erection to the extent practical
3. ~~Design all necessary concrete pads, pipe stanchions, and foundations with fasteners, grout, or anchor bolts to be furnished by others.~~ Allow for 1 inch of grout under floor supported pipe stanchions for leveling, or provide other field adjustable means of leveling floor supports. Post installed anchor bolts shall have a minimum pullout safety factor of five. Show the required minimum anchor bolt embedment depth on the hanger drawings. Contractor's design of reinforcing steel where required to be embedded into existing concrete shall be based upon a post installed drill and grout method. Contractor shall indicate type of grout to be used for the post installed drill and grouting of reinforcing steel and include a minimum of three acceptable domestic grout manufacturers for Engineer's selection.

4. As a standard notation on the Contractor's pipe assembly drawings, Contractor shall include a notation to use care to not damage reinforcing steel during the installation work when drilling holes in concrete for post installed anchor bolts. Notation to additionally require that installing contractor local the rebar using a rebar locator prior to drilling holes and map the rebar locations for conflict with the holes. Contractor may be directed by Engineer to supply spare plates in the event that the originally provided plate cannot be field adjusted in location or field modified to miss the reinforcing steel.
5. Spring supports shall be provided with travel stop to lock the spring in cold position when locked assemblies shall be capable of carrying hydrostatic load. Locking device for springs shall be attached to casing by chains or approved method. All springs shall be locked in cold position for shipping.
6. All systems under this Contract shall be designed so that no damage to hangers or hanger supports will result during testing of the piping system.

C. Pipe hanger assemblies, anchors, and sway braces shall be designed by the hanger manufacturer in accordance with the latest editions of ASME B31.1, MSS SP58, and the following:
1. Make calculations to determine the appropriate design (D), erection (E) (for cold spring), and hot (H) positions of the piping. For non-cold sprung piping systems, generally cold (C), design (D), and erect (E) are the same position. Structural attachment shall be such that the hanger rods to be plumb in the hot position.
2. Make weight and moment balance calculations to determine the required supporting force on each hanger and the reaction on equipment.
3. Locate supports so that the spacing does not exceed that given in Table 121.5 of ASME B31.1, except in the center spans of straight runs where the spacing may be increased 20%. The vertical deadweight deflection between supports should be very small and allow piping to have positive slope towards drip pockets for proper drainage to avoid water hammer. Design for seismic and winds loads as specified in DIVISON 1.
4. Locate the first rigid hanger in a system so that the restraining action of the hanger produces a stress no greater than one quarter of the allowable stress listed in Appendix A of ASME B31.1 as calculated at the system's terminal connection (e.g. equipment nozzle or header) under any condition.
5. No rigid hanger (rod hanger) shall be subjected to a net uplift load under any condition.
6. Locate supports at concentrated loads to prevent excessive sustained stresses in the system.
7. Locate supports on horizontal runs near elbows within one quarter of the support span listed in ASME Table 121.5.
8. Locate supports adjacent to safety valves so as to prevent excessive deflection and moments due to reaction of discharging safety valves. Supports shall be rigid or shock and sway suppressors to accommodate the discharge of safety valves.
9. Locate supports and hangers such that the resultant reactions imposed on floor mounted equipment connections due to the weight of the piping system, or thermal expansion of the system does not exceed the following unless otherwise noted:
   a. Resultant Force $\pm$ 100 lbs.
   b. Resultant Moment $\pm$ 1000 ft-lbs.
   c. In-line supported Equipment shall have zero (0) forces and moments.
10. Provide permanent hot and cold position indicators adjacent to the travel slot for all constant and variable spring hangers. Position indicators shall be clearly visible from a distance of 30 feet.

11. All constant and variable spring hangers shall be provided with a name plate. As a minimum, the following information shall be stamped on the name plate:
    a. Support identification number.
    b. Manufacturer's model/figure number.
    c. Size.
    d. Load (lbs).
    e. Calculated travel (inches) and direction.
    f. Total travel (inches).
12. Provide chain, wire, or bolt for attaching travel stops to spring/constant housing for future use.
13. Riser clamps attached to the rigid rods shall be designed such that all of applicable load can be transferred to one side of riser clamp. Spring supported riser clamps that are to be pinned during hydrostatic testing shall be designed such that all of the hydrostatic load can be transferred to one side of clamp.
14. Riser clamps shall be designed to use shear lugs or trunnions to prevent the clamp from slipping.
15. Shock and sway suppressors for absorbing the safety relief valve discharge force, seismic, or other causes shall be designed by the manufacturer to a bleed rate necessary to limit displacement to 0.25-inch (6 mm) during the complete load duration. Total travel for shock and sway suppressors shall be at least 1 inch greater than design travel. Shock and sway suppressors shall have adequate adjustment after installation.
16. Constant springs shall have total travel range greater of 20% or 1 inch over the design travel. The design travel shall be centered within the total travel range. Constant spring supporting effort shall not exceed 6% deviation from specified load. Variable springs shall not exceed 25% load variability. Provide spring as specified above and in accordance with MSS SP-58 Table 5.
17. Pipe insulation shall be accounted for in design of pipe clamps and other pipe attachments.
18. Rigid struts shall be capable of field adjustment while supporting design load. Field adjustment allowance shall be at least plus or minus 3 inches.
19. Coordinate hanger design and location to ensure that no interferences will exist between hangers, pipes, and building steel or electrical apparatus and HVAC duct work.
20. Design all auxiliary steel required to properly support the piping with the same safety factor stress levels as the main hanger components in accordance with MSS SP58.
21. Contractor shall be responsible for follow-up on hangers to help solve vibration or movement problems of pipe apparent after start-up.

2.03 CONSTRUCTION:

A. Pipe hanger assemblies, anchors, and sway braces shall be constructed of the following materials:
    1. Pipe support components shall be suitable for service at their maximum sustained operating temperature. Materials of pipe supports such as pipe clamps and other components with design temperature of less than 800°F shall be carbon steel of an ASTM type having a minimum yield strength of 35,000 psi and a minimum ultimate strength of 58,000 psi.

2. Hanger rods shall be carbon steel cut to length and threaded in the factory. Material shall have a minimum ultimate tensile strength of 50,000 psi as indicated in ASME B31.1 Table 121.7.2(A). Threaded length of rod shall be long enough for the pipe support adjustment. For a cold-sprung system, the threaded length and turnbuckle gap shall accommodate support adjustment from the erected elevation to the cold elevation.
3. Clevises, turnbuckles, and eye nuts shall be forged steel.
4. Eye rods shall have full and neatly welded eyes with the cross sectional strength of the eye greater than or equal to strength of the rod.
5. All guide or pipe supports that include a friction load shall use the following materials:
   a. RTFE slides for lines which have a design temperature less than or equal to 450°F.
   b. Graphite slides of bolted design for lines which have a design temperature greater than 450°F.
6. Protection saddles up to 800°F shall be carbon steel as specified in paragraph 2.03A.1 of this Section.
7. Clean all pipe hanger assemblies to SSPC-SP6 quality and 1.0 mil minimum profile depth, and coat with manufacturer's standard coating system at 2 mils minimum dry film thickness.
8. All miscellaneous carbon steel hanger components located in unenclosed areas shall be galvanized, with the exception of lugs and clips welded directly to pipes or structural members which shall be coated with weldable primer.
9. Clean and coat all supports in accordance with SECTION 099000.

B. Pipe hanger assemblies, anchors, guides, restraints, and sway braces shall use only the following acceptable types of components as outlined in MSS SP58:
   1. Upper Supports: Type 22 with bolt and Type 57. If the horizontal movement of the pipe results in a vertical angle of hanger rod greater than four degrees (4°) between structural and pipe attachment pivot points, a horizontal traveler or equal may be used where approved by Engineer.
   2. Intermediate Supports: Types 13, 14, 17, 51, 52, 53, 54, 55, and 56.
   3. Lower Supports: Types 2, 3, 4, 8, 24, 35, 37, 39, 42, and steel plate lugs shop welded to the pipe. Type 1 may be used on noninsulated piping systems. Where a riser clamp is used as this lower support on a vertical line operating above 200°F, provide adequate shear lugs welded to the pipe to keep the clamp from slipping on the pipe. Use alloy steel components on all lines over 750°F as specified in paragraph 2.03 A.4 this Section.

PART 3 - EXECUTION - Not Applicable.

END OF SECTION 485940

SECTION 485990 - PIPING INSTALLATION

PART 1 - GENERAL

1.01 SUMMARY:

A. Shop erect and install piping and accessories within the silos, PCM, equipment enclosure (if applicable), and on equipment skids to the greatest extent possible. Additionally, install accessories for all piping supplied in the shop to the greatest extent possible.

B. Piping erection and installation includes the following:
   1. Installation of hangers, supports, and anchors.
   2. Fabrication and erection of piping systems.
   3. Makeup of flanged, screwed, and solder joints.
   4. Connections to equipment.
   5. Furnishing and installing miscellaneous valves.
   6. Identification of piping including grade, schedule, piece mark numbers, and connection locations.
   7. Testing of piping systems.

1.02 REFERENCES :

A. Applicable Codes and Standards:
   1. Design, erect, weld, fabricate, and test Equipment and Materials in accordance with, but not limited to, the following codes and standards:
      a. American Society of Mechanical Engineers (ASME):
         (1) Boiler and Pressure Vessel Code.
         (2) B31.1 - Code for Pressure Piping - Power Piping.
      b. American Welding Society (AWS).
      c. Pipe Fabrication Institute (PFI):
         (1) ES-3 - Fabricating Tolerances.
         (2) ES-16 - Access Holes and Plugs for Radiographic Inspection of Pipe Welds.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 1.

B. Submittals required shall include the following:
   1. Welding procedures as specified.
   2. Welders qualification test records as specified.
   3. Weld radiograph reports as specified.
   4. Hanger and support adjustment reports as specified.
   5. Post-heat treatment temperature records as specified.
   6. Data reports as required by ASME B31.1 and the ASME Boiler and Pressure Vessel Code.

1.04 QUALITY ASSURANCE:

A. Welding Procedures and Qualifications:
   1. Prepare welding procedures designed for field welding under the conditions of this Contract and as follows:
      a. Include certified copies of the qualification test records as evidence that the procedures have been qualified in accordance with the latest revisions of the following codes:
         (1) ANSI B31.1.
         (2) ASME Boiler and Pressure Vessel Code.

b. Submit in a form similar to the "Recommended Forms of Procedure Specifications" outlined in the above codes.

2. Qualify all welders and welding operators in accordance with the following:
   a. Qualify in strict compliance with the following codes.
      (1) ASME B31.1.
      (2) ASME Boiler and Pressure Vessel Code.
   b. Qualify for each welding procedure to be used.
   c. Submit qualification test records for position 2G and 5G, or 6G and certify each welder and welding operator on the job for each welding procedure they are to use before they do any welding.
3. Submit field welding procedures and qualification test records as Submittals. Welding procedures and welders qualification test cost shall be at Contractor's expense.

B. Inspections and Stamping:
1. Compliance with the requirements of ASME B31.1 shall be verified by an authorized code recognized insurance or inspection company.
2. Compliance with the requirements of the ASME Boiler and Pressure Vessel Code shall be verified by an authorized code inspector.
3. Inspect shop welds in accordance with the requirements of section 485935 including radiography of all shop welds in the lines specified to receive radiographic inspection.
4. Contractor shall assume the expense for all inspections required.

PART 2 - PRODUCTS – Not Applicable.

PART 3 - EXECUTION

3.01 INSTALLATION OF HANGERS, SUPPORTS, AND ANCHORS:

A. Install hangers, supports, and anchors in strict accordance with the hanger manufacturer's recommendations.

B. Remove paint in area of weld on structural steel before welding hanger attachments.

3.02 FABRICATION AND ERECTION:

A. General:
1. Shop fabricate and erect piping in accordance with the requirements of ASME B31.1, and the ASME Boiler and Pressure Vessel Code if under the jurisdiction of that code.
2. Shop fabricate piping in strict accordance with all requirements of SECTION 485935.
3. Weld valves into pipe lines in open position to prevent damage to valve seat unless otherwise noted by valve manufacturer's installation instructions.
4. Make last weld joint only after all flanged joints have been coupled and after the connection has been positioned true-to-line, facing, and position.
5. Keep plugs in radiograph access holes at all times except when radiographic inspections are being made. Seal weld radiograph access hole plugs in accordance with PFI ES-16 after the welds have been radiographed and accepted.

B. Small Piping:
1. Shop fabricate and erect piping 2 inches and smaller in accordance with the following:
   a. Do not route small pipe liquid lines over electrical panels, switchgear motor control centers, or other electrical items unless approved by Engineer as the only reasonable routing.

b. Lines may include five diameter bends in lieu of elbows and shall include standard reducers for pipe size reductions. Bushings shall not be used for pipe size reductions.
c. Provide offsets, fittings, unions, drip pockets, vents, drains, hangers, and supports to make a complete installation.
d. Contractor shall be responsible for designing the hanger systems in accordance with SECTION 485940 of the Specifications to allow for thermal expansion of the pipe and movement of the equipment connections.
e. Use tees for all branch connections.
f. Install globe valves so that the direction of flow is with the upstream pressure under the disc.
g. Furnish and install all necessary pipe and fittings required to install all relief valves in a vertical position. Furnish tail pipes and route to a place where the discharge will not injure personnel when operating the piece of equipment.
h. Install drain lines from drip pockets to traps without pockets.
i. Provide all required miscellaneous vents and drains whether indicated or not.
j. Furnish and install unions in piping systems using screwed joints as follows:
   (1) Install so lines may be broken for maintenance, valves may be removed, and equipment disconnected.
   (2) Install in lines which are erected without unions and which, in the opinion of Engineer, cannot be properly maintained.
   (3) Install dielectric unions wherever copper pipe is joined to iron or steel pipe or equipment. Install in positions which receive axial thrust only.
k. Furnish and install flanges in piping system using socket weld joints as follows:
   (1) Install so lines may be broken for maintenance.
   (2) Install in lines which are erected without flanges and which, in the opinion of Engineer, cannot be properly maintained.

2. Provide instrument connections on small piping as follows:
   a. Of the same design as the piping system to which they connect.
   b. Of the size and type specified in SECTION 485935.
   c. Furnish tees, nipples, and couplings as required to accommodate temperature wells without restricting flow.
3. Provide drain connections on small piping as follows:
   a. At all low points and between all header sectionalizing valves on all piping systems.
   b. Of the same design as the piping system to which they connect.
   c. Of the size and type specified in SECTION 485935.
4. Provide vent connections on small piping as follows:
   a. At all high points of all piping systems.
   b. Of the same design as the piping system to which they connect.
   c. Of the size and type specified in SECTION 485935.

3.03 MAKEUP OF FLANGED, SCREWED AND SOLDER JOINTS:

A. Flanged Joints:
1. Apply gaskets for low pressure, low temperature joints dry. Apply all other gaskets in accordance with the gasket manufacturer's instructions.
2. Use anti-seize compound to lubricate all flange bolt and stud-bolt threads. Anti-seize compound shall be suitable for temperatures up to 1000°F, and shall be "Molykote G" or approved equal.

3. Tighten flanged joints to properly compress the gasket and to obtain the design loading recommended by the gasket manufacturer. Do not exceed the maximum stress values allowed by ASME B31.1 for the bolting materials used.

B. Screwed Joints:
   1. Use anti-seize compound to lubricate all screwed pipe joints, with the compound applied to male threads only. Anti-seize compound shall be as specified above for flange bolt and stud-bolt threads.
   2. Seal weld all screwed thermowells where noted on Instrument Data Sheet.

C. Silver Brazed Joints.
   1. Clean joint thoroughly with steel wool or emery cloth and a suitable solvent before assembling.
   2. Apply a suitable flux, if required, assemble joint, and braze using AWS equivalent BCu P-3 filler metal.

3.04 CONNECTIONS TO EQUIPMENT:

A. Furnish all material to complete screwed, flanged, and welded connections of all pipe systems to equipment. Equipment located inside of the silos shall be connected to the greatest extent possible with all piping prior to shipment to the field.

B. Leave final pipe flanges that connect to equipment loose until final field fit-up to allow for misaligned flanges on equipment.

C. Connections to equipment made by this Contract shall be disconnected and connected as required for checking the alignment of the equipment. Any misalignment of the piping shall be corrected by this Contractor.

D. Piping connected to equipment which must vary from the specifications because of requirements peculiar to the particular equipment furnished by this Contract, shall be furnished and installed as required to make a complete and workable installation without additional cost to the Owner; this requirement shall include changes required in the piping systems because of design changes made by the manufacturer between the time of design and the time of installation and because of equipment furnished of different manufacturer or type than that specified.

3.05 MISCELLANEOUS VALVES:

A. Instrument Root Valves:
   1. Furnish root valves for all instrument and sample connections, except connections for temperature wells, including connections on all piping and equipment furnished by others and erected under this Contract.
   2. Root valves shall be gate or globe valves conforming to the piping specification of the line or equipment to which they are connected.

B. Instrument Air Supply Root Valves:
   1. Furnish and install a root valve for each instrument air supply tubing takeoff from an instrument air header.
   2. Instrument air supply root valves shall be gate or globe valves conforming to the piping material, as specified, of the Instrument Air Header to which they are connected.

C. Drain and Vent Valves:
   1. Drain and vent valves shall be gate or globe valves conforming to the piping specification of the line to which they are connected.
   2. Drain and vent valves shall be the same as the connection size.
   3. Drain and vent valves shall have a threaded outlet nipple (and threaded cap) of the same schedule as the inlet pipe.

D. Strainer Blowdown Valves:
   1. Furnish blowdown valves and discharge piping to equipment drains for all Y-type strainers.
   2. Strainer blowdown valves and discharge piping shall conform to the piping specification of the line in which the strainer is installed.

3.06 PIPING IDENTIFICATION:

A. The piece mark number for all prefabricated pipe sections shall be clearly visible.

B. Identify all connections on piping with a label painted on the pipe and visible from the floor after erection. The connections shall be labeled as follows:

Type Connection	Label
Instrument connection	Instrument tag number
Drain connection	"D"
Vent connection	"V"
Radiograph access hole	"R"

3.07 TESTING OF PIPING SYSTEMS:

A. Provide piping system test requirements for use by installation contractor.

END OF SECTION 485990

SECTION 488030 – FLOW MODEL STUDY

PART 1 - GENERAL

1.01 SUMMARY:

A. Contractor shall construct a physical flow model and a Computational Fluid Dynamics (CFD) single phase flow model to execute a flow model test the flue gas flow path from the economizer outlet to the precipitator inlet for Green Units 1 and 2.
   1. The flow model studies shall be used to optimize the location and quantity of injection lances for the injection locations. For each unit, injection of hydrated lime shall be upstream of the air preheaters and PAC injection shall be downstream of the air preheaters in the split duct arrangement.
   2. One model shall be created for Green Units 1 and 2 which are considered similar units. The model shall be from the economizer outlet to the precipitator inlets. The precipitator inlet is considered to be where the first field begins. This model will be used to simulate both ACI and DSI systems for each unit.
   3. Optimized flow is considered to be uniform distribution of the hydrated lime and carbon within the ductwork with particulate concentration plus or minus 15% RMS.
   4. The flow model study shall be used to adjust flue gas distributions and flow patterns to minimize erosion.
   5. The results of the physical model shall be used to adjust the CFD model.

1.02 SUBMITTALS

A. Submit as specified in DIVISION 1.
B. Includes, but not limited to, the following:
   1. Instrumentation information and locations.
C. The Contractor shall provide at least three references of previous CFD modeling experience including the program that was utilized.
D. Flow Model Test Report (Physcial and CFD model):
   1. A flow model test report shall be prepared to document the results of the physical flow model and a test report shall be prepared to document the results of the CFD flow model testing.
   2. The test report shall include, as a minimum, the following sections:
      a. Executive Summary, describing in general terms the results and conclusions drawn from the flow model tests.
      b. Introduction, including the general practices used to design the model and perform the testing; including an explanation of the theory used to correlate the modeling conditions with the expected full size system conditions.
      c. Testing, including a description of the actual testing process; and installation or modeling of flow correction devices.
      d. Test Results and Recommendations; including how the Contractor wil use the results to extrapolate to the full size system.
      e. Appendix; including drawings of the model, and sketches showing the instrumentation used; photographs of the testing; and other pertinent information to create a complete report.
E. Three (3) copies of a DVD of the flow model study shall be submitted with the final physical flow model report.

SECTION 488030 – FLOW MODEL STUDY: continued

PART 2 - PRODUCTS:

2.01 GENERAL

A. Modeler shall design and construct the physical model and CFD model so that full-size flow patterns, velocity profiles and flyash distribution are simulated in the models of the ductwork and equipment.
B. All internal structural members 3 inches in diameter or greater shall be modeled.
C. Flow shall be optimized over the range of operating conditions specified in Appendix 011101-A. The model shall be conducted at a minimum of three loads for each unit: 100% of the performance gas flow and conditions, the minimum gas flow and conditions from the design range, and the maximum gas flow and conditions from the design range.
D. The flow model study shall be used to determine the optimum quantity, type, size, and locations of any flue gas mixing and/or flow correction devices (turning vanes) to provide even activated carbon or hydrated lime distribution, plus or minus 15% RMS, wthin the flue gas (if required).
E. Conduct model tests and continue model testing until all problem areas related to gas flow, gas flow distribution, activated carbon and hydrated lime distribution, particulate fallout, pressure drop, etc., have been identified.
F. Determine gas pressure and velocity distributions throughout the duct system.
G. Provide complete listing of all pressure drop data for locations immediately upstream and downstream of areas of interest before and after corrective device added. Pressure taps in physical model shall be located before and after each corrective device, if applicable.
H. Identify areas of flow separation or undesirable turbulence.
I. Modify models and/or add corrective devices to solve problems. Rerun model tests. Continue these activities until an economical solution has been determined for all problem areas.
J. The model testing shall also investigate potential areas of fly ash/PAC/sorbent dropout, and shall adjust the ductwork and/or flow correction devices to mitigate dropout.
K. Dropout testing shall be performed using ash, cork dust, hollow glass spheres, or an Engineered approved equal alternative at all test conditions for the physical flow model.
L. Flow visualization shall be based on the use of smoke, or other Engineer approved equal, for the physical flow model.
M. The physical flow models shall be performed with a tracer gas, or other Engineer approved equal, to simulate the injection of hydrated lime and activated carbon and to determine distribution.
N. The Owner and/or Engineer shall be provided with a schedule of model testing activities at least one month prior to model testing. The schedule shall be updated at least two weeks in advance of model testing.
O. For the physical flow model, the Contractor shall construct a three-dimensional minimum ~~1/12~~ 1/35 to 1/40 physical scale model of the ductwork and a 1/12 to 1/15 dust model from the economizer outlet to the precipitator inlets, including the air preheaters.
P. For the CFD model the Contractor shall construct a full-scale three-dimensional model of the ductwork from the economizer outlet to the precipitator inlets, including the air preheaters.
Q. The Owner and/or the Engineer shall have the right to attend and observe the testing.
R. The Contractor shall perform any other flow model tests that it deems necessary to optimize the performance of the systems.
S. Final physical model testing shall be recorded with video camera(s) and digital media for future reference.

T. The Contractor shall store the physical model for a minimum of one (1) year after initial gas flow through the full size system. Owner shall have an option to receive the model prior to disposal.

2.02 TESTS

A. Dynamic and geometric similitude shall be observed in all phases of the model study, where possible.

B. The model shall be conducted at a minimum of three loads for each unit: 100% of the performance gas flow and conditions, the minimum gas flow and conditions from the design range, and the maximum gas flow and conditions from the design range referenced in Appendix 011101-A. Tests shall be used to:
   1. Determine gas pressure and velocity distributions throughout the duct system.
   2. Identify and mitigate areas of flow separation or undesirable turbulence.
   3. Identify and mitigate areas of ash/PAC/sorbent dropout.
   4. Optimize lance placement for improved PAC/sorbent distributions.
   5. Improve flow distribution with correction devices, if required.

C. As a minimum velocity and total pressure distribution shall be provided at the following locations for each model:
   1. Economizer outlet duct.
   2. Air preheater outlet ducts.
   3. Precipitator inlet ducts.
   4. PAC injection location(s).
   5. Sorbent injection location(s).

2.03 MINIMUM PERFORMANCE GUIDELINES:

A. The internal flow distribution devices, if required, will be optimized to achieve the following at 100% design flow with the minimum practical pressure loss:
   1. Where practical, velocity distribution in the ductwork, with a RMS deviation less than 15% of the mean velocity.

B. Once the system is optimized for 100% gas flow, further modifications shall be developed and implemented to obtain acceptable conditions in the system at all test conditions.

2.04 REPORTS

A. At a minimum, the test report shall contain at least the following:
   1. Complete explanation of test procedures including flow rates, pressures, calculations and assumptions. List and justify deviations in dynamic and geometric similitude by model from full-size installation.
   2. A scale drawing of full-size installation showing any modifications made and devices added to ductwork as a result of study.
   3. Isovelocity diagrams and histograms, indicating the root mean square (RMS) velocity deviation and mean velocity, at strategic points which shall include, but not be limited to, following:
      a. Economizer outlet
      b. Air preheater outlets
      c. Precipitator inlets
      d. PAC injection location(s)
      e. Sorbent injection location(s)

4. A complete description of the physical flow model testing, and CFD flow model simulations, including a description of the actual testing and CFD modeling process; and installation or modeling of flow correction devices.
5. Recommendations and conclusions shall cover methods to provide the following results:
   a. Minimize pressure drop.
   b. Minimize fallout of flyash in the ductwork.
   c. Maximize PAC/sorbent distribution.

PART 3 - EXECUTION – NOT APPLICABLE

END OF SECTION 488030

DIVISION 49 – DATA TO BE SUBMITTED WITH BID

SECTION 490000 - DATA TO BE SUBMITTED WITH BID – ACI AND DSI SYSTEMS

PART 1 - GENERAL

1.01 SUPPLEMENTAL INFORMATION:

A. General arrangement drawings for Contractor's Scope of Work. Drawings shall show location of all major equipment, structural steel, access platforms, stairs and doors.
B. Equipment data: Provide equipment information in Appendix 490000-A Fill-In-Data.
C. Piping and instrument diagrams (P&IDs) of complete system.
D. Complete motor list.
E. System I/O list.
F. List of acceptable PACs with expected Delivery Cost.
G. Expected Delivery Cost for hydrated lime.
H. Expected Delivery Cost for trona.
I. Functional description of operation for each major piece of equipment or system.
J. CFD Modeling software and experience list with this software modeling ACI and DSI systems.
K. All performance correction curves.

PART 2 - PRODUCTS - NOT APPLICABLE.

PART 3 - EXECUTION - NOT APPLICABLE.

END OF SECTION 490000

DIVISON 49 - DATA TO BE SUBMITTED WITH BID Appendix 490000-A Fill-In-Data PROPOSAL DATA ACI and DSI Systems				
ITEM	DESCRIPTION			UNITS
		Green Unit 1	Green Unit 2	
	Activated Carbon Silos			
1	Quantity	1	1	
2	Diameter			ft
3	Height			ft
4	Capacity			ft^3
5	Expected Linear Feet of Field Welds			ft
6	Number of separately shipped pieces.			
7	Plate Material			
8	Plate Thickness			in
9	Erected Weight			lbs
10	Operating Weight (full)			lbs
	Hydrated Lime Silos			
11	Quantity	1	1	
12	Diameter			ft
13	Height			ft
14	Capacity			ft^3
15	Expected Linear Feet of Field Welds			ft
16	Number of separately shipped pieces.			
17	Plate Material			
18	Plate Thickness			in
19	Erected Weight			lbs
20	Operating Weight (full)			lbs
	Hydrated Lime Silos (20' diameter option)			
21	Quantity	1	1	
22	Diameter	20	20	ft
23	Height			ft
24	Capacity			ft^3
25	Expected Linear Feet of Field Welds			ft
26	Number of separately shipped pieces.			
27	Plate Material			
28	Plate Thickness			in
29	Erected Weight			lbs
30	Operating Weight			lbs
	Activated Carbon Silo Weigh Hoppers			
31	Quantity	2	2	
32	Capacity			ft^3
33	Materials of Construction			
	Hydrated Lime Silo Weigh Hoppers			
34	Quantity	2	2	
35	Capacity			ft^3
36	Materials of Construction			
	Bin Vent Filters			
37	Quantity	2	2	

Appendix 490000-A Fill-In-Data PROPOSAL DATA ACI and DSI Systems				
ITEM	DESCRIPTION			UNITS
38	Type			
39	Manufacturer and Model Number			
40	Nominal Capacity			acfm
41	Bag Surface Area			ft^2
42	Bag Life			years
43	Total Air to cloth ratio			$acfm/ft^2$
	Hydrated Lime Blowers			
44	Quantity	2	2	
45	Normal Operating Quantity	1	1	
46	Manufacturer and Model Number			
47	Nominal Capacity			acfm at psig
48	Motor:			
49	Manufacturer			ft
50	Model			
51	Rated Horsepower			HP
52	Rated Voltage			VAC
53	Full Load Amps			A
54	Normal Operating Load			A
55	Locked rotor amps			A
56	Full load RPM			rpm
57	Service Factor			1.15
58	Efficiency at full-load			
59	Efficiency at 3/4-load			
60	Efficiency at 1/2-load			
61	Power factor at full-load			
62	Power factor at 3/4-load			
63	Power factor at 1/2-load			
	Activated Carbon Blowers			
64	Quantity	2	2	
65	Normal Operating Quantity	1	1	
66	Manufacturer and Model Number			
67	Nominal Capacity			acfm at psig
68	Motor:			
69	Manufacturer			
70	Model			
71	Rated Horsepower			HP
72	Rated Voltage			VAC
73	Full Load Amps			A
74	Normal Operating Load			A
75	Locked rotor amps			A
76	Full load RPM			rpm
77	Service Factor			1.15
78	Efficiency at full-load			
79	Efficiency at 3/4-load			
80	Efficiency at 1/2-load			

Appendix 490000-A Fill-In-Data PROPOSAL DATA ACI and DSI Systems				
ITEM	DESCRIPTION			UNITS
81	Power factor at full-load			
82	Power factor at 3/4-load			
83	Power factor at 1/2-load			
	Hydrated Lime Screw Feeders			
84	Quantity	2	2	
85	Normal operating quantity	1	1	
86	Manufacturer and Model			
87	Type			
88	Nominal Capacity			lb/hr
89	Turndown Ratio			
90	Feed Accuracy			%
91	Motor:			
92	Manufacturer			
93	Model			
94	Rated Horsepower			HP
95	Rated Voltage			VAC
96	Full Load Amps			A
97	Normal Operating Load			A
98	Locked rotor amps			A
99	Full load RPM			rpm
100	Service Factor			1.15
101	Efficiency at full-load			
102	Efficiency at 3/4-load			
103	Efficiency at 1/2-load			
104	Power factor at full-load			
105	Power factor at 3/4-load			
106	Power factor at 1/2-load			
	Activated Carbon Screw Feeders			
107	Quantity	2	2	
108	Normal operating quantity	1	1	
109	Manufacturer and Model			
110	Type			
111	Nominal Capacity			lb/hr
112	Turndown Ratio			
113	Feed Accuracy			%
114	Motor:			
115	Manufacturer			
116	Model			
117	Rated Horsepower			HP
118	Rated Voltage			VAC
119	Full Load Amps			A
120	Normal Operating Load			A
121	Locked rotor amps			A
122	Full load RPM			rpm
123	Service Factor			1.15

Appendix 490000-A Fill-In-Data PROPOSAL DATA ACI and DSI Systems				
ITEM	DESCRIPTION			UNITS
124	Efficiency at full-load			
125	Efficiency at 3/4-load			
126	Efficiency at 1/2-load			
127	Power factor at full-load			
128	Power factor at 3/4-load			
129	Power factor at 1/2-load			
	Hydrated Lime Rotary Feeders			
130	Quantity	2	2	
131	Normal operating quantity	1	1	
132	Manufacturer and Model			
133	Material:			
134	Housing			
135	Rotor			
136	Seal Strips			
137	Motor:			
138	Manufacturer			
139	Model			
140	Rated Horsepower			HP
141	Rated Voltage			VAC
142	Full Load Amps			A
143	Normal Operating Load			A
144	Locked rotor amps			A
145	Full load RPM			rpm
146	Service Factor			1.15
147	Efficiency at full-load			
148	Efficiency at 3/4-load			
149	Efficiency at 1/2-load			
150	Power factor at full-load			
151	Power factor at 3/4-load			
152	Power factor at 1/2-load			
	Activated Carbon Rotary Feeders			
153	Quantity	2	2	
154	Normal operating quantity	1	1	
155	Manufacturer and Model			
156	Material:			
157	Housing			
158	Rotor			
159	Seal Strips			
160	Motor:			
161	Manufacturer			
162	Model			
163	Rated Horsepower			HP
164	Rated Voltage			VAC
165	Full Load Amps			A

Appendix 490000-A Fill-In-Data PROPOSAL DATA ACI and DSI Systems				
ITEM	DESCRIPTION			UNITS
166	Normal Operating Load			A
167	Locked rotor amps			A
168	Full load RPM			rpm
169	Service Factor			1.15
170	Efficiency at full-load			
171	Efficiency at 3/4-load			
172	Efficiency at 1/2-load			
173	Power factor at full-load			
174	Power factor at 3/4-load			
175	Power factor at 1/2-load			
	Activated Carbon Silo HVAC Heaters			
176	Quantity			
177	Manufacturer and Model			
178	Heat Source			
179	Rated Capacity			kW
	Activated Carbon Silo HVAC Ventilators			
180	Quantity			
181	Manufacturer and Model			
182	Rated Airflow			
183	Motor:			
184	Manufacturer			
185	Model			
186	Rated Horsepower			HP
187	Rated Voltage			VAC
188	Full Load Amps			A
189	Normal Operating Load			A
190	Locked rotor amps			A
191	Full load RPM			rpm
192	Service Factor			1.15
193	Efficiency at full-load			
194	Efficiency at 3/4-load			
195	Efficiency at 1/2-load			
196	Power factor at full-load			
197	Power factor at 3/4-load			
198	Power factor at 1/2-load			
	Activated Carbon Silo HVAC Louvers and Motorized Dampers			
199	Quantity			
200	Manufacturer and Model			
201	Size			Height x Width
202	Motor:			
203	Manufacturer			
204	Model			
205	Rated Horsepower			HP
206	Rated Voltage			VAC

Appendix 490000-A Fill-In-Data PROPOSAL DATA ACI and DSI Systems				
ITEM	DESCRIPTION			UNITS
207	Full Load Amps			A
208	Normal Operating Load			A
209	Locked rotor amps			A
210	Full load RPM			rpm
211	Service Factor			1.15
212	Efficiency at full-load			
213	Efficiency at 3/4-load			
214	Efficiency at 1/2-load			
215	Power factor at full-load			
216	Power factor at 3/4-load			
217	Power factor at 1/2-load			
	Hydrated Lime Silo HVAC Heaters			
218	Quantity			
219	Manufacturer and Model			
220	Heat Source			
221	Rated Capacity			kW
	Hydrated Lime Silo HVAC Ventilators			
222	Quantity			
223	Manufacturer and Model			
224	Rated Airflow			
225	Motor:			
226	Manufacturer			
227	Model			
228	Rated Horsepower			HP
229	Rated Voltage			VAC
230	Full Load Amps			A
231	Normal Operating Load			A
232	Locked rotor amps			A
233	Full load RPM			rpm
234	Service Factor			1.15
235	Efficiency at full-load			
236	Efficiency at 3/4-load			
237	Efficiency at 1/2-load			
238	Power factor at full-load			
239	Power factor at 3/4-load			
240	Power factor at 1/2-load			
	Hydrated Lime Silo HVAC Louvers and Motorized Dampers			
241	Quantity			
242	Manufacturer and Model			
243	Size			
244	Motor:			
245	Manufacturer			
246	Model			
247	Rated Horsepower			HP

Appendix 490000-A Fill-In-Data PROPOSAL DATA ACI and DSI Systems				
ITEM	DESCRIPTION			UNITS
248	Rated Voltage			VAC
249	Full Load Amps			A
250	Normal Operating Load			A
251	Locked rotor amps			A
252	Full load RPM			rpm
253	Service Factor			1.15
254	Efficiency at full-load			
255	Efficiency at 3/4-load			
256	Efficiency at 1/2-load			
257	Power factor at full-load			
258	Power factor at 3/4-load			
259	Power factor at 1/2-load			
	Dehumidification Units			
260	Quantity			
261	Manufacturer and Model			
262	Size LxWxH			ft
263	Type			
264	Capacity			scfm
265	Maximum inlet pressure			psi
266	Pressure loss			psi
267	Regeneration Type			
268	Heater Capacity			KW
269	Heater Voltage			V
270	Outlet Air Dew Point			deg F
	Air Compressors			
271	Quantity			
272	Manufacturer and Model			
273	Size LxWxH			ft
274	Type			
275	Capacity			scfm
276	Inlet Filter Particulate Removal Efficiency			
	After Coolers			
277	Quantity			
278	Manufacturer and Model			
279	Cooling Required			
	Lubrication Systems			
280	Pumps, Mfg. Model No.			
281	Pumps, HP			
282	Oil Cooler, Mfg / Model			
283	Oil Cooler Type			
284	Motor:			
285	Manufacturer			
286	Model			
287	Rated Horsepower			HP

Appendix 490000-A Fill-In-Data PROPOSAL DATA ACI and DSI Systems				
ITEM	DESCRIPTION			UNITS
288	Rated Voltage			VAC
289	Full Load Amps			A
290	Normal Operating Load			A
291	Locked rotor amps			A
292	Full load RPM			rpm
293	Service Factor			1.15
294	Efficiency at full-load			
295	Efficiency at 3/4-load			
296	Efficiency at 1/2-load			
297	Power factor at full-load			
298	Power factor at 3/4-load			
299	Power factor at 1/2-load			
	Air Dryers			
300	Manufacturer and Model			
301	Type			
302	Capacity			
303	Rated Voltage			V
304	Full Load Current			Amps
305	Pressure Drop Across Dryer			psi
306	Purge Air Requirement			scfm
	Air Receiver Tanks			
307	Manufacturer and Model			
308	Size HxDia			in
309	Capacity			gallons
309	Maximum Pressure Rating			psig
	Power Control Module			
310	Supplier			
311	Size LxWxH			ftxftxft
312	Fire Panel Supplier/Model			
	Equipment Enclosure (If Applicable)			
313	Supplier			
314	Size LxWxH			ftxftxft
	Power Control Module HVAC Heaters			
315	Quantity			
316	Manufacturer and Model			
317	Heat Source			
318	Rated Capacity			kW
	Power Control Module HVAC Ventilators			
319	Quantity			
320	Manufacturer and Model			
321	Rated Airflow			
322	Motor:			
323	Manufacturer			
324	Model			
325	Rated Horsepower			HP

Appendix 490000-A Fill-In-Data PROPOSAL DATA ACI and DSI Systems				
ITEM	DESCRIPTION			UNITS
326	Rated Voltage			VAC
327	Full Load Amps			A
328	Normal Operating Load			A
329	Locked rotor amps			A
330	Full load RPM			rpm
331	Service Factor			1.15
332	Efficiency at full-load			
333	Efficiency at 3/4-load			
334	Efficiency at 1/2-load			
335	Power factor at full-load			
336	Power factor at 3/4-load			
337	Power factor at 1/2-load			
	Power Control Module Louvers and Motorized Dampers			
338	Quantity			
339	Manufacturer and Model			
340	Size			
341	Motor:			
342	Manufacturer			
343	Model			
344	Rated Horsepower			HP
345	Rated Voltage			VAC
346	Full Load Amps			A
347	Normal Operating Load			
348	Locked rotor amps			A
349	Full load RPM			rpm
350	Service Factor			1.15
351	Efficiency at full-load			
352	Efficiency at 3/4-load			
353	Efficiency at 1/2-load			
354	Power factor at full-load			
355	Power factor at 3/4-load			
356	Power factor at 1/2-load			
	Motor Control Centers (MCC)			
357	Manufacturer and Model			
358	Nominal Voltage Rating			V
359	Maximum Voltage Rating			V
359	Bus Bracing (Symmetrical Amperes)			KAIC
360	Bus Material			KAIC
361	Combination Starters:			
362	Manufacturer and Model			
362	Short Circuit Rating			KAIC
363	Overload Relay Model			
364	Number of Contactor Aux Contacts			
365	Number of Overload Relay Inputs/Outputs			

Appendix 490000-A Fill-In-Data PROPOSAL DATA ACI and DSI Systems				
ITEM	DESCRIPTION			UNITS
365	Number of Circuit Breaker Trip Aux Contacts			
	480V-120/208Vac Lighting Transformer			
366	Manufacturer and Model			
367	Output Capacity Rating			
368	Input Voltage Rating			V
368	Output Voltage Rating			V
	480V-480/277Vac Lighting Transformer			
369	Manufacturer and Model			
370	Output Capacity Rating			
371	Input Voltage Rating			V
371	Output Voltage Rating			V
	480V-120/208Vac Transformer			
372	Manufacturer and Model			
373	Output Capacity Rating			
374	Input Voltage Rating			V
374	Output Voltage Rating			V
	208/120Vac Power Panel			
375	Manufacturer and Model			
376	Short Circuit Capability			
377	Circuit Breaker Model or Type			V
	480/277Vac Power Panel			
378	Manufacturer and Model			
379	Short Circuit Capability			
380	Circuit Breaker Model or Type			V
	Stair Tower			
381	Total Structural Steel Weight			tons
382	Number of field connections			
	Stair Tower (20' dia hyd. lime silo option)			
383	Total Structural Steel Weight			tons
384	Number of field connections			
	Pipe Rack			
385	Total Structural Steel Weight			tons
386	Number of field connections			
	Platforms			
387	Total Structural Steel Weight			tons
388	Number of field connections			
	Pipe Supports			
389	Total Structural Steel Weight			lbs
	Miscellaneous Steel			
390	Total Structural Steel Weight			lbs

SECTION 491000 – EXPECTED PERFORMANCE

PART 1 - GENERAL

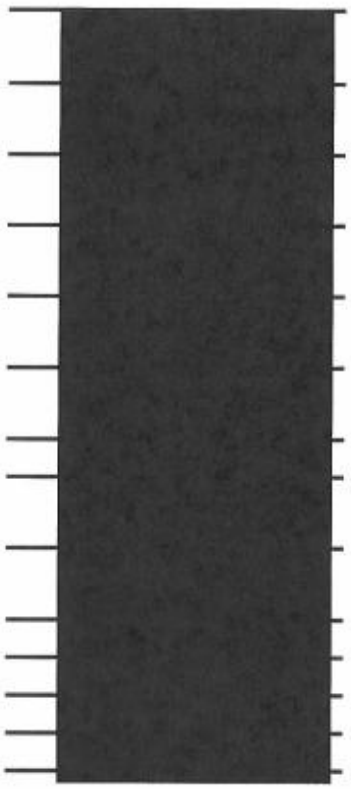
1.01 GENERAL

A. Contractor shall submit the following expected performance data for the ACI/DSI System to be as listed below when the system is operated at the performance conditions specified in APPENDIX 011101-A System Design Criteria and Parameters.

1. Green Unit 1:
   a. Hg Emission Rate at precipitator outlet on a 30-day rolling average, lb/mmBtu
   b. PM Emission Rate at precipitator outlet on a 30-day rolling average, lb/mmBtu
   c. Activated carbon consumption at maximum uncontrolled Hg, lb/mmacf
   d. Activated carbon consumption at minimum uncontrolled Hg, lb/mmacf
   e. Hydrated lime injection rate at maximum uncontrolled SO_3, lb/hr
   f. Hydrated lime injection rate at minimum uncontrolled SO_3, lb/hr
   g. Trona injection rate at maximum uncontrolled SO_3, lb/hr
   h. Trona injection rate at minimum uncontrolled SO_3, lb/hr
   i. Target SO_3 concentration to improve mercury removal efficiency, ppm
   j. Bin vent filter bag life, years
   k. Increase in pressure drop between economizer outlet and precipitator outlet, inches WG
   l. System(excluding compressed air) power consumption (average consumption in 24 hr period), kW
   m. Green Station (Units 1 & 2) compressed air power consumption (average consumption in 24 hr period), kW
   n. Hydrated lime silo bin vent air flow, acfm
   o. Activated carbon silo bin vent air flow, acfm
2. Green Unit 2:
   a. Hg Emission Rate at precipitator outlet on a 30-day rolling average, lb/mmBtu
   b. PM Emission Rate at precipitator outlet on a 30-day rolling average, lb/mmBtu
   c. Activated carbon consumption at maximum uncontrolled Hg, lb/mmacf

SECTION 491000 – EXPECTED PERFORMANCE: continued

d. Activated carbon consumption at minimum uncontrolled Hg, lb/mmacf
e. Hydrated lime injection rate at maximum uncontrolled SO_3, lb/hr
f. Hydrated lime injection rate at minimum uncontrolled SO_3, lb/hr
g. Trona injection rate at maximum uncontrolled SO_3, lb/hr
h. Trona injection rate at minimum uncontrolled SO_3, lb/hr
i. Target SO_3 concentration to improve mercury removal efficiency, ppm
j. Bin vent filter bag life, years
k. Increase in pressure drop between economizer outlet and precipitator outlet, inches WG
l. System(excluding compressed air) power consumption (average consumption in 24 hr period), kW
m. Hydrated lime silo bin vent air flow, acfm
n. Activated carbon silo bin vent air flow, acfm
o. Hydrated lime silo bin vent air flow, acfm
p. Activated carbon silo bin vent air flow, acfm



PART 2 - PRODUCTS – Not Applicable

PART 3 - EXECUTION – Not Applicable

END OF SECTION 491000

SECTION 492000 - PERFORMANCE GUARANTEES

PART 1 - GENERAL

1.01 GENERAL

A. Contractor guarantees the performance of the ACI/DSI System to be as listed below when the system is operated at the design conditions specified in APPENDIX 011101-A System Design Criteria and Parameters.

1. The following ACI/DSI system guarantees are "Make Good" performance guarantees:

2.

a. Maximum Hg Emission Rate at precipitator outlet on a 30-day rolling average, lb/TBtu

~~b. Maximum PM Emission Rate at precipitator outlet on a 30-day rolling average, lb/mmBtu~~

c. Bin Vent Emissions (grains/dry standard cubic foot)

d. Sound pressure levels, dBA (near field)

3. The following ACI/DSI System Guarantees are subject to Liquidated Damages.

a. Green Unit 1

(1) Activated carbon consumption at Performance conditions, lbs/mmacf

(2) Maximum Activated carbon usage, lb/hr

(3) Maximum SO_3 concentration at air preheater outlet, ppm

(4) Bin vent filter bag life, years

DSI Reagant Hydrated Lime:

(5) Hydrated lime consumption at Performance conditions, lb/hr

(6) System(excluding compressed air) power consumption (average consumption in 24 hr period), kW

(7) Compressed air power consumption (average consumption in 24 hr period), kW

DSI Reagant Trona:

(8) Trona consumption at Performance conditions, lbs/hr

(9) System(excluding compressed air) power consumption (average consumption in 24 hr period), kW

(10) Compressed air power consumption (average consumption in 24 hr period), kW

b. Green Unit 2

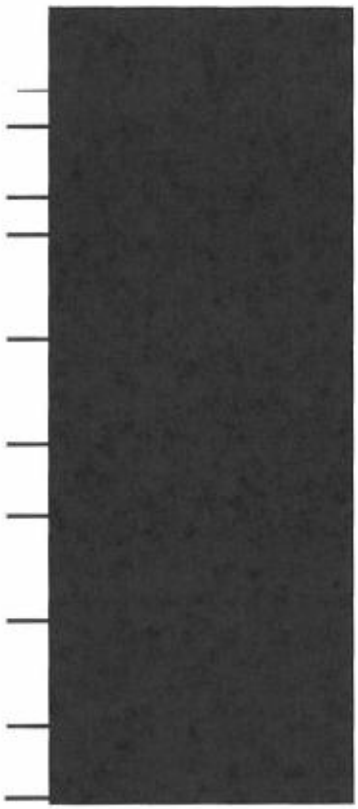
(1) Activated carbon Consumption at Performance conditions, lbs/mmacf
(2) Maximum Activated carbon usage, lb/hr
(3) Maximum SO_3 concentration at air preheater outlet, ppm
(4) Bin vent filter bag life, years

DSI Reagant Hydrated Lime:

(5) Hydrated lime consumption at Performance conditions, lb/hr
(6) System(excluding compressed air) power consumption (average consumption in 24 hr period), kW
(7) Compressed air power consumption (average consumption in 24 hr period), kW

DSI Reagant Trona:

(8) Trona consumption at Performance conditions, lbs/hr
(9) System(excluding compressed air) power consumption (average consumption in 24 hr period), kW
(10) Compressed air power consumption (average consumption in 24 hr period), kW

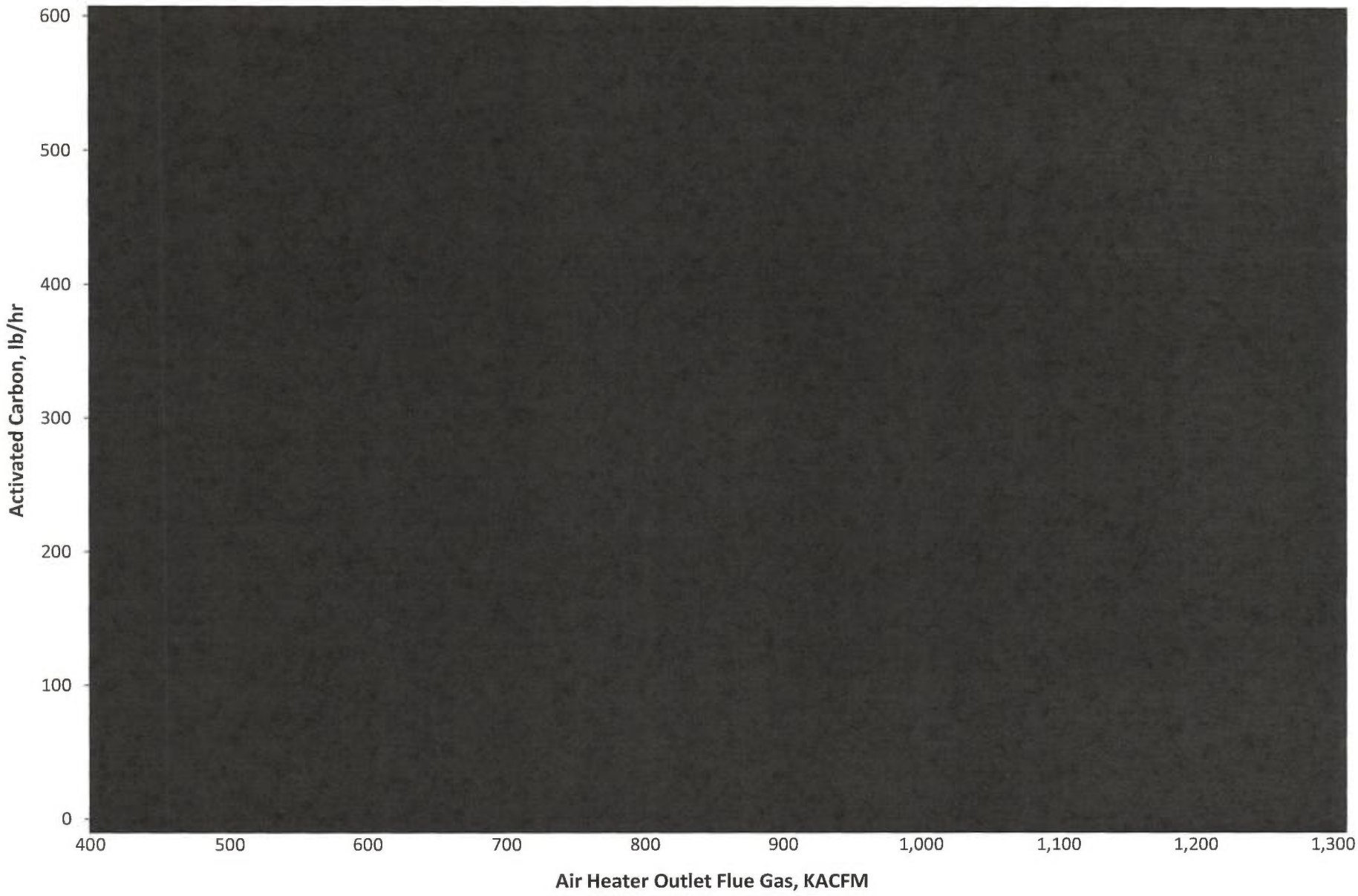


END OF SECTION 492000

Babcock Power
ENVIRONMENTAL

Performance Curve 1
Activated Carbon Flow vs. Flue Gas Flow

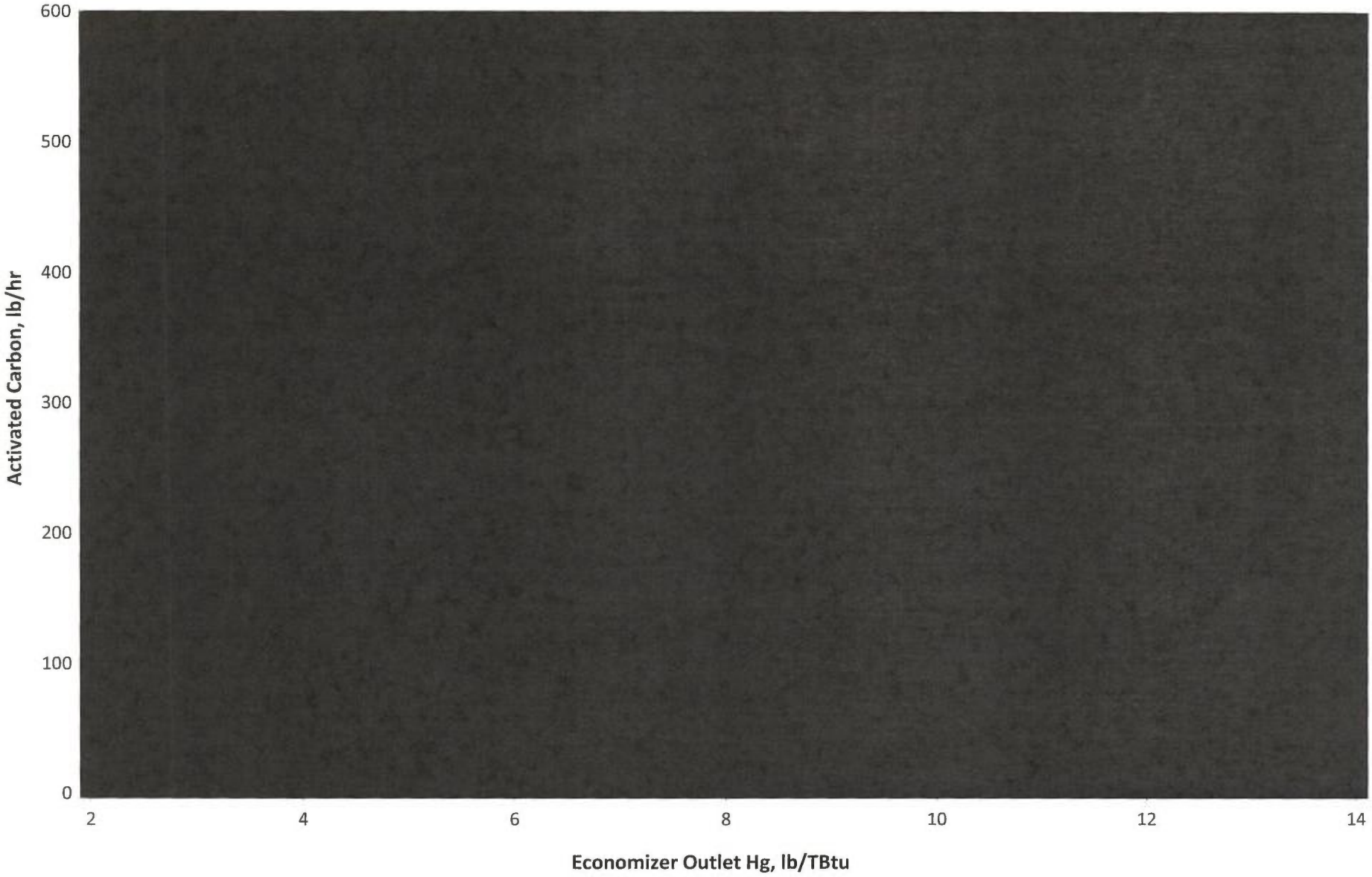
Design Conditions: 300°F Air Heater Outlet Temperature, 9.8 lb Hg/TBtu at Economizer Outlet



Babcock Power ENVIRONMENTAL

Performance Curve 2
Activated Carbon Flow vs. Hg Concentration

Design Conditions: 300°F Air Heater Outlet Temperature, 1,050 KACFM Flue Gas Flow

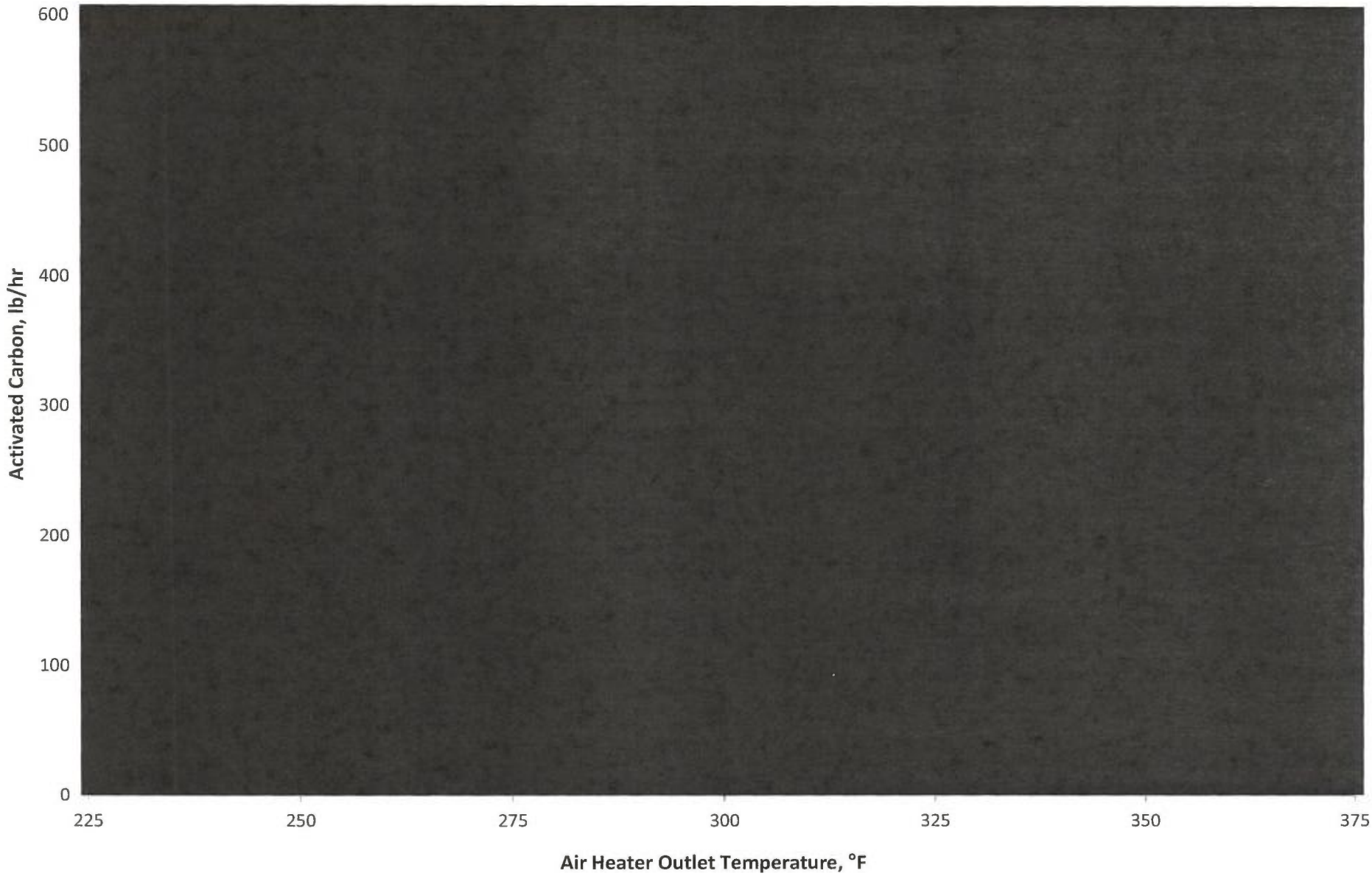


Babcock Power ENVIRONMENTAL

Performance Curve 3

Activated Carbon Flow vs. Temperature

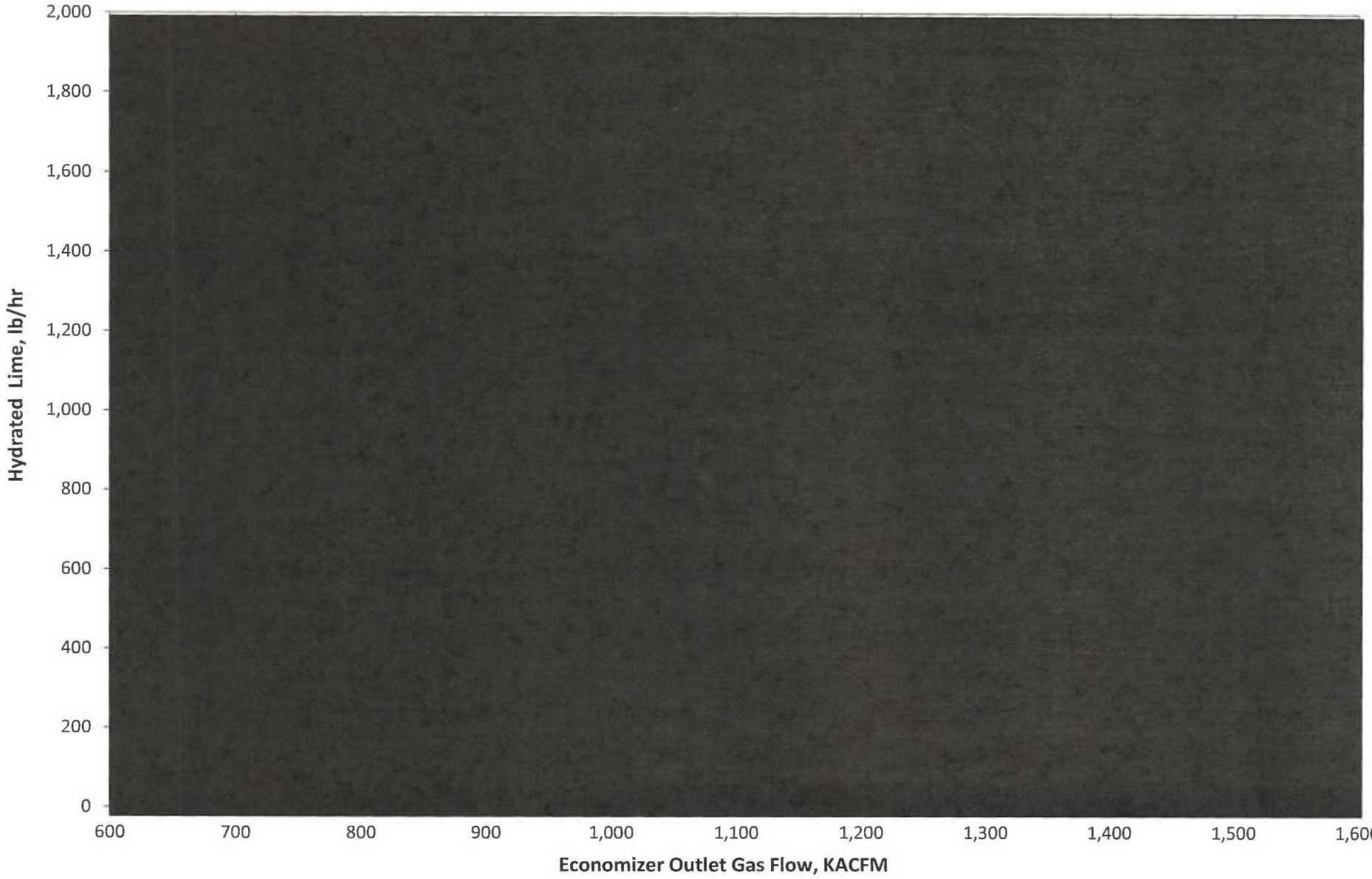
Design Conditions: 9.8 lb Hg/TBtu at Economizer Outlet, 1,050 KACFM Air Heater Outlet Flue Gas Flow



Babcock Power
ENVIRONMENTAL

Performance Curve 4
Hydrated Lime Flow vs. Flue Gas Flow

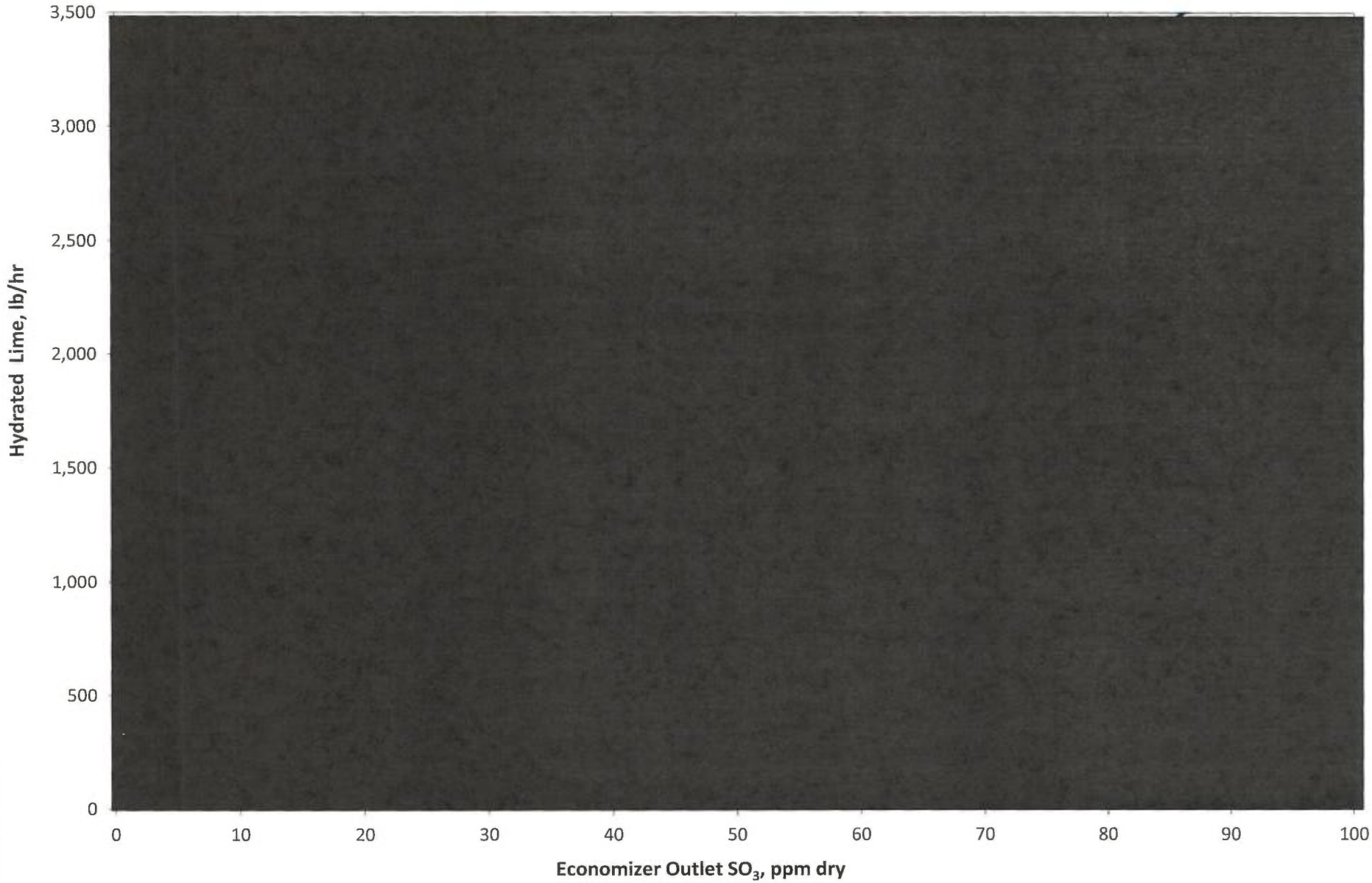
Design Conditions: 32 ppm SO_3, dry at Economizer Outlet



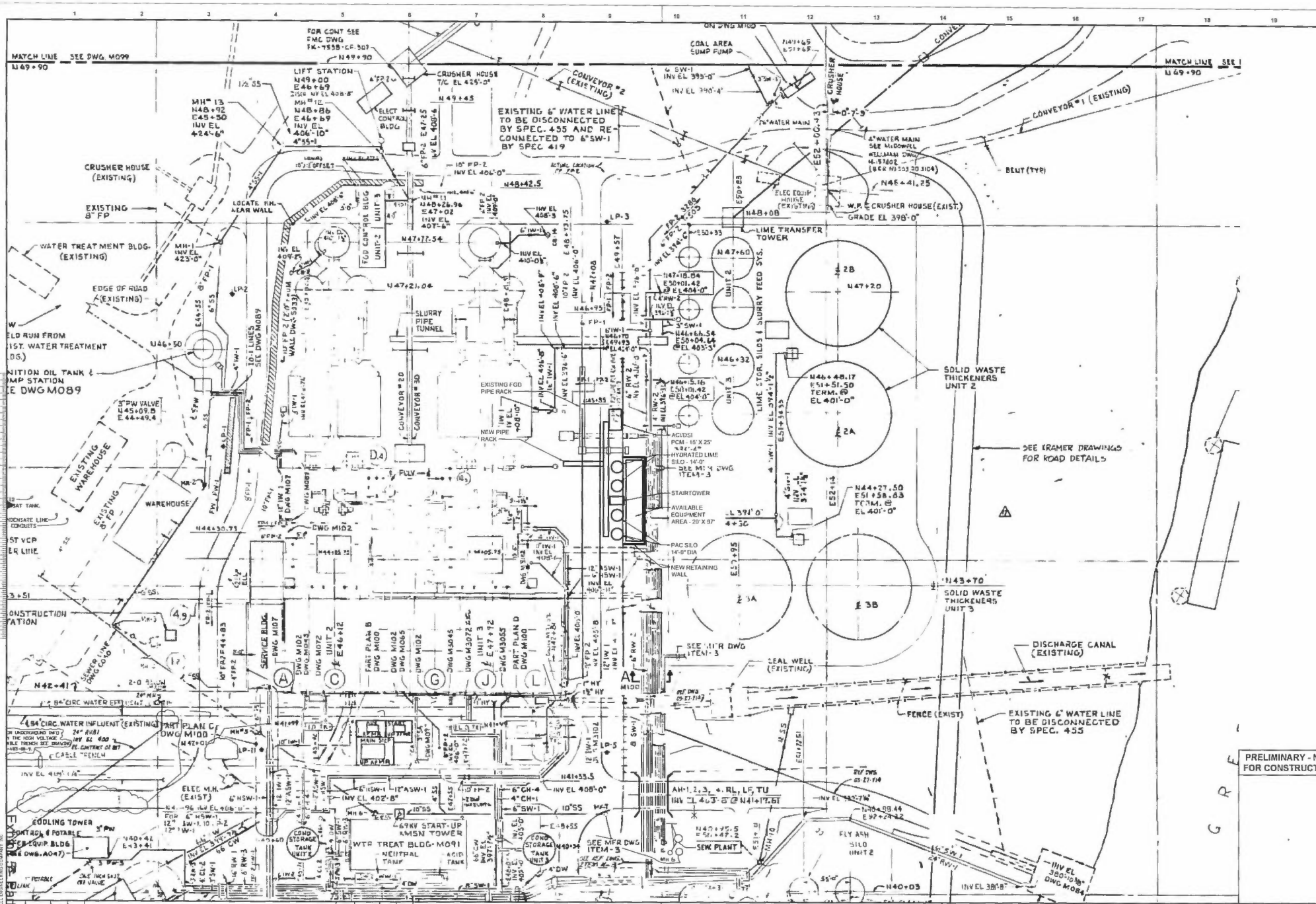
Babcock Power
ENVIRONMENTAL

Performance Curve 5
Hydrated Lime Flow vs. SO_3 Concentration

Design Conditions: 2,588 KACFM Economizer Outlet Flue Gas Flow



General Arrangement Drawings



no.	date	by	ckd	description
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C	07/25/13	MAA		ISSUED FOR REVIEW
B	07/19/13	MAA		ISSUED FOR REVIEW
A	07/10/13	MAA		ISSUED FOR REVIEW

Big Rivers

BIG RIVERS ELECTRIC CORPORATION
ROBERT D. GREEN STATION UNITS 1 & 2

Burns & McDonnell

KANSAS CITY, MO 64114
816-333-9400

designed D. GUINTA | detailed M. ATHERTON

NORTH

SCALE IN FEET

BIG RIVERS ROBERT D. GREEN MATS COMPLIANCE PROJECT APPENDIX A-5

project 73627 | contract

drawing GA-001 — rev. D

sheet 1 of 1 sheets

file Green GA.dwg

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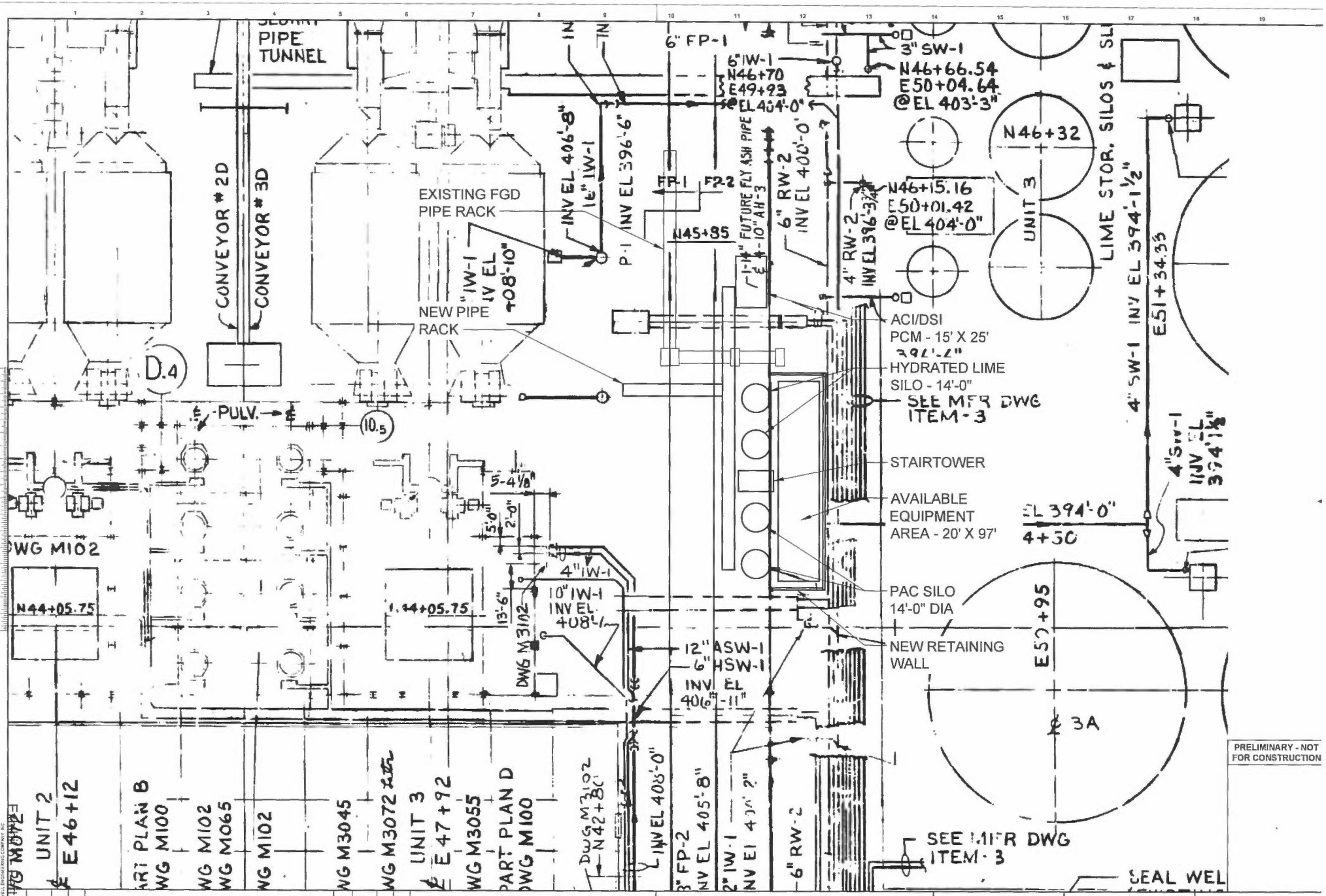

PRELIMINARY - NOT FOR CONSTRUCTION

no.	date	by	ckd	description
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C	07/25/13	MAA		ISSUED FOR REVIEW
B	07/19/13	MAA		ISSUED FOR REVIEW
A	07/10/13	MAA		ISSUED FOR REVIEW

Big Rivers

BIG RIVERS ELECTRIC CORPORATION
ROBERT D. GREEN STATION UNITS 1 & 2

Burns & McDonnell
KANSAS CITY, MO 64114
816-333-9400

designed: D. GUINTA
detailed: M. ATHERTON

NORTH

SCALE IN FEET

BIG RIVERS ROBERT D. GREEN
MATS COMPLIANCE PROJECT
APPENDIX A-6

project: 73827
contract:
drawing: GA-002
rev.: D
sheet 1 of 1 sheets
file: Green GA.dwg

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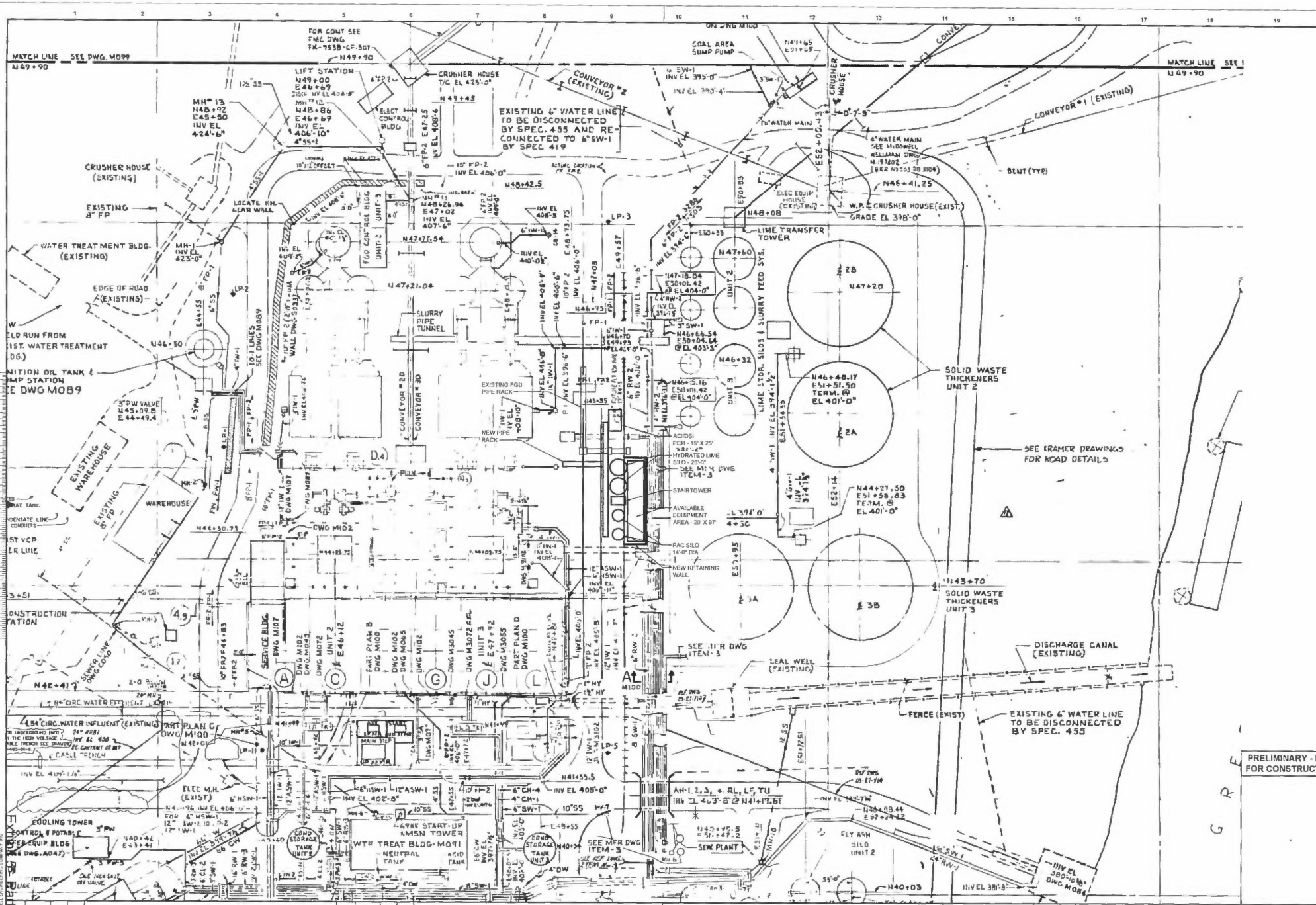

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B	07/25/13	MAA		ISSUED FOR REVIEW
A	07/19/13	MAA		ISSUED FOR REVIEW

Big Rivers

BIG RIVERS ELECTRIC CORPORATION
ROBERT D. GREEN STATION UNITS 1 & 2

Burns & McDonnell
KANSAS CITY, MO 64114
816-333-9400

designed D. GUINTA | detailed M. ATHERTON

NORTH

SCALE IN FEET

BIG RIVERS ROBERT D. GREEN MATS COMPLIANCE PROJECT APPENDIX A-7

project 73827 | contract

drawing GA-003 — rev. C

sheet 1 of 1 sheets

file Green GA.dwg

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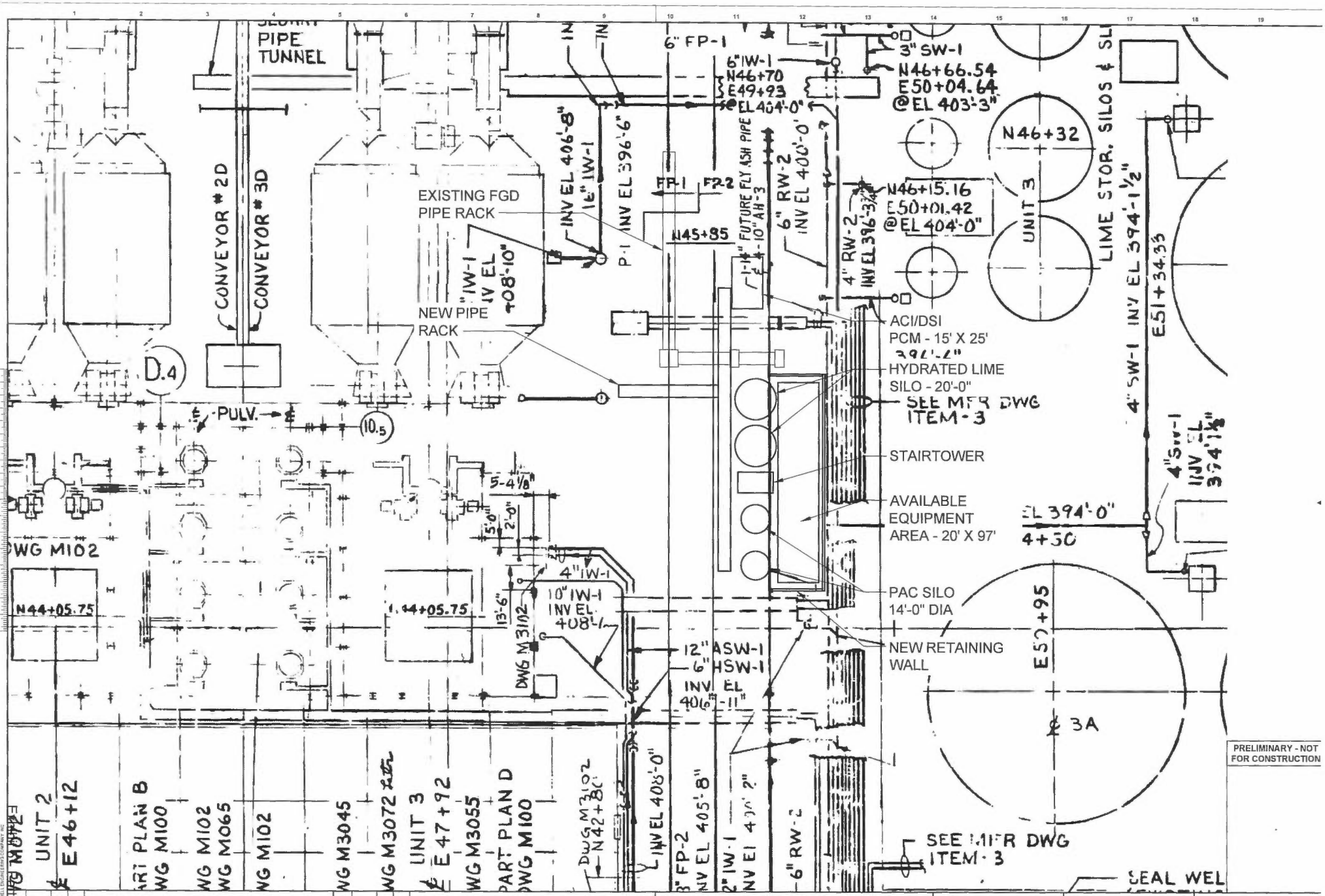

PRELIMINARY - NOT FOR CONSTRUCTION

no.	date	by	ckd	description
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B	07/25/13	MAA		ISSUED FOR REVIEW
A	07/19/13	MAA		ISSUED FOR REVIEW

Big Rivers

BIG RIVERS ELECTRIC CORPORATION
ROBERT D. GREEN STATION UNITS 1 & 2

Burns & McDonnell
KANSAS CITY, MO 64114
816-333-9400

designed D. GUINTA | detailed M. ATHERTON

NORTH

SCALE IN FEET

BIG RIVERS ROBERT D. GREEN
MATS COMPLIANCE PROJECT
APPENDIX A-8

project 73827 | contract

drawing GA-004 — rev. C

sheet 1 of 1 sheets

file Green GA.dwg

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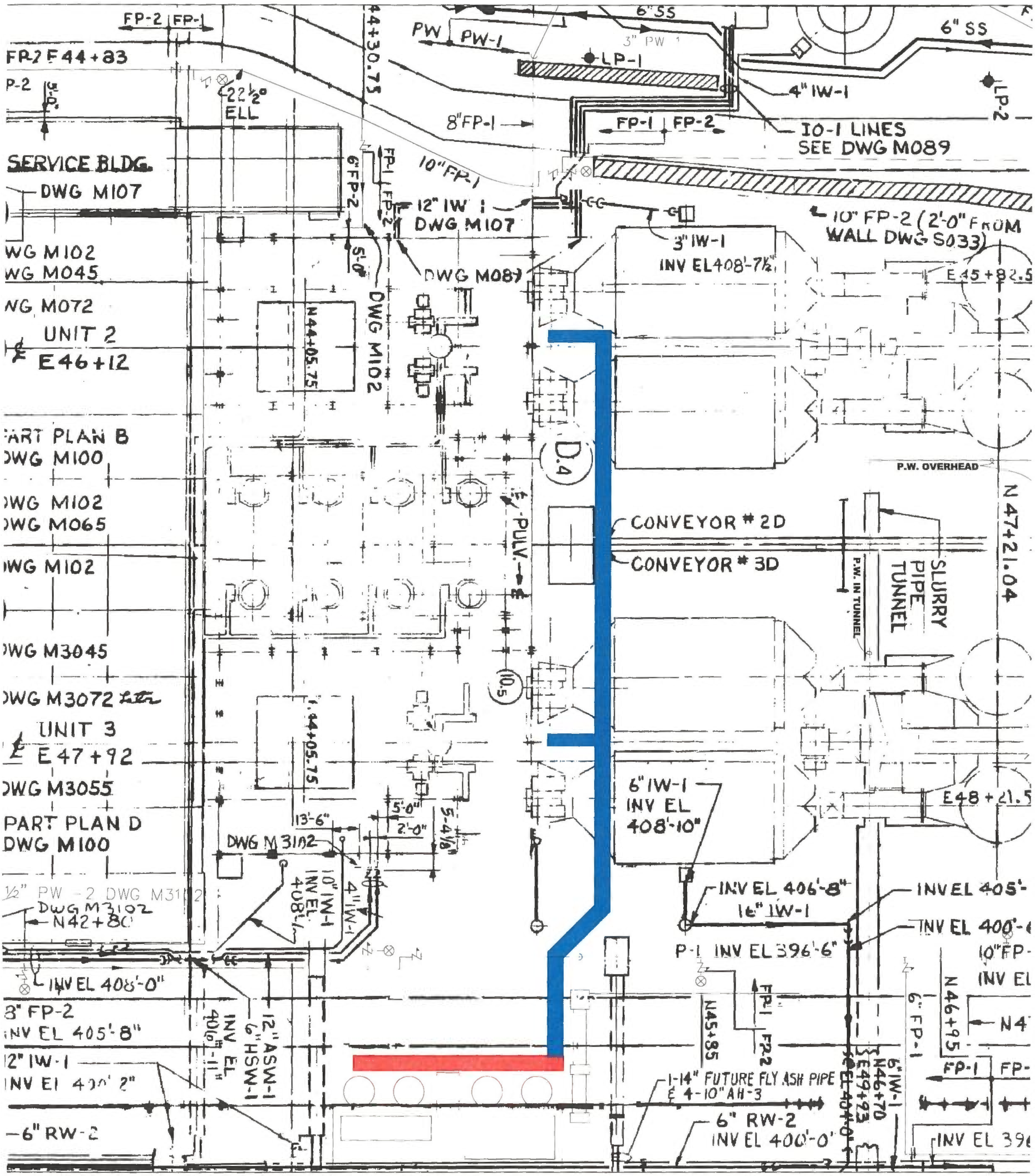
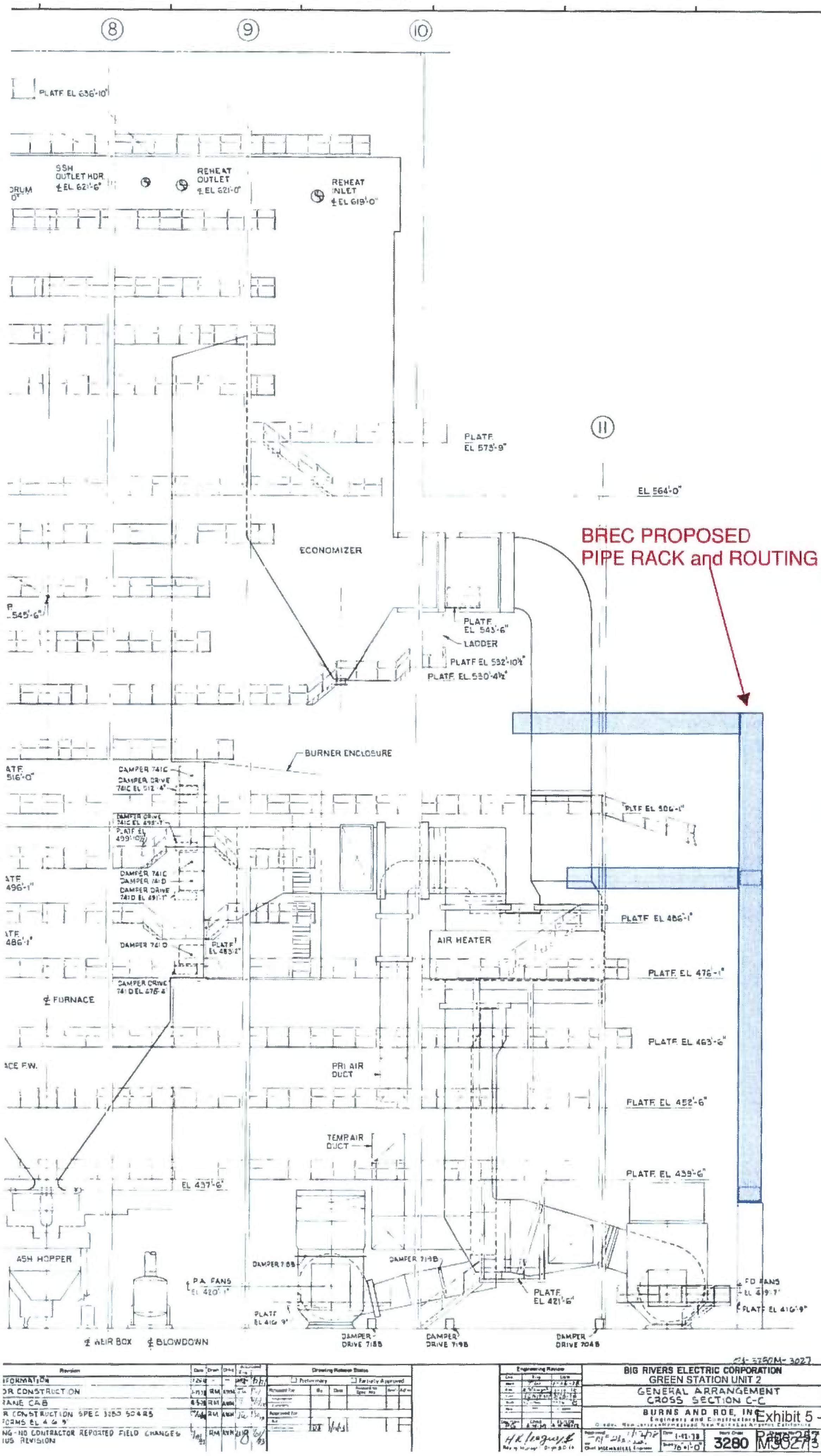
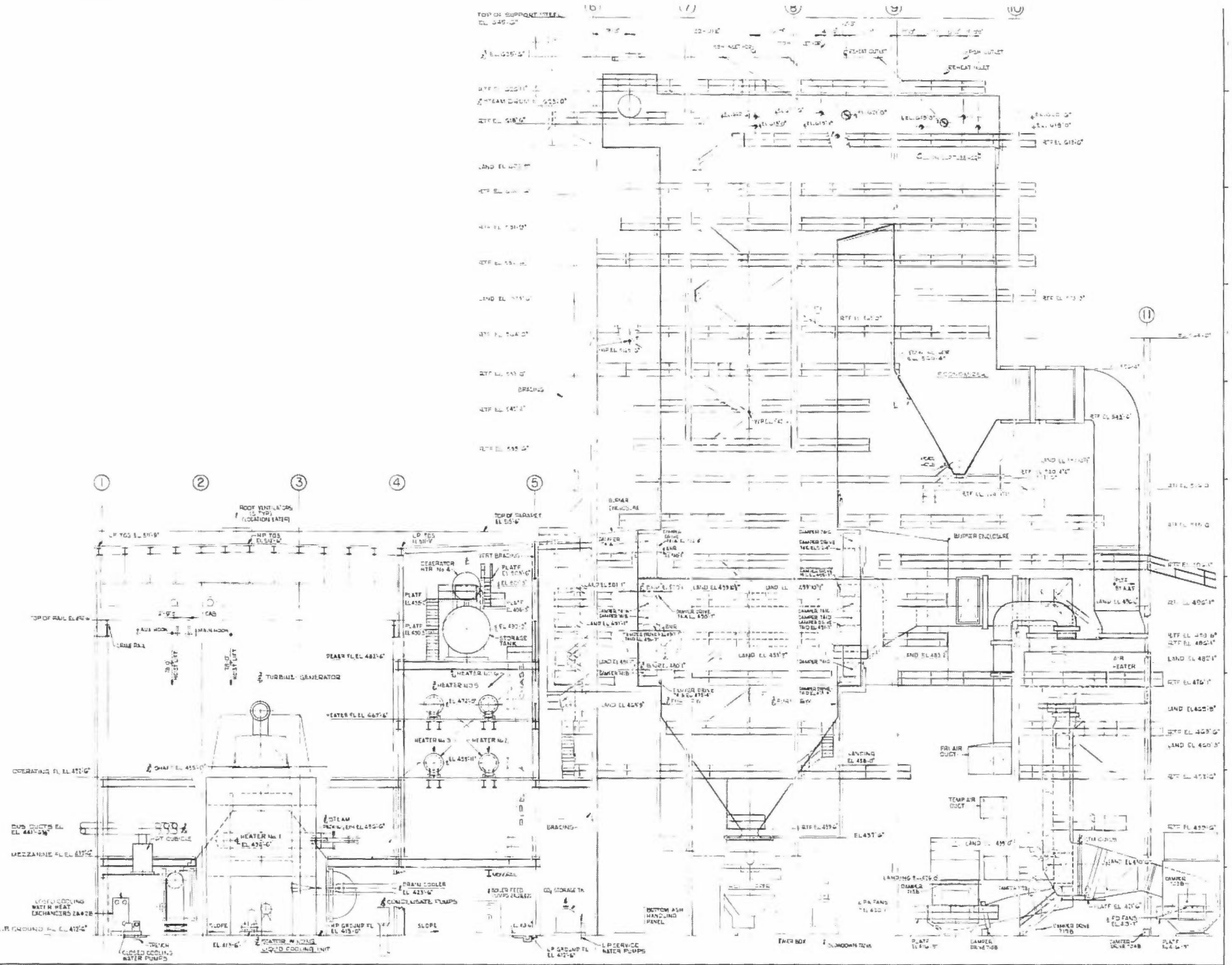
Green Piping Corridor Drawings


SERVICE BLDG.
DWG M107
UNIT 2
E46+12
UNIT 3
E47+92
CONVEYOR # 2D
CONVEYOR # 3D
SLURRY PIPE TUNNEL
P.W. OVERHEAD
P.W. IN TUNNEL
10-1 LINES
SEE DWG M089
10" FP-2 (2'-0" FROM WALL DWG S033)
3" IW-1
INV EL 408'-7½"
6" IW-1
INV EL
408'-10"
INV EL 406'-8"
16" IW-1
P-1 INV EL 396'-6"
1-14" FUTURE FLY ASH PIPE
& 4-10" AH-3
6" RW-2
INV EL 400'-0"
INV EL 408'-0"
8" FP-2
INV EL 405'-8"
12" IW-1
6" RW-2
PART PLAN D
DWG M100
PART PLAN B
DWG M100
N47+21.04
E45+82.5
E48+21.5



8
9
10
11
K
J
H
G
F
E
D
C
B
A
PLATF EL 636'-10"
SSH OUTLET HDR ℄ EL 621'-6"
REHEAT OUTLET ℄ EL 621'-0"
REHEAT INLET ℄ EL 619'-0"
PLATF EL 575'-9"
EL 564'-0"
BREC PROPOSED
PIPE RACK and ROUTING
ECONOMIZER
PLATF EL 543'-6"
LADDER
PLATF EL 532'-10½"
PLATF EL 530'-4½"
BURNER ENCLOSURE
PLATF EL 506'-1"
PLATF EL 486'-1"
AIR HEATER
PLATF EL 476'-1"
℄ FURNACE
PLATF EL 463'-6"
PRI AIR DUCT
PLATF EL 452'-6"
TEMP AIR DUCT
PLATF EL 439'-6"
EL 437'-6"
ASH HOPPER
P.A. FANS
PLATF EL 421'-6"
FD FANS
℄ WEIR BOX
℄ BLOWDOWN
DAMPER DRIVE 718B
DAMPER DRIVE 719B
DAMPER DRIVE 704B
BIG RIVERS ELECTRIC CORPORATION
GREEN STATION UNIT 2
GENERAL ARRANGEMENT
CROSS SECTION C-C
BURNS AND ROE, INC.
3280
M30273

Green Ductwork and Air Preheater Drawings



BIG RIVERS ELECTRIC CORPORATION
GENERAL ARRANGEMENT
SECTION C-C
BURNS AND ROE, INC.
3280 M027 5

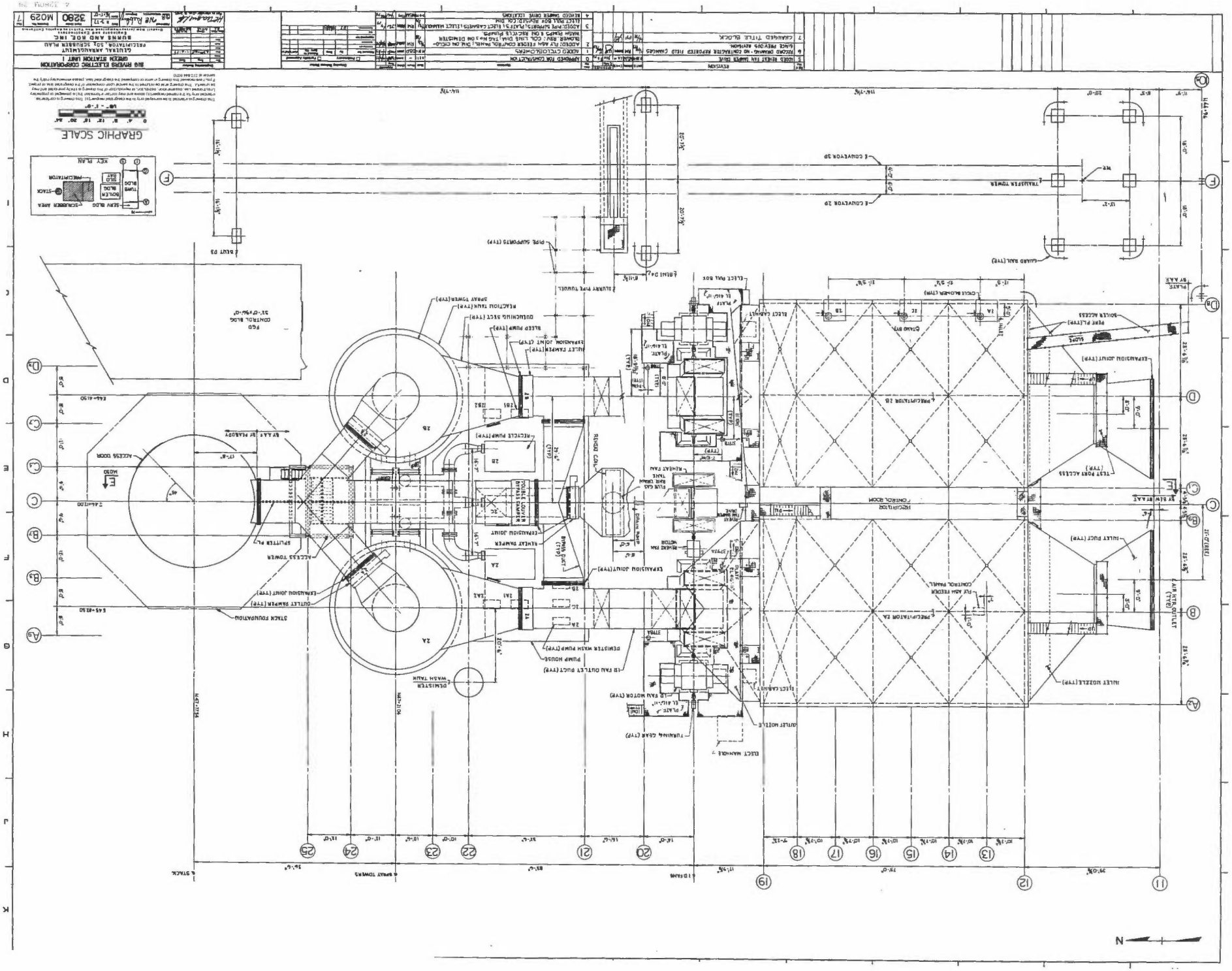
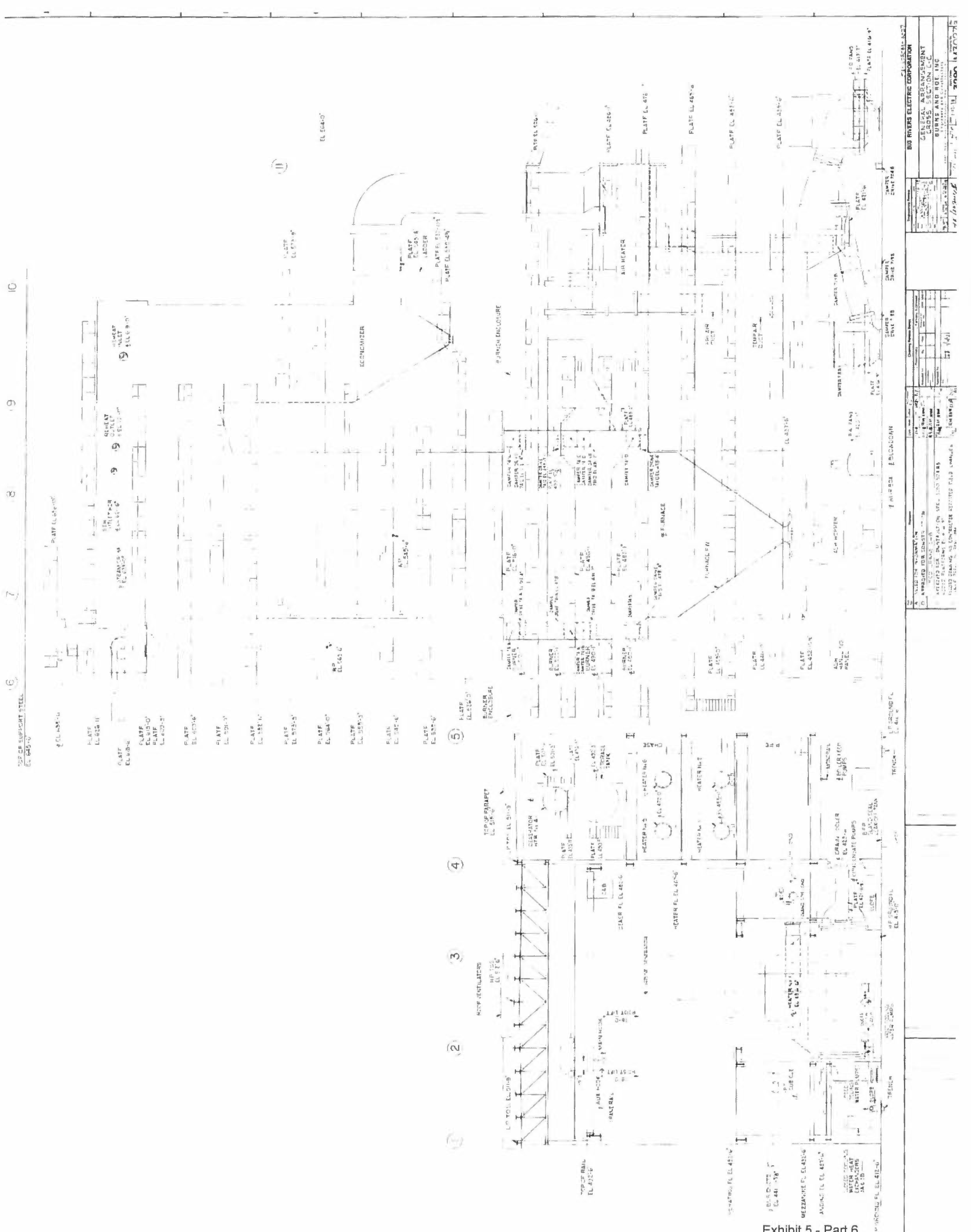
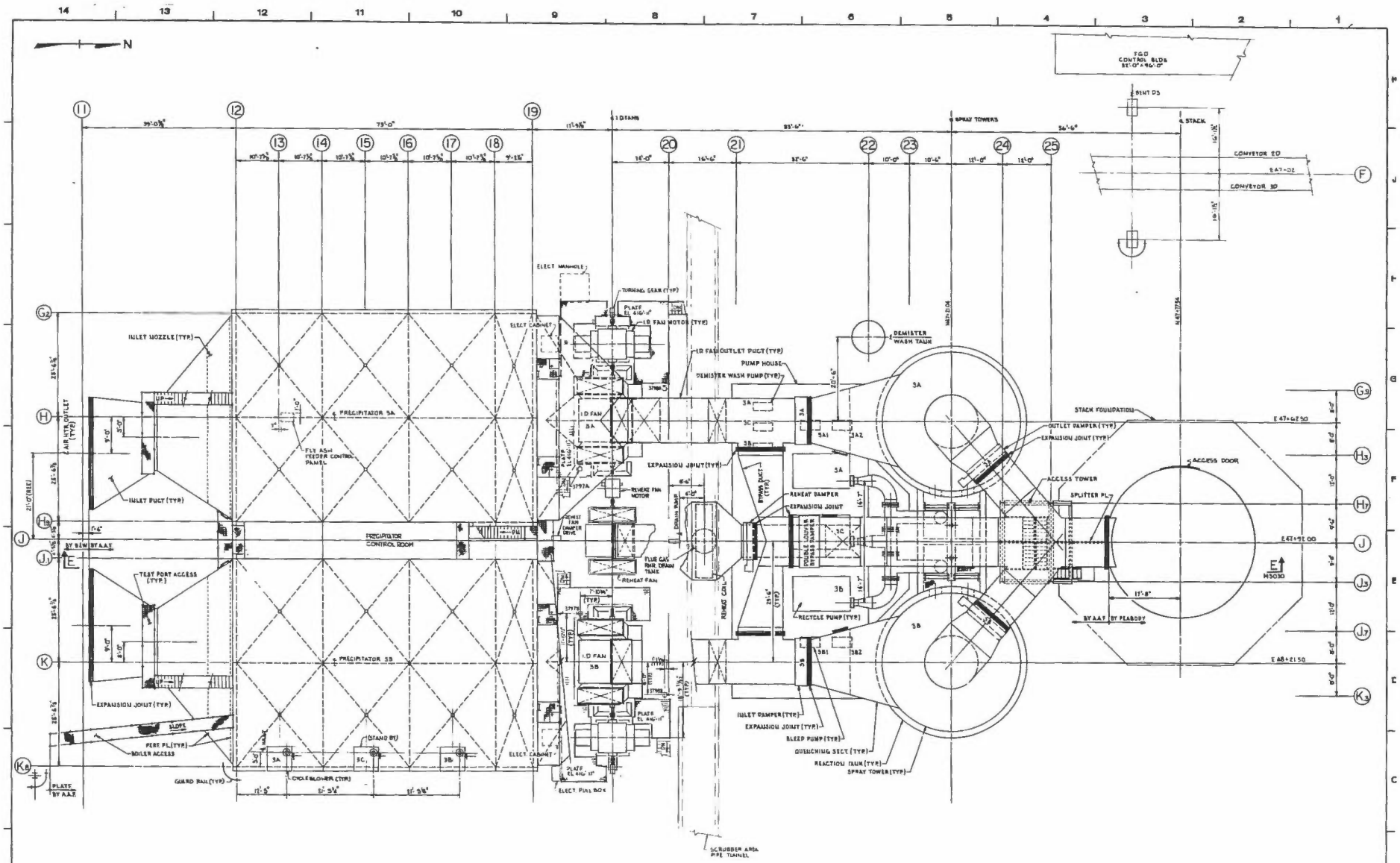
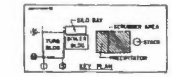


Exhibit 5 - Part 6
Page 260 of 352



BIG RIVERS ELECTRIC CORPORATION
GENERAL ARRANGEMENT
CROSS SECTION C-C
BURNS AND ROE, INC
ECONOMIZER
AIR HEATER
BURNER ENCLOSURE
FURNACE
ROOF VENTILATORS
TOP OF PARAPET
TOP OF SUPPORT STEEL





GRAPHIC SCALE

0 4' 8' 12' 16' 20' 24'

1/8" = 1'-0"

No.	Revision	Date	Drawn	Check	Engr
4	REVISED LOCATION OF CYCLE BLOWERS B&C	4-9-76	LC		
5	RECORD DRAWING - NO CONTRACTOR REPORTED FIELD CHANGES SINCE PREVIOUS REVISION	6-4-76	RM	KWK	JW

No.	Revision	Date	Drawn	Check	Engr
0	APPROVED FOR CONSTRUCTION	3-5-76	RM	KWK	JW
1	APPROVED FOR CONSTRUCTION SPEC 3280-504 RB REVISED COLUMN LINE DIMENSIONS. ADDED: FLY ASH FEEDER CONTROL PANEL; CONVEYORS 2D & 3D; I.E.G.D CONTROL BLDG. PLATFORMS; TUNNEL; ELECT PULL BOX; ELECT MANHOLE; CABINETS	3-26-76	RM	KWK	JW
2	REVISED DAMPER DRIVE LOCATIONS	4-9-76	RM	KWK	JW
3	ADDED REHEAT FAN DAMPER DRIVE	4-30-76	RM	KWK	JW

Engineering Design		
Mech.		
Elec.		
Civil		
Struct.		
Arch.		
Proj. Engr.		
Engr. Mgr.		

Drawing Release Status		
Preliminary		
Partially Approved		
Approved for Const.	5-7-76	
Corrections		
Approved as Noted		
Not Approved		
Withdrawn		

OA-3280M-3029

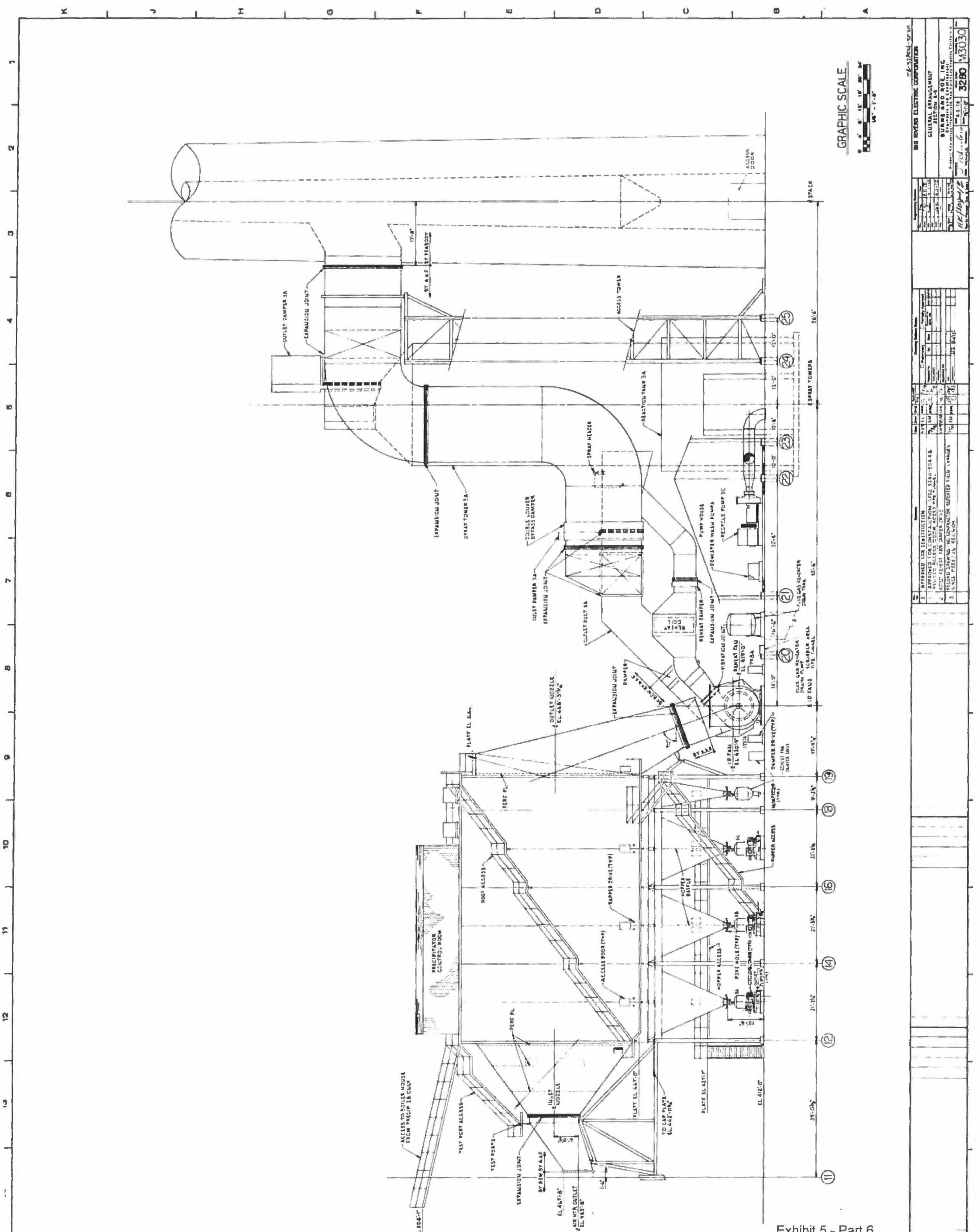
BIG RIVERS ELECTRIC CORPORATION
GREEN STATION UNIT 2

GENERAL ARRANGEMENT
PRECIPITATOR 3D & SCRUBBER PLAN

BURNS AND ROE, INC.
Engineers and Constructors
Woodcliff Lake, New Jersey and Los Angeles, California

Date 4-9-76
Scale 1/8" = 1'-0"
Job No. 3280
Dwg. No. M3029
Rev. 5

4-3280M-3029


GRAPHIC SCALE
BIG RIVERS ELECTRIC CORPORATION
GENERAL ARRANGEMENT
BURNS AND ROE, INC.
PRECIPITATOR CONTROL ROOM
SPRAY TOWERS
PUMP HOUSE
ACCESS TOWER
REACTION TANK 3A
SPRAY TOWER 3A
EXPANSION JOINT
OUTLET DAMPER 3A
3280
M3030

THIS DWG. IS SUPCD. FROM
4-401-00-2

REVISIONS			
NO.	DESCRIPTION	DATE	APPROVED
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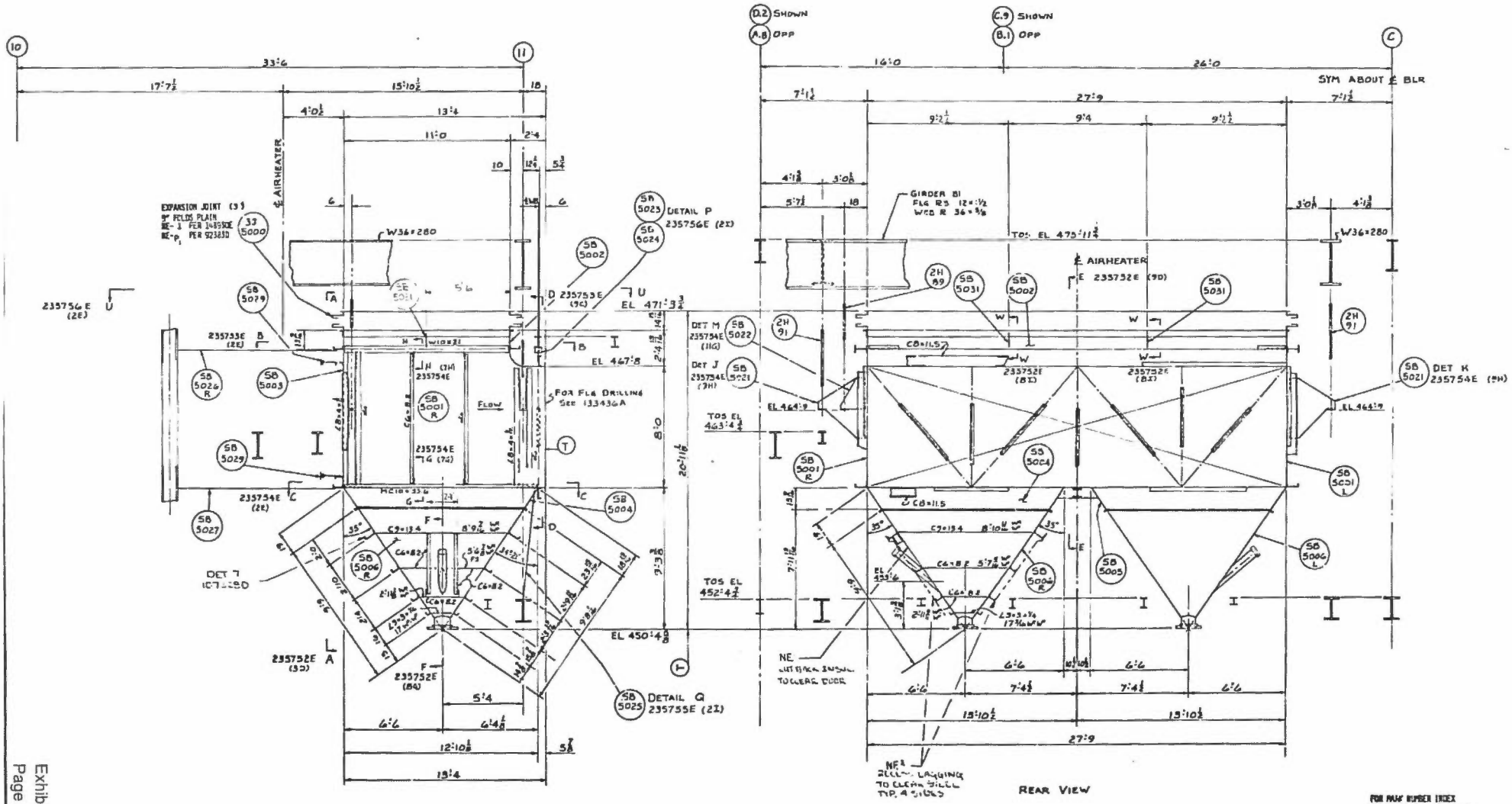
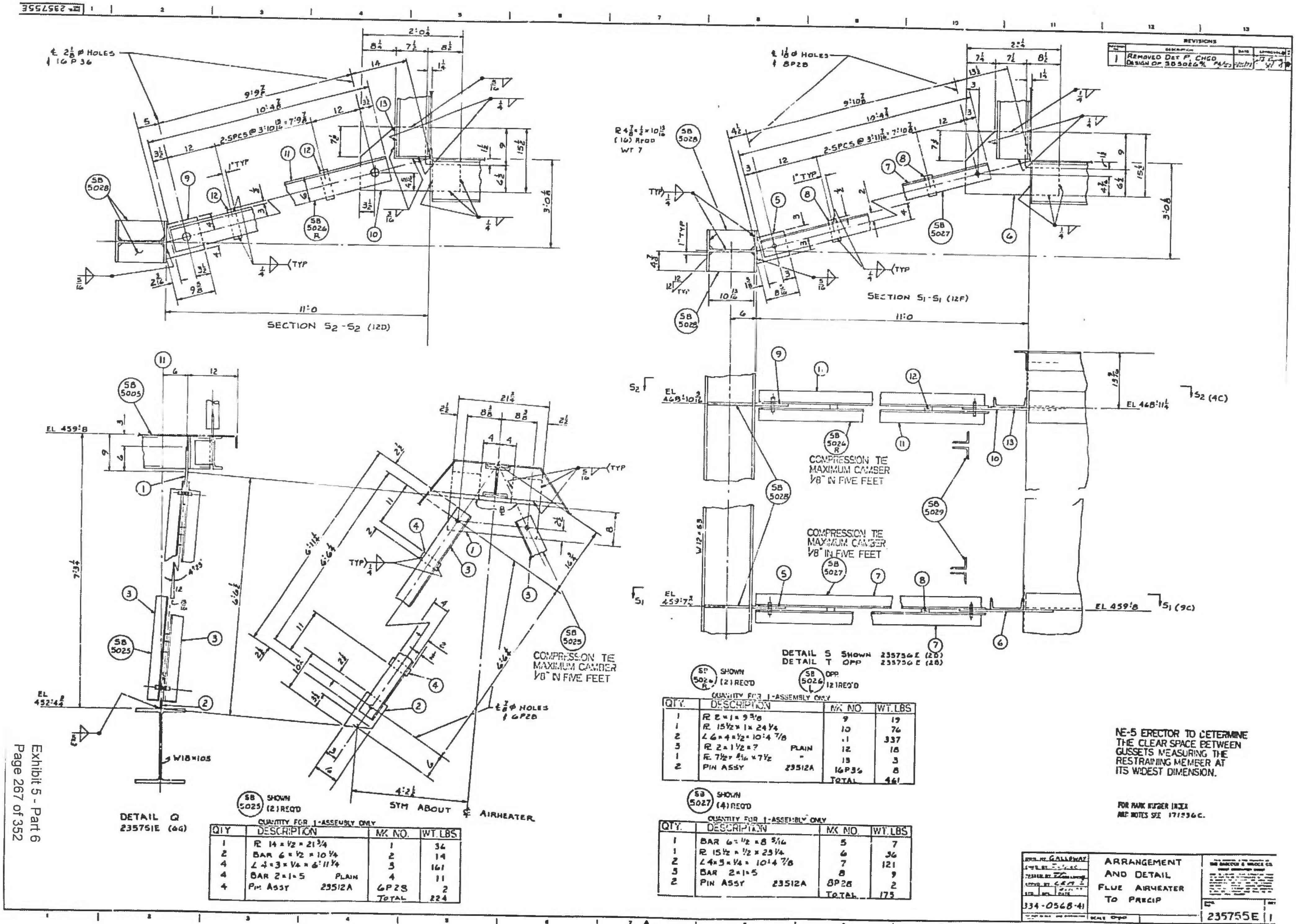


DRN. BY GALLOWAY	ARRANGEMENT FLUE AIRHEATER TO PRECIP.	
CHKD. BY		
TRACED BY		
APPD. BY		
334-0568-41		235751E 1



SB 5025 SHOWN (2) REQ'D

QUANTITY FOR 1-ASSEMBLY ONLY

QTY	DESCRIPTION	MK NO.	WT. LBS
1	R 14 × 1/2 × 21 3/4	1	36
2	BAR 6 × 1/2 × 10 1/4	2	14
4	∠ 4 × 3 × 1/4 × 6'-11 1/4	3	161
4	BAR 2 × 1 × 5 PLAIN	4	11
4	PIN ASSY 23512A	6P28	2
		TOTAL	224

SB 5026 R SHOWN (2) REQ'D; SB 5026 L OPP (2) REQ'D

QUANTITY FOR 1-ASSEMBLY ONLY

QTY.	DESCRIPTION	MK NO.	WT. LBS
1	R 8 × 1 × 9 3/8	9	19
1	R 15 1/2 × 1 × 24 1/4	10	76
2	∠ 6 × 4 × 1/2 × 10'-4 7/8	11	337
3	R 2 × 1 1/2 × 7 PLAIN	12	18
1	R 7 1/2 × 5/16 × 7 1/2	13	3
2	PIN ASSY 23512A	16P36	8
		TOTAL	461

SB 5027 SHOWN (4) REQ'D

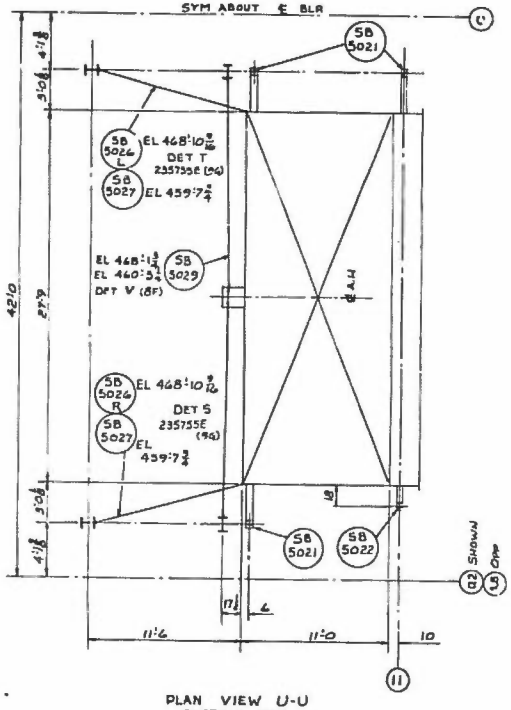
QUANTITY FOR 1-ASSEMBLY ONLY

QTY.	DESCRIPTION	MK NO.	WT. LBS
1	BAR 6 × 1/2 × 8 5/16	5	7
1	R 15 1/2 × 1/2 × 23 1/4	6	36
2	∠ 4 × 3 × 1/4 × 10'-4 7/8	7	121
3	BAR 2 × 1 × 5	8	9
2	PIN ASSY 23512A	8P28	2
		TOTAL	175

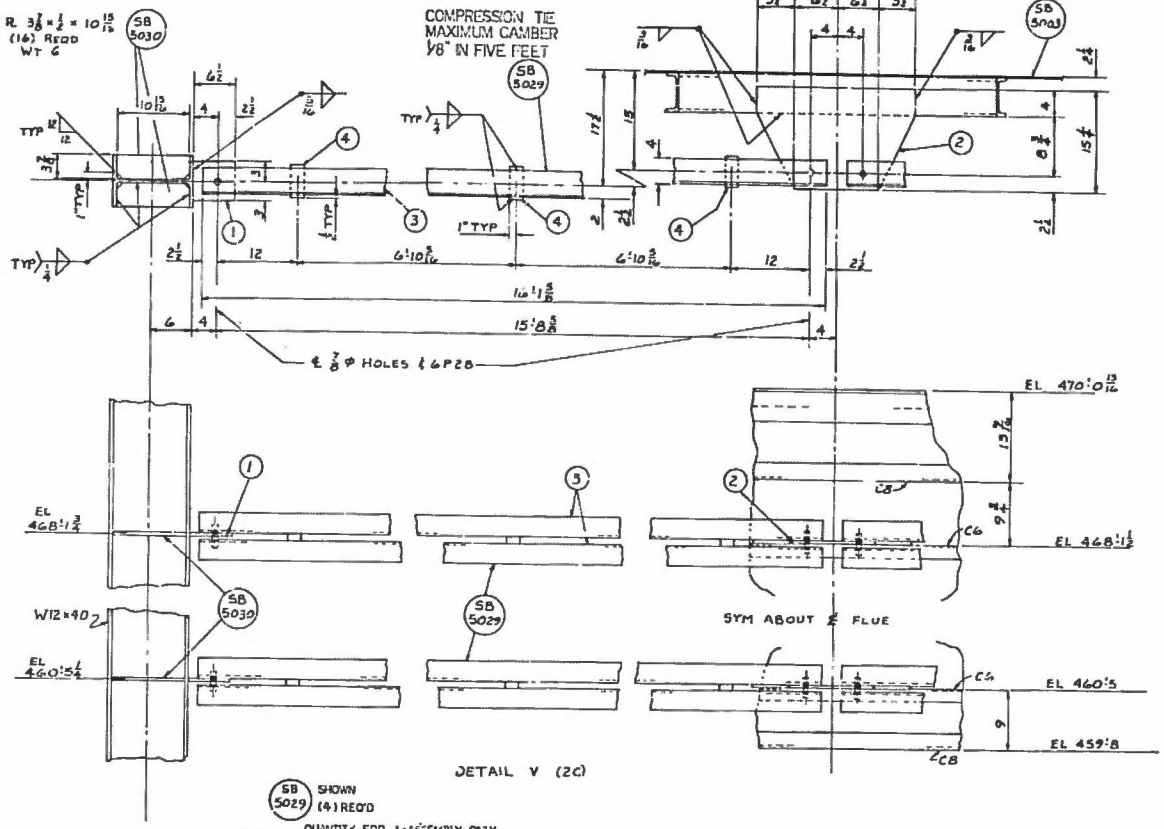
NE-5 ERECTOR TO DETERMINE THE CLEAR SPACE BETWEEN GUSSETS MEASURING THE RESTRAINING MEMBER AT ITS WIDEST DIMENSION.

FOR MARK NUMBER INDEX AND NOTES SEE 171536C.

REVISIONS			
NO.	DESCRIPTION	DATE	APPROVED
1	ADDED DET P (2X)	4/20	



PLAN VIEW U-U
235751E (1D)

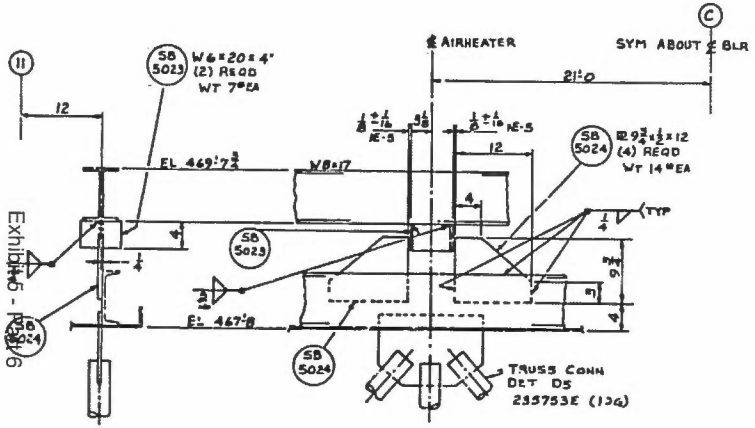


DETAIL V (2C)

SB 5029 SHOWN (4) REQ'D

QUANTITY FOR 1-ASSEMBLY ONLY

QTY	DESCRIPTION	MK. NO.	WT. LBS
2	BAR 4 x 1/2 x 4 1/2	1	11
1	R 15 1/4 x 1/2 x 24	2	43
4	∠ 4 x 3 x 1/4 x 14'-1 5/8	3	374
6	BAR 2 x 1 x 5 PLAIN	4	17
4	PIN ASSY 2351EA	6P28	2
		TOTAL	447



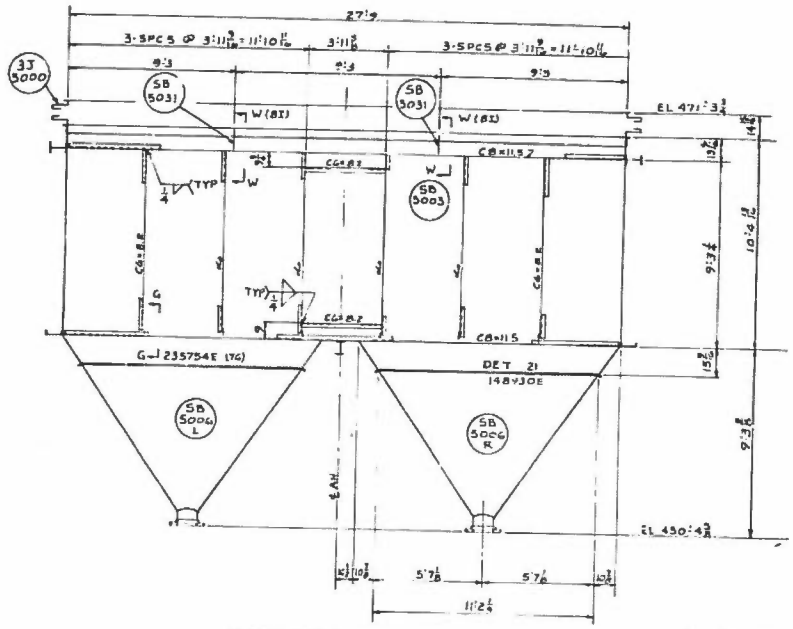
DETAIL P
235751E (4C)

FOR PARK NUMBER INDEX
AND NOTES SEE 171536C.

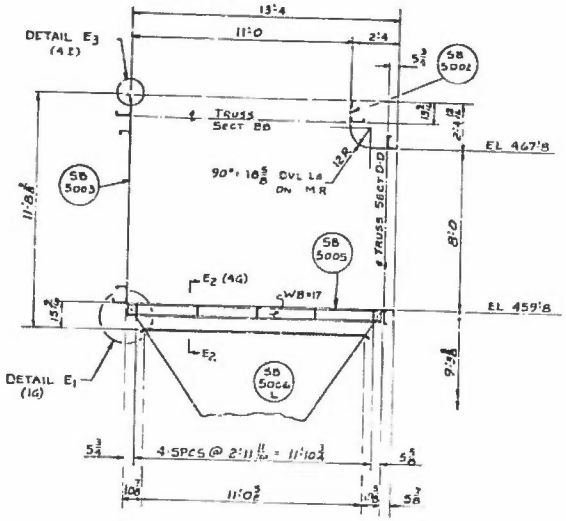
DRWN. BY CALLOWAY	ARRANGEMENT AND DETAIL FLUE AIRHEATER TO PRECIP.	
CHKD. BY		
APPD. BY		
DATE 4/6/77		
334-0548-41		235756E

REVISIONS

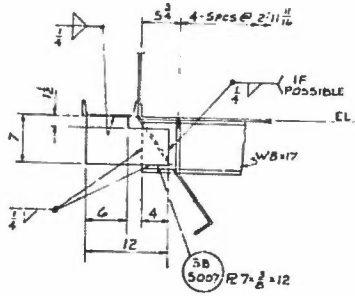
DESCRIPTION	DATE	APPROVED



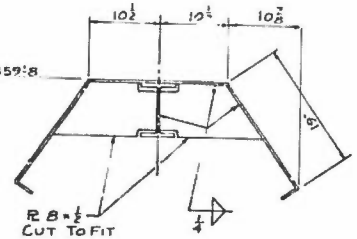
FRONT VIEW A-A
235751E (3G)



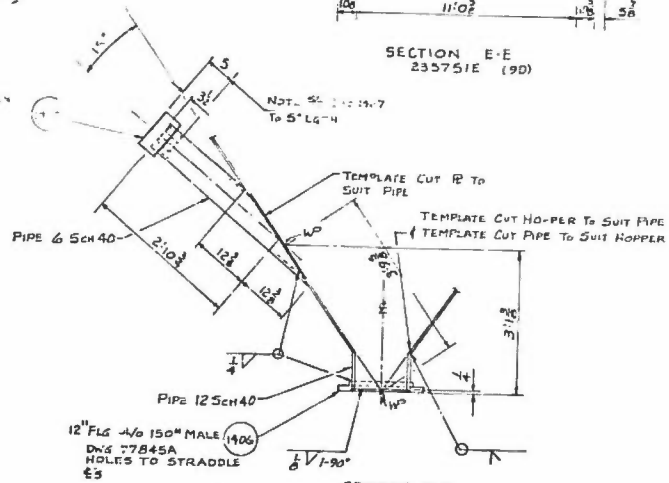
SECTION E-E
235751E (9D)



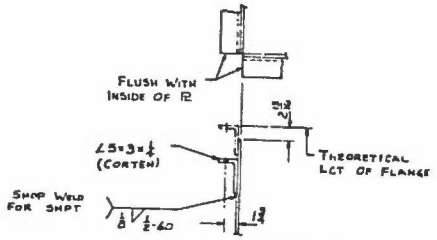
DETAIL E1 (8C)



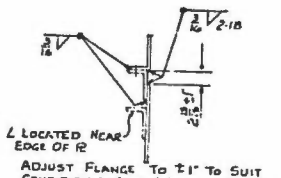
SECTION E2-E2 (9C)



SECTION F-F
235751E (4G)

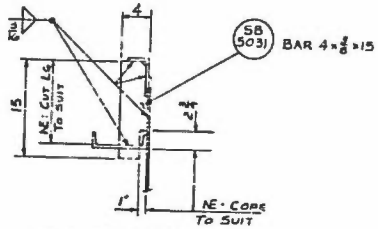


ADJUSTABLE FLANGE
(SHOP ASSY)



ADJUST FLANGE TO ±1" TO SUIT CONDITION (SEAL WELD IN PLACE.
ADJUSTABLE FLANGE
(FIELD ASSY)

DETAIL E3 (8A)



SECTION W-W (3B-4B)
235751E (9D-10D)

R. D. GREEN - I

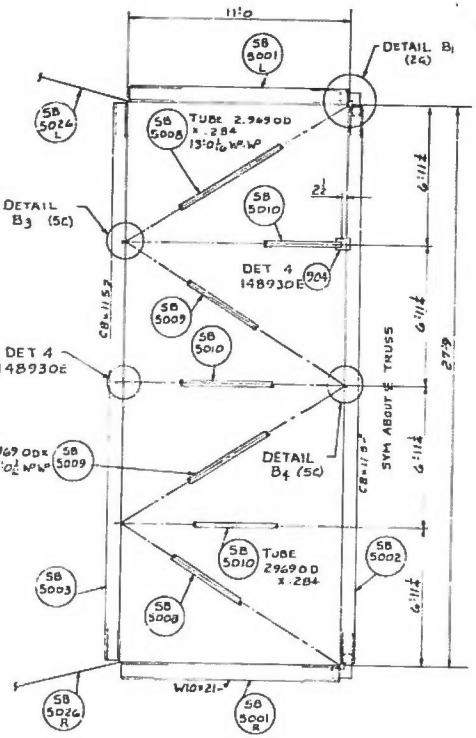
SEP 26 '78

CONTRACT 401

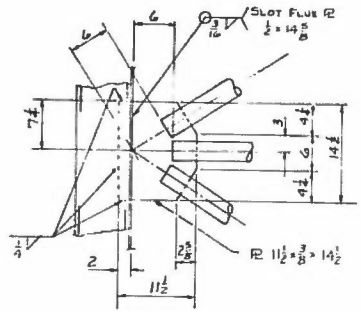
FOR PARK NUMBER INDEX AND NOTES SEE 1713396C

4-401-00-0343 Rw.0

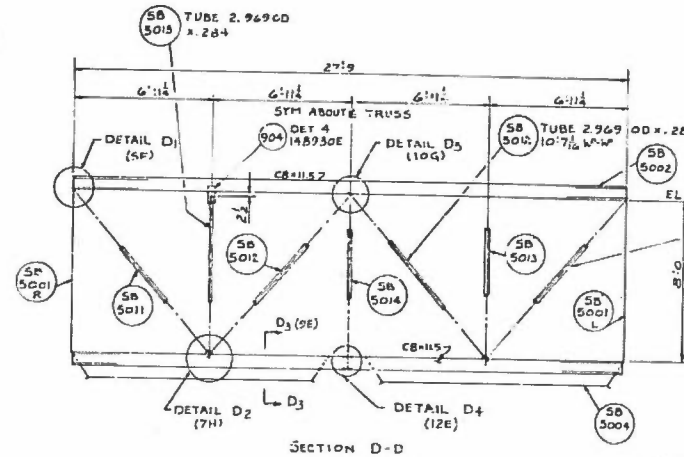
APP'D BY GALLOWAY	ARRANGEMENT FLUE AIRHEATER TO PRECIP.	
CHKD BY		
DESIGNED BY		
334-0568-41		235752 E



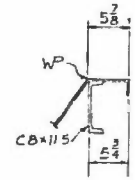
SECTION B-B
235751E (3D)



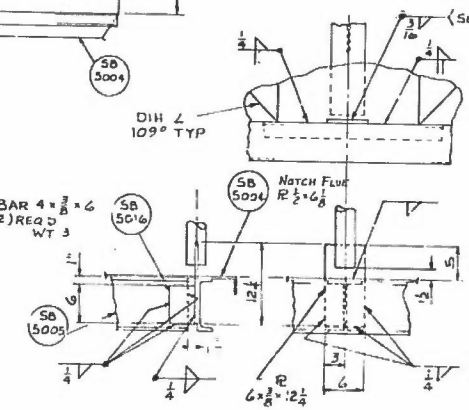
DETAIL B3 SHOWN (1B)
DETAIL B4 OPP (3C)

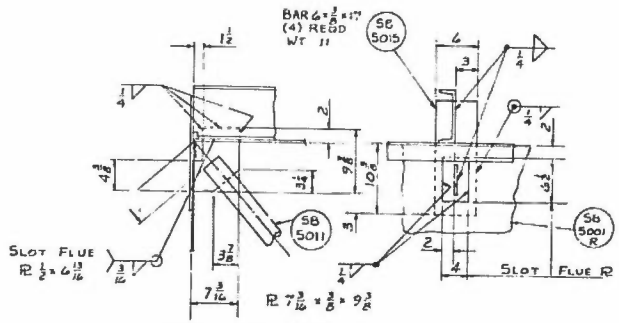


SECTION D-D
235751E (5D)

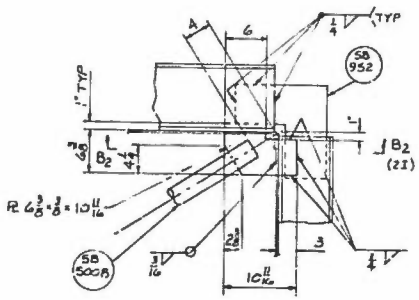


SECTION D3-D3
(9C)

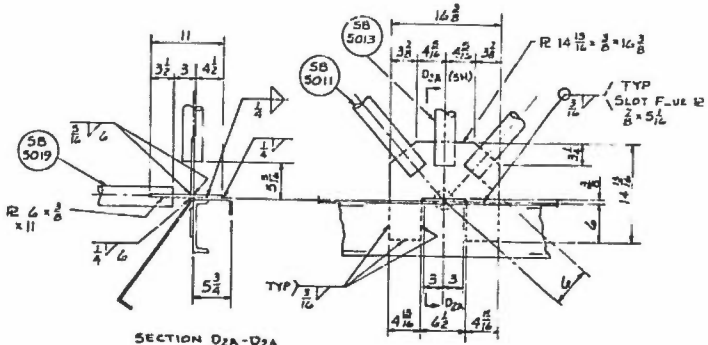




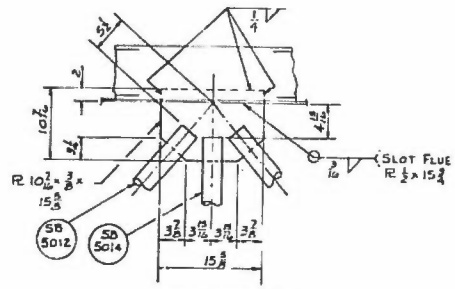
DETAIL D1 (8B)



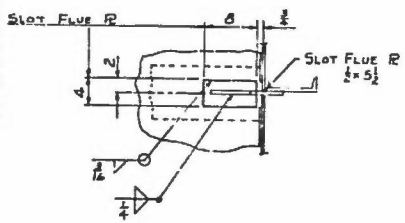
DETAIL B1 (3A)



DETAIL D2 (8C)



DETAIL D5 (9B)



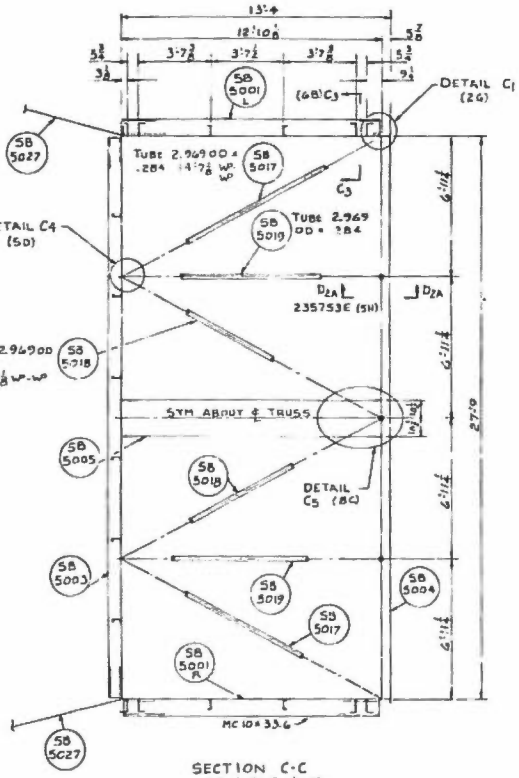
SECTION B2-S2 (3F)

FOR PARK NUMBER INDEX AND NOTES SEE 171356C.

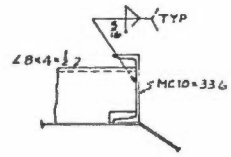
4-401-00-0344 Rev 0

DRN BY GALLOWAY	ARRANGEMENT FLUE AIRHEATER To PRECIP	235753 E
334-0568-41		

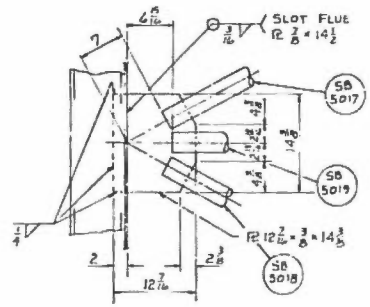
REVISIONS



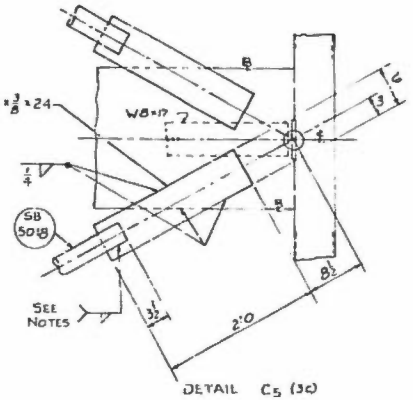
SECTION C-C
235751E (5F)



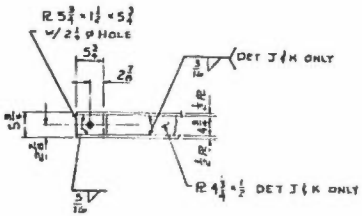
SECTION C3-C3 (3A)
TYPICAL



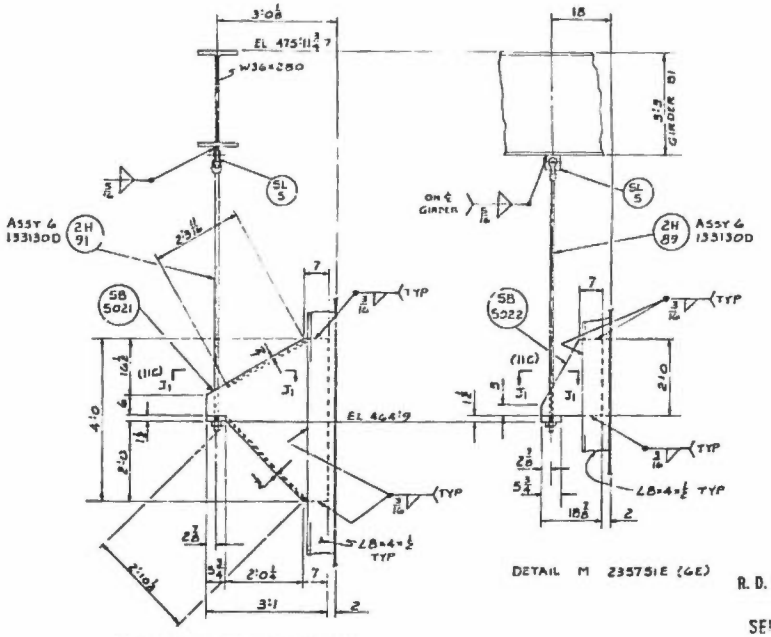
DETAIL C4 (1B)



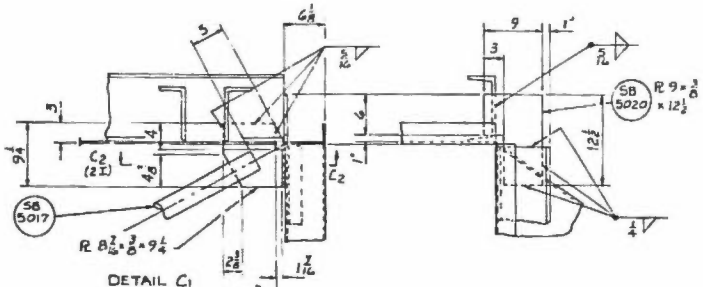
DETAIL C5 (3C)

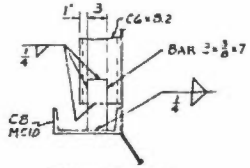


SECTION J1-J1
(9F-11F)

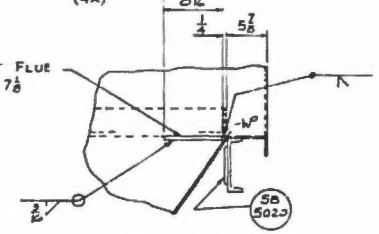


DETAIL J SHOWN 235751E (6E)
DETAIL K OPP 235751E (12E)

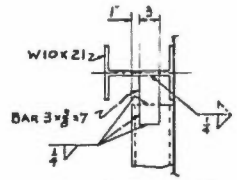




SECTION G-G
235751E (4E)
235752E (2C)



SECTION C2-C2 (2G)



SECTION H-H
235751E (4D)

R. D. GREEN

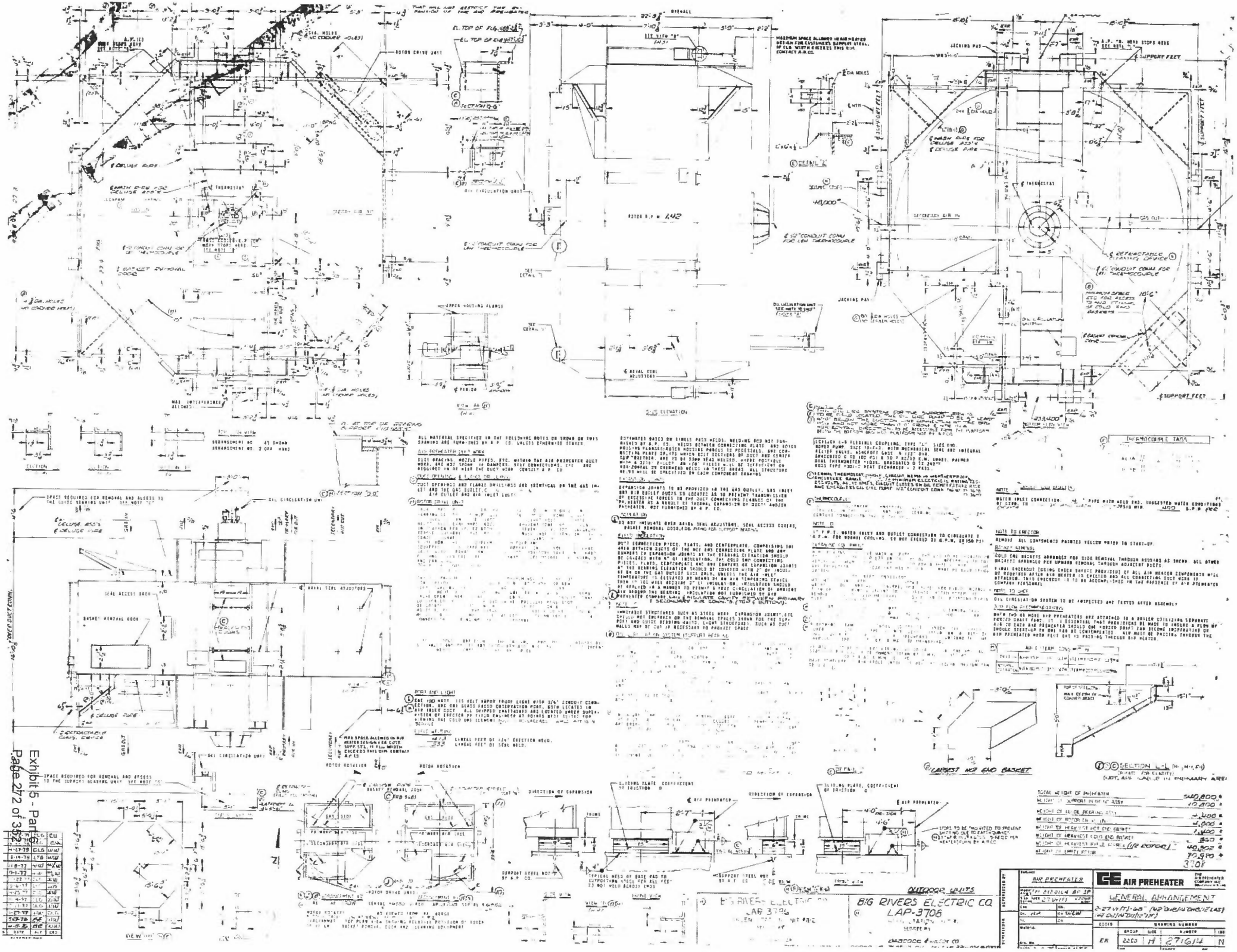
SEP 26 78

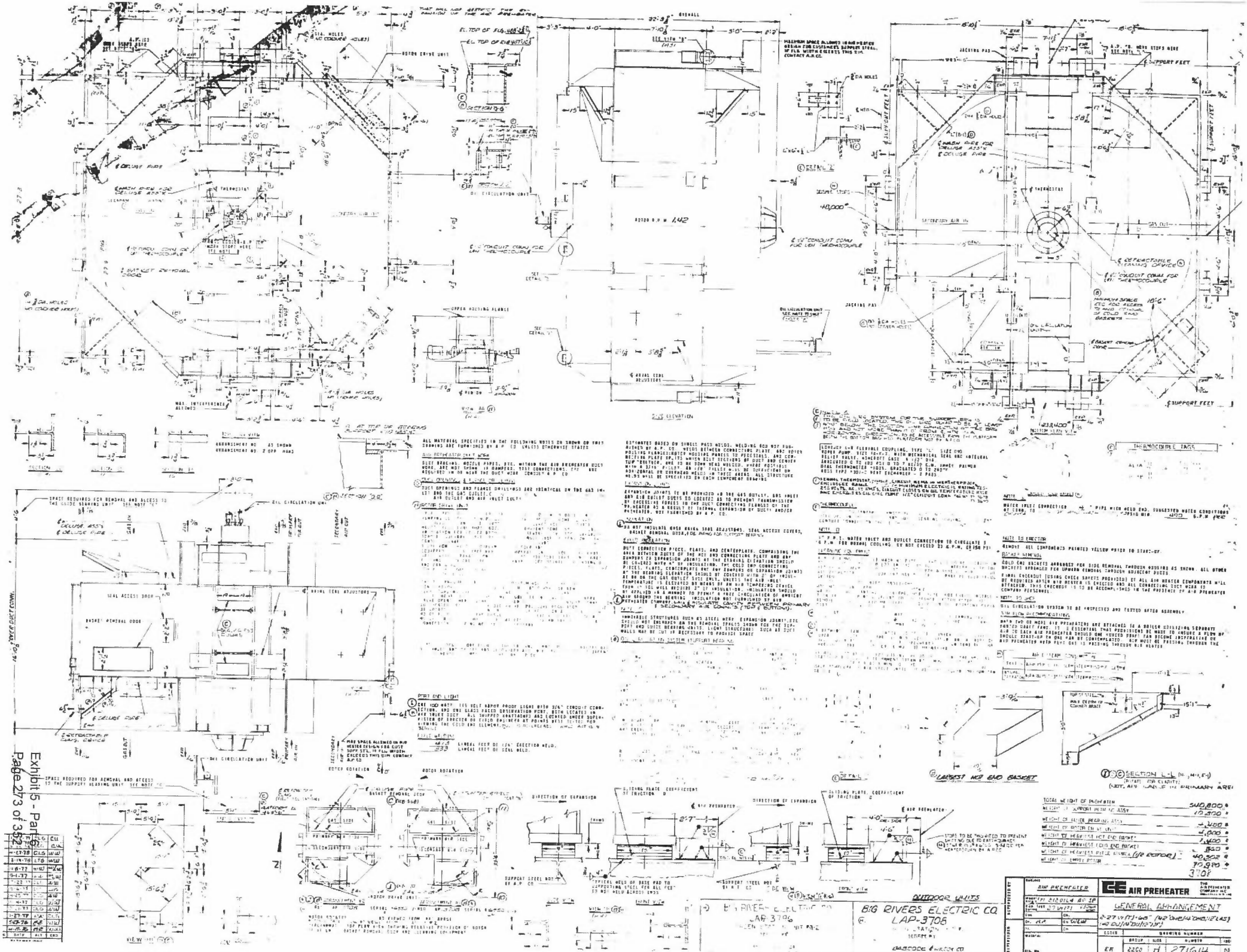
CONTRACT 401

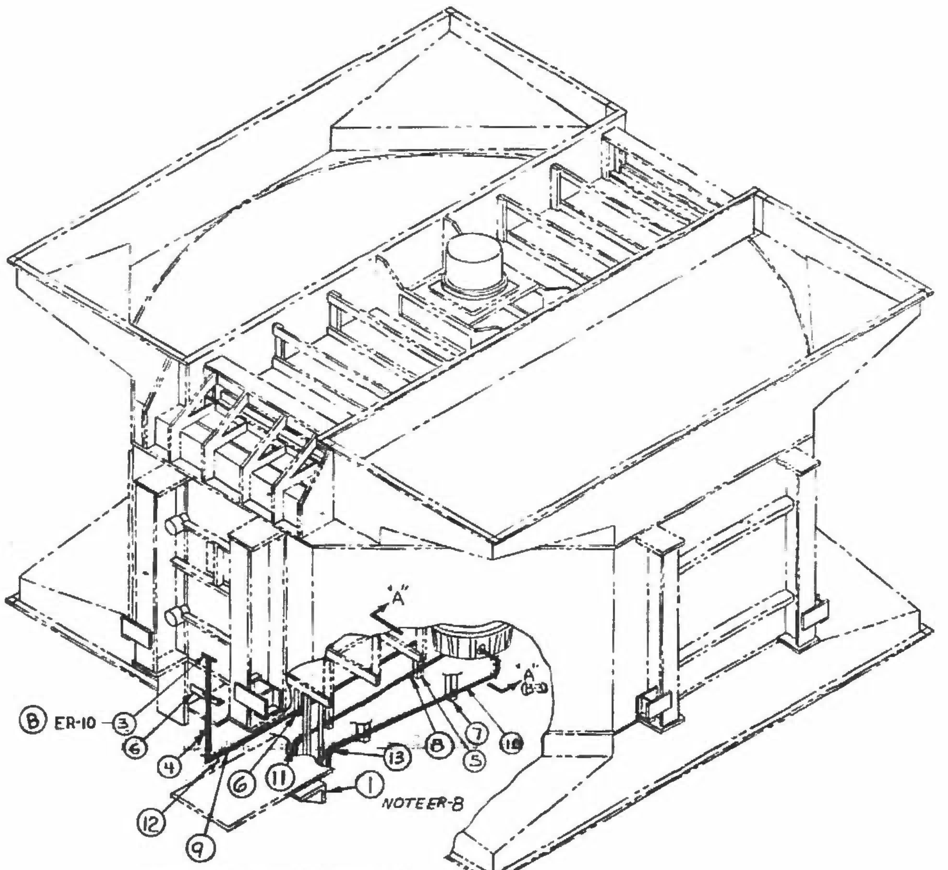
FOR PARK ROPER INDEX AND NOTES SEE 17-336C.

4-401-00 0345 Cw.0

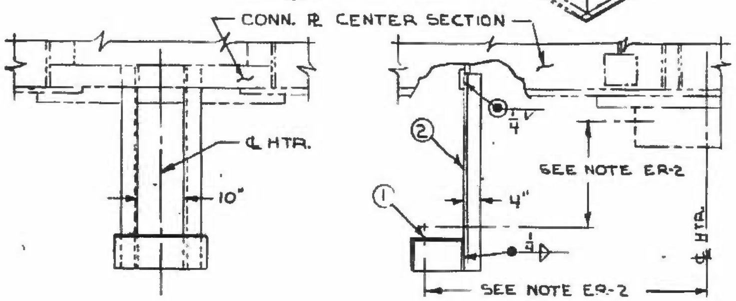
DRN BY GALLOWAY	ARRANGEMENT FLUE AIRHEATER TO PRECIP	235754E
334-056 B-41		



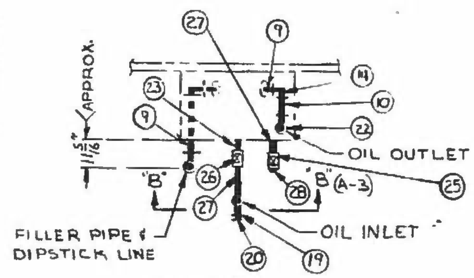

BIG RIVERS ELECTRIC CO.
LAP-3706
OUTDOOR UNITS
AIR PREHEATER
GENERAL ARRANGEMENT
DRAWING NUMBER
ER 2200 H 271614 N



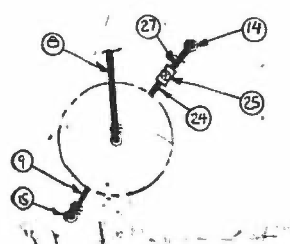
	REF. NO.	PART CODE NO.	DRAWING NO.	REQ'D	MAT'L.	DESCRIPTION	
	1		B-51296	1		OIL CIRCULATION UNIT (SEE SPEC. FOR ASS'Y. NO.)	SI
	2	01100	C-2-68379	2	5306	4" x 3" x 1/2" ANGLE x 78"	SI
	3		D-40880	1		DIPSTICK ASS'Y. - ASS'Y. #7	SI
	4		E-8-222225	1		FILLER PIPE	SI
(A)	5		E-27637	2		1" PIPE BRACKET ASS'Y. - ASS'Y. #3	SI
	6		E-27639	2		1-1/2" PIPE BRACKET ASS'Y. - ASS'Y. #3	SI
(A)	7		E-27640	2		2" PIPE BRACKET ASS'Y. - ASS'Y. #3	SI
(A)	8	00200	C-8-68379	3	6504	1" x 120" SCH. 40 P & O PIPE RANDOM	SI
	9	00200	C-9-68379	3	6504	1-1/2" x 120" SCH. 40 P & O PIPE RANDOM	SI
(A)	10	00200	C-10-68379	3	6504	2" x 120" SCH. 40 P & O PIPE RANDOM	SI
	11	30100	P-8-27324	3	3010	1" x 90° ELBOW	SI
	12	30100	P-12-27324	5	3010	1-1/2" x 90° ELBOW	SI
	13	30100	P-16-27324	4	3010	2" x 90° ELBOW	SI
	14	30110	P-25-29331	1	3011	2" x 1-1/2" x 90° REDUCING ELBOW	SI
	15	30120	P-12-29329	1	3012	1-1/2" x 90° FEMALE UNION ELBOW	SI
	16	30280	P-8-29326	1	3028	1" FEMALE UNION	SI
	17	30280	P-12-29326	1	3028	1-1/2" FEMALE UNION	SI
	18	30280	P-16-29326	1	3028	2" FEMALE UNION	SI
	19	30260	P-8-29333	1	3026	1" UNION TEE-FEMALE UNION ON OUTLET	SI
	20	30210	P-8-25970	1	3021	1" SQUARE HEAD PIPE PLUG	SI
	21	30050	P-12-25425	2	3005	1-1/2" COUPLING	SI
	22	30120	P-16-29329	1	3012	2" x 90° FEMALE UNION ELBOW	SI
	23	30010	P-22-29371	1	3001	1" x 12" LONG PIPE NIPPLE	SI
	24	02500	C-24-68379	1	6504	1-½" x 18" SCH #40 P E O PIPE - THRD BOTH ENDS	S
	25	71030	P-7-1205	2	7103	1½" GATE VALVE 100# KENNEDY	S
	26	71030	P-5-1205	1	7103	1" GATE VALVE 100# KENNEDY	S
	~~27~~	~~30010~~	~~P-4-29371~~	~~3~~	~~3001~~	~~1" x 3" LONG PIPE NIPPLE~~	S
	28	30210	P-12-25970	1	3021	1-½" SQ. HD. PIPE PLUG 300	S
(A)	29	30050	P-8-25425	1	3005	1" COUPLING	S
(A)	30	30050	P-16-25425	1	3005	2" COUPLING	S



VIEWS SHOWING LOCATION & WELDING OF CIRC. UNIT BASE & SUPPORT ANGLES



VIEW "A-A" (C-3)



VIEW "B-B" (B-3)

NOTES TO ERECTOR:

ER-1 REFER TO G.A.D. FOR ORIENTATION OF PIPING.
ER-2 (A) OIL CIRC. UNIT PUMP MUST BE AT LEAST 4'-0" BELOW SUCTION LINE CONNECTION AT BEARING AND NOT MORE THAN 17'-0" FROM ℄ OF HEATER IN THE HORIZONTAL DIRECTION. APPROVAL MUST BE OBTAINED FROM A.P. CO. ENG. DEPT. FOR CONDITIONS OTHER THAN THE ABOVE.
ER-3 ALL HORIZONTAL PIPING TO BE LEVEL.
ER-4 ALL CIRCULATION PIPING TO BE HELD BELOW OIL LEVEL IN BEARING.
ER-5 ~~ALL PIPE TO BE WELDED STEEL, PICKLED TO THOROUGHLY CLEAN AND OILED.~~ PIPE FITTINGS TO BE THOROUGHLY CLEANED OUT BEFORE ASSEMBLY. USE TEFLON PIPE DOPE TAPE ON ALL THREADED JOINTS.
ER-6 ALL PIPE BRACKETS TO BE CUT TO FIT AND WELDED SUCH THAT CLAMP IS BELOW PIPE. 3/16 POSITION CLAMP
ER-7 LOCATE UNIONS NEAR BEARING AND CIRC. UNIT FOR ACCESS OR REMOVAL.
ER-8 CRANE RELIEF VALVE SETTING IN REF. #1-50 PSIG.
ER-9 HEAT TAPES MAY BE REQUIRED DUE TO LONG PIPE RUNS. (A)
(B) ER-10 OIL FILLER PIPE & DIPSTICK WILL BE LOCATED BETWEEN HEATERS.

MICROFILMED R. D. GREEN SEP 05 CONTRACT HDE

NOTE: SPECIAL FOR AP-3708 & AP-3796

6-26-78	DLG	WW	
3-14-78	LTG	WW	
12-15-77	JK	CEW	
DATE	ALT'D	CKD.	
REVISIONS			

BIG RIVERS ELECTRIC CO.
REID STATIONS NO. 2 & 3
SEBREE, KENTUCKY
BABCOCK & WILCOX CO.
CONT. NO. 339-0568-370

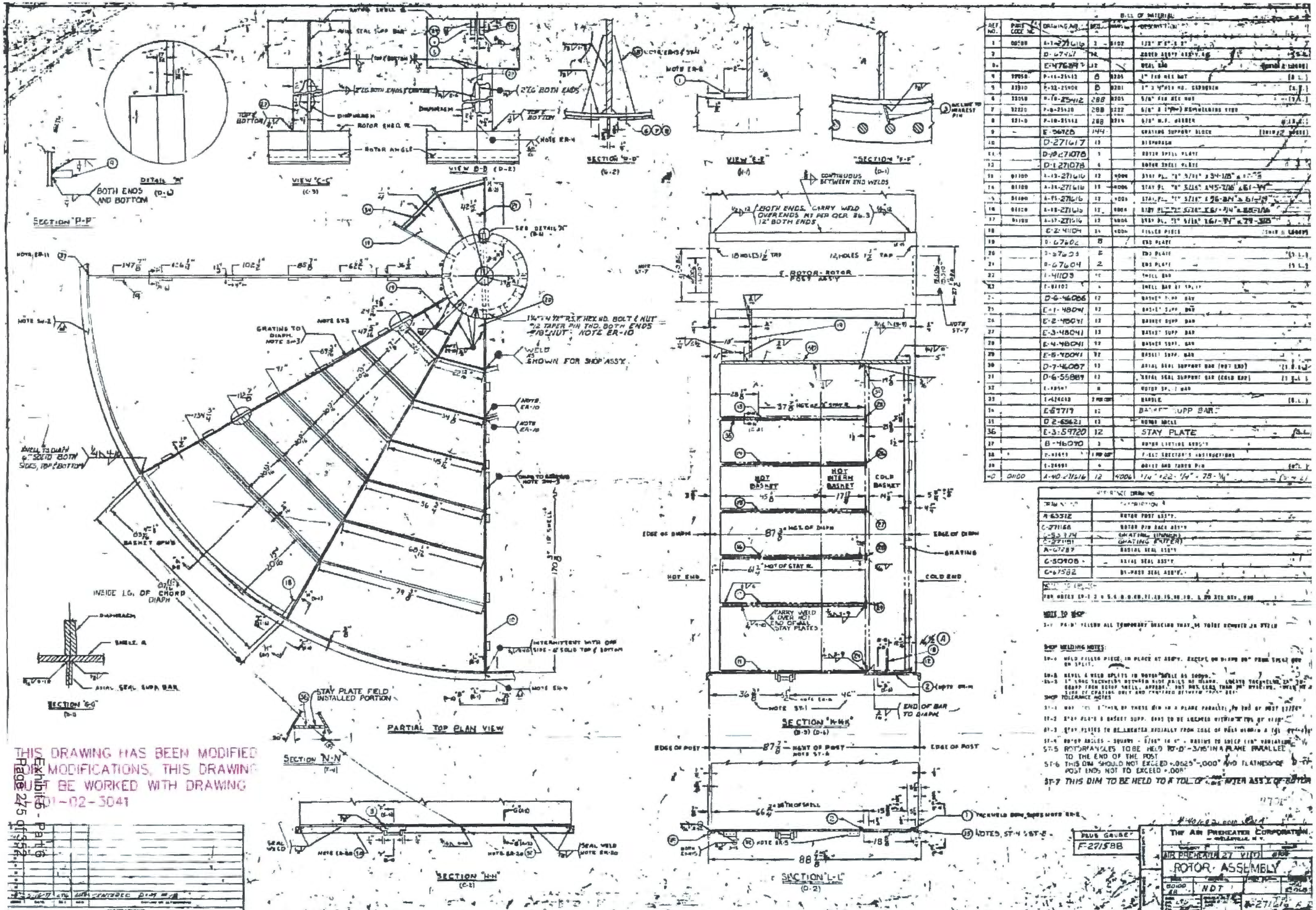
CORPORATE FILES

Subject: AIR PREHEATER
Model/Arr'g't: M-2220164-AP, M-2230164-AP
Size, Type Series: 24½ - 34-VI
Dr. DV — Ch. WLW
DATE 9-14-77

CE PROCESS EQUIPMENT

SUGGESTED OIL PIPING SUPPORT BEARING

CODE	GROUP	SIZE	NUMBER	
ER 90100	E702	C	68379	C


PARTIAL TOP PLAN VIEW
SECTION "P-P"
DETAIL "A"
VIEW "C-C"
VIEW D-D
SECTION "G-G"
VIEW "E-E"
SECTION "F-F"
SECTION "K-KK"
SECTION "N-N"
SECTION "H-H"
SECTION "L-L"
BOTH ENDS AND BOTTOM
STAY PLATE FIELD INSTALLED PORTION
INSIDE LG. OF CHORD DIAPH.
HOT BASKET
INTERM BASKET
COLD BASKET
HOT END
COLD END
EDGE OF DIAPH
EDGE OF POST
GRATING
WELD AS SHOWN FOR SHOP ASS'Y.
BILL OF MATERIAL
STAY PLATE
BASKET SUPP BAR
ST-5 ROTOR ANGLES TO BE HELD TO 0"-3/16 IN A PLANE PARALLEL TO THE END OF THE POST
ST-6 THIS DIM SHOULD NOT EXCEED +.0625"-.000" AND FLATNESS OF POST ENDS NOT TO EXCEED +.008"
ST-7 THIS DIM TO BE HELD TO A TOL. OF
PLUG GAUGE F-27158B
THE AIR PREHEATER CORPORATION
ROTOR ASSEMBLY
NDT
THIS DRAWING HAS BEEN MODIFIED FOR MODIFICATIONS, THIS DRAWING MUST BE WORKED WITH DRAWING
01-02-3041
ALTERATIONS

NOTES TO ERECTOR:

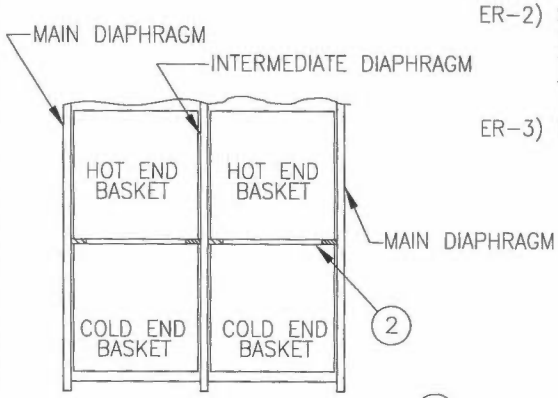
ER-1) AFTER INSTALLING COLD END BASKETS, INSTALL SEALING BAR ASSEMBLIES BETWEEN HOT AND COLD END BASKETS. DO NOT WELD IN PLACE.

ER-2) SEALS ARE DESIGNED TO FIT TIGHTLY IN EACH COMPARTMENT IT MAY BE NECESSARY TO SLIDE THE SEAL DOWN AGAINST THE DIAPHRAGM VERTICALLY OR TO ANGLE THE SEAL INTO PLACE. TRIM SEALS TO FIT COMPARTMENT ONLY AS LAST OPTION.

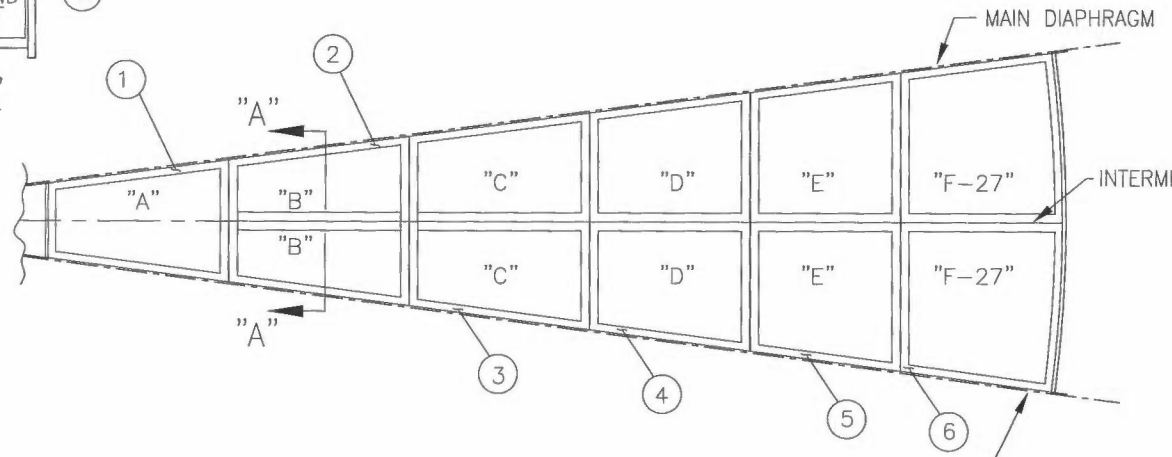
ER-3) INSTALL HOT END BASKETS.

BILL OF MATERIAL

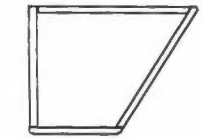
REF. NO.	QTY.	DESCRIPTION	SL
1	12	"A" BASKET SEALING BAR ASSEMBLY	SL
2	24	"B" BASKET SEALING BAR ASSEMBLY	SL
3	24	"C" BASKET SEALING BAR ASSEMBLY	SL
4	24	"D" BASKET SEALING BAR ASSEMBLY	SL
5	24	"E" BASKET SEALING BAR ASSEMBLY	SL
6	24	"F-27" BASKET SEALING BAR ASSEMBLY	SL



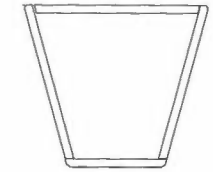
SECTION "A-A"



PARTIAL HOT END VIEW



ISO VIEW



TOP VIEW

TYPICAL "A" BASKET SEAL ASS'Y

H				
G				
F				
E				
D				
C				
B	10-00	NAM	BLM	ADDED QTY. TO BOM
A	DATE	DR.	CK.	COMMENTS
	ALTERATIONS			

W:\STAND;;\BASKETS\FLOATING SEALS

SUPERSEDED BY

SUPERSEDES

ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

THIRD ANGLE

SUBJECT AIR PREHEATER

API NO.

SIZE 27 V-VI

DR CEI CK CU

APPR. BY

DATE 10-19-00

ABB AIR PREHEATER, INC.
WELLSVILLE, NEW YORK

BASKET SEALING BAR INSTALLATION

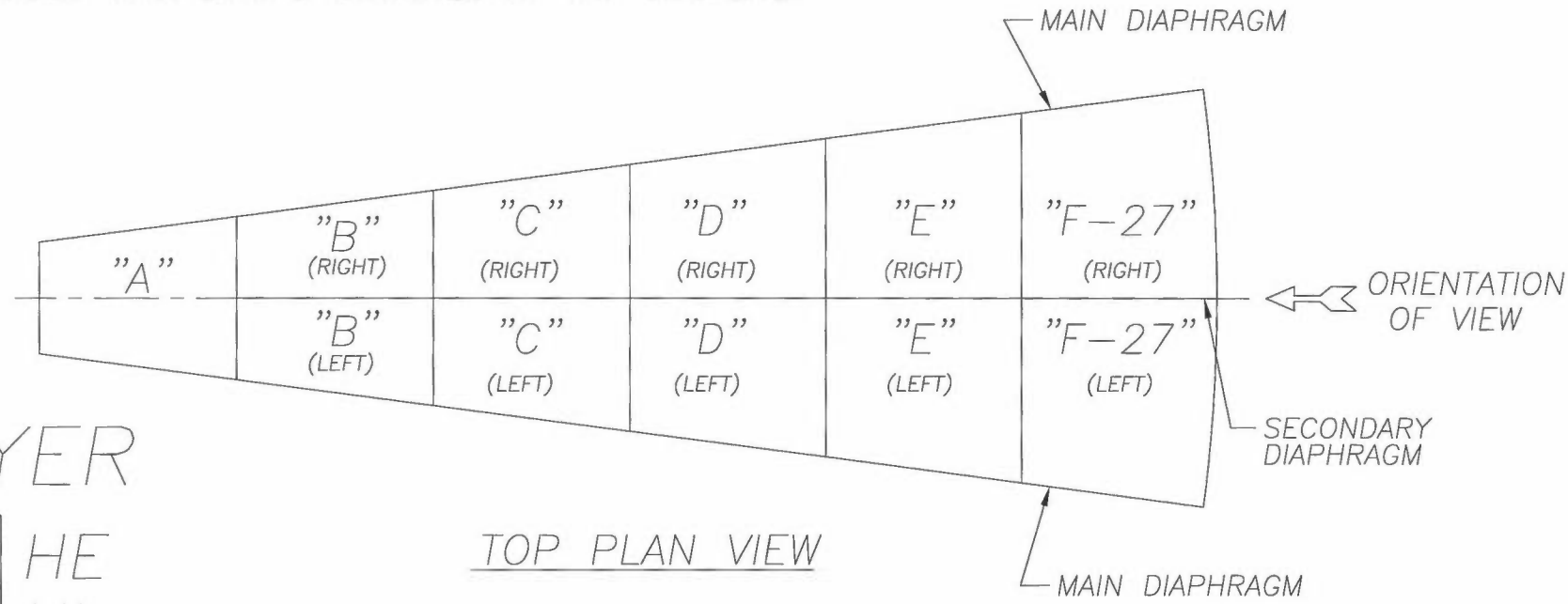
CODE	GROUP	SIZE	DWG NO.	REV
ER	0204	D	273091	A

SCALE NTS WT SHEET OF

4-401-02-3039

NOTE TO ERECTOR:

AFTER BASKETS HAVE BEEN INSTALLED, ANY BYPASS GAPS GREATER THAN 1/4" SHOULD BE SEALED WITH STRIPS OBTAINED AT THE JOB SITE.



TOP PLAN VIEW

LAYER

- [X] HE
- [ ] HI
- [X] CE
- [ ] CI

MARK	DATE	DR.	CK.
H			
G			
F			
E			
D			
C			
B			
A			

ALTERATIONS

SUPERSEDED BY

SUPERSEDES

ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

THIRD ANGLE

SUBJECT AIR PREHEATER

API NO.

SIZE 27 V,VI

DR CEI CK CU

APPR. BY

DATE 9-7-00

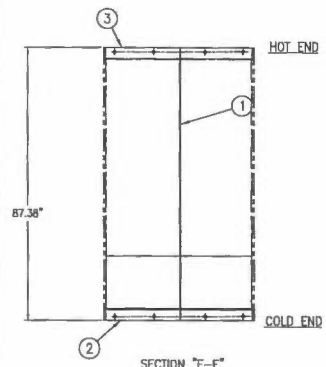
ABB AIR PREHEATER, INC.
WELLSVILLE, NEW YORK

BASKET ARRANGEMENT DRAWING

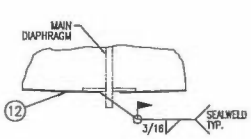
CODE	GROUP	SIZE	DWG NO.	REV
ER	0200	E	273099	

SCALE NTS WT SHEET OF

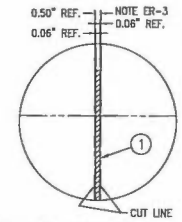
4-401-02-3040



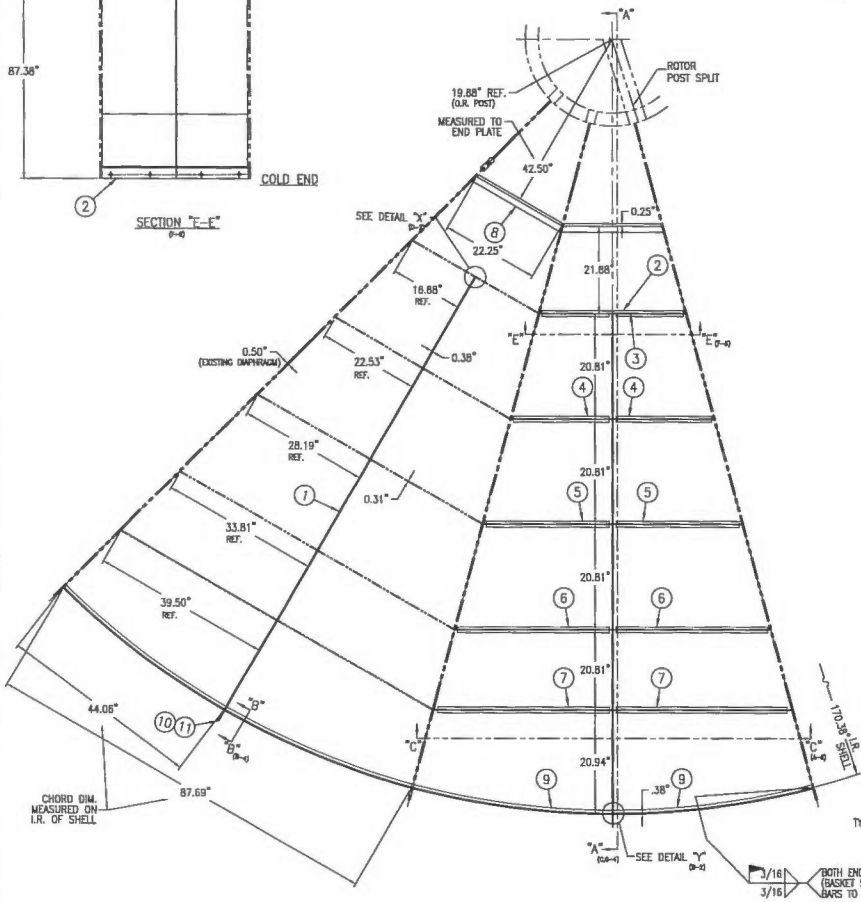
SECTION "E-E"

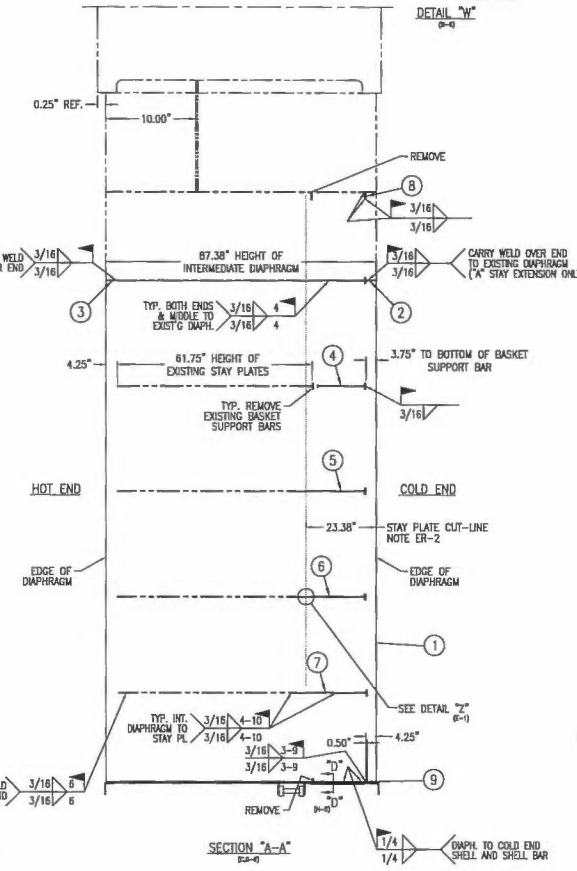


SECTION "D-D"



DETAIL "W"





SECTION "A-A"

NOTES TO ERECTOR:

ER-1 REMOVE ALL ELEMENT BASKETS FROM ALL LAYERS UP TO "A" COMPARTMENT BEFORE PERFORMING ROTOR MODIFICATION WORK. REMOVE "A" STAY EXTENSION AND THEN REMOVE "A" ELEMENT BASKET.

ER-2 REMOVE THE EXISTING BASKET SUPPORT BARS AND GRATING AND DISCARD. TRIM STAY PLATES TO DIMENSION SHOWN IN SECTION "A-A".

ER-3 LOCATE THE CENTER OF EACH STAY PLATE EXCEPT THE "A" STAY PLATE AND CUT A NOTCH AS SHOWN IN SECTION "C-C". ALL OF THE SLOTS ARE TO BE "IN LINE" WITH EACH OTHER BECAUSE THE INTERMEDIATE DIAPHRAGM WILL BE PLACED INSIDE THESE SLOTS.

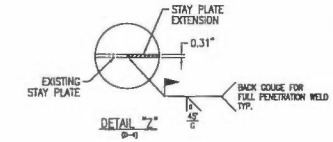
ER-4 INSTALL THE STAY PLATE EXTENSIONS AS SHOWN. (EXTRA CARE SHOULD BE TAKEN TO MAKE SURE THAT THE STAY PLATE EXTENSIONS LINE UP WITH THE CORRESPONDING EXISTING STAY PLATES.)

ER-5 INSTALL THE INTERMEDIATE DIAPHRAGM AS SHOWN. LOCATE THE INTERMEDIATE DIAPHRAGM IN SUCH A WAY THAT THE SECTOR COMPARTMENT IS DIVIDED INTO TWO EQUAL POCKETS. WELD THE INTERMEDIATE DIAPHRAGM AS SHOWN.

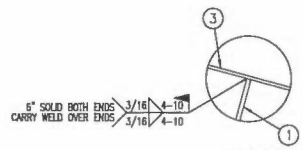
ER-6 INSTALL THE BASKET SUPPORT BARS REF. #8 AND #9, AS SHOWN AND WELD INTO PLACE.

ER-7 WELD THE BASKET COVERS IN PLACE ON THE SHELL O.R. CENTERED OVER THE OPENINGS. (REFER TO SECTION "D-D") REMOVE AND DISCARD ALL WELD STUDS.

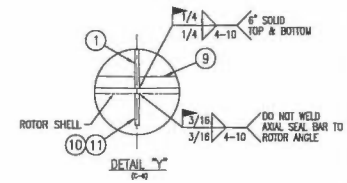
ER-8 INSTALL THE AXIAL SEAL SUPPORT BARS AS SHOWN AND WELD INTO PLACE.



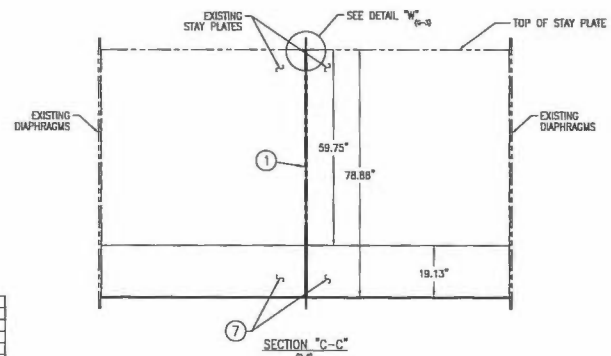
DETAIL "Z"



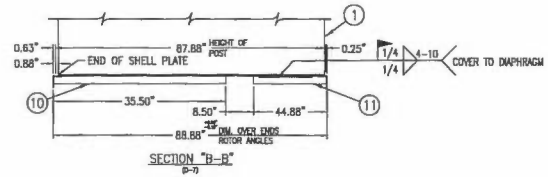
DETAIL "X"



DETAIL "Y"



SECTION "C-C"



SECTION "B-B"

Ⓐ CERTIFIED FOR CONSTRUCTION

REF	Drawing #	QTY.	MATL	DESCRIPTION	S.L.
1	C-273106	12		INTERMEDIATE DIAPHRAGM DETAIL	SL
2	C-273108	12		"A" STAY PLATE EXTENSION ASSEMBLY (CE)	SL
3	E-273107	12		"A" STAY PLATE EXTENSION (HE)	SL
4	C-17-99682	24		"B" STAY PLATE EXTENSION ASSEMBLY	SL
5	C-18-99682	24		"C" STAY PLATE EXTENSION ASSEMBLY	SL
6	C-19-99682	24		"D" STAY PLATE EXTENSION ASSEMBLY	SL
7	C-20-99682	24		"E" STAY PLATE EXTENSION ASSEMBLY	SL
8	E-59719	12		BASKET SUPPORT BAR	SL
9	H-8-273105	24	5102	BSKT. SUPPORT BAR: 0.50" X 1.00" X 44.00" ROLLED TO 169.38" I.R. (170.38" O.R.)	SL
10	D-7-46067	12		AXIAL SEAL SUPPORT BAR (HE)	SL
11	D-273109	12		AXIAL SEAL SUPPORT BAR (CE)	SL
12	C-273129	12		ROTOR COVER	SL

H				
G				
F				
E				
D				
C				
B				
A	11-2-00	JRC	ACS	ADDED "CERTIFIED FOR CONSTRUCTION"
MARK	DATE	DR.	CK.	COMMENTS

ALTERATIONS

3706

SUPERSEDED BY: ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED. THIRD ANGLE

SUPERSEDES: SUBJECT AIR PREHEATER; APL NO.; SIZE 27 VIT; DR JRC; CK DV; APPR. BY; DATE 9-01-00

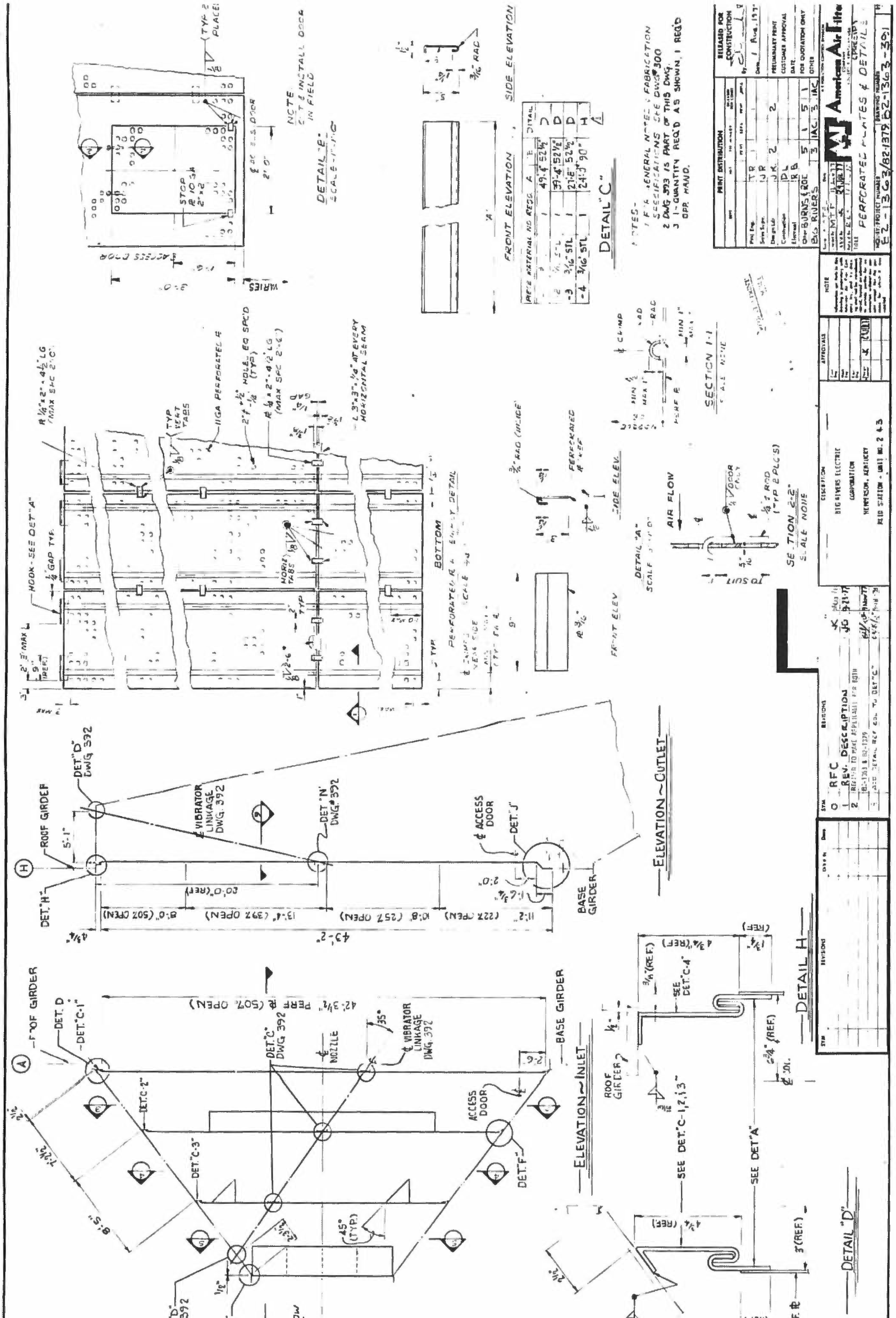
ABB AIR PREHEATER, INC. WELLSVILLE, NEW YORK

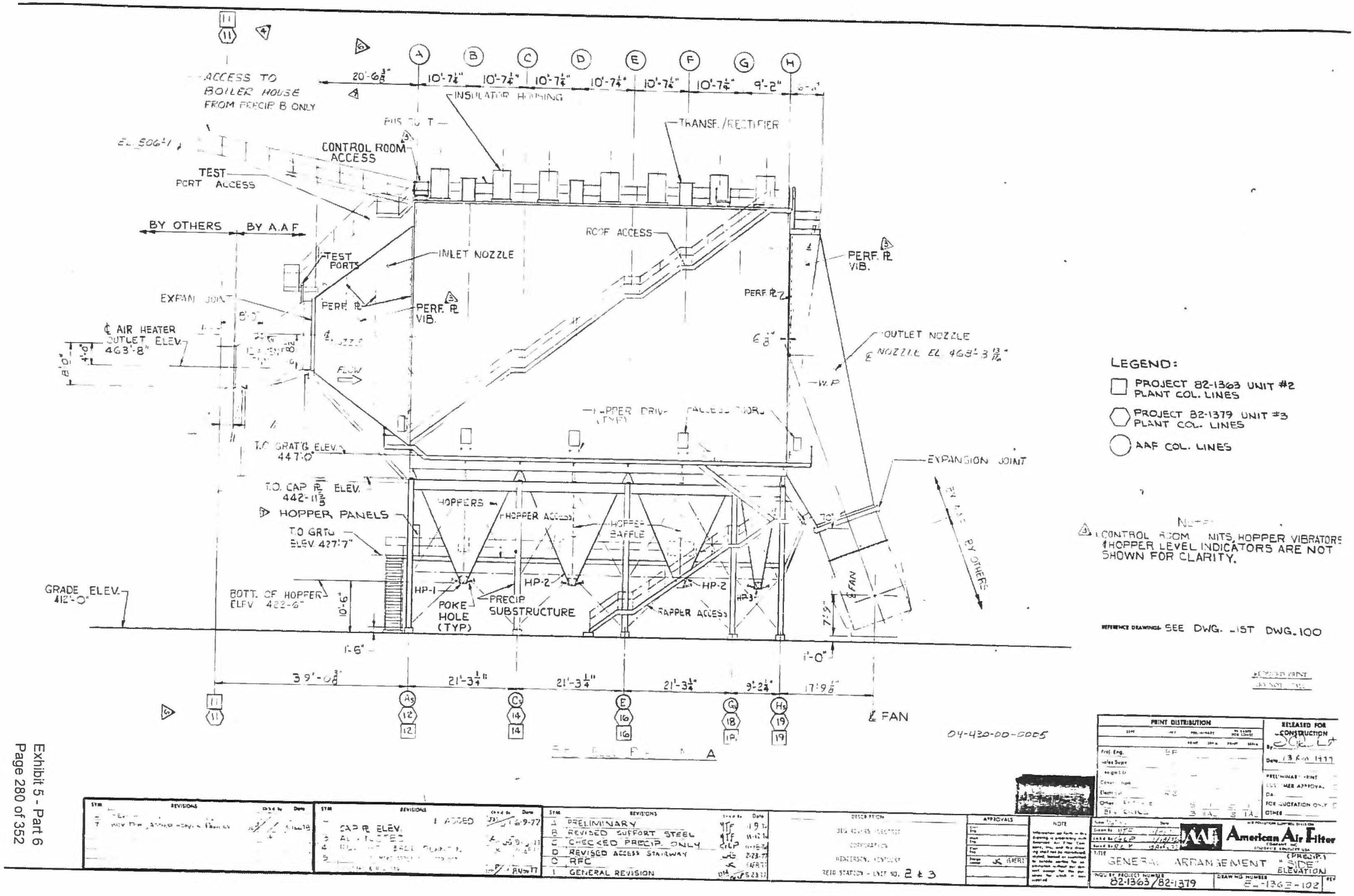
ROTOR MODIFICATION FOR DUPLEX™ SEALING

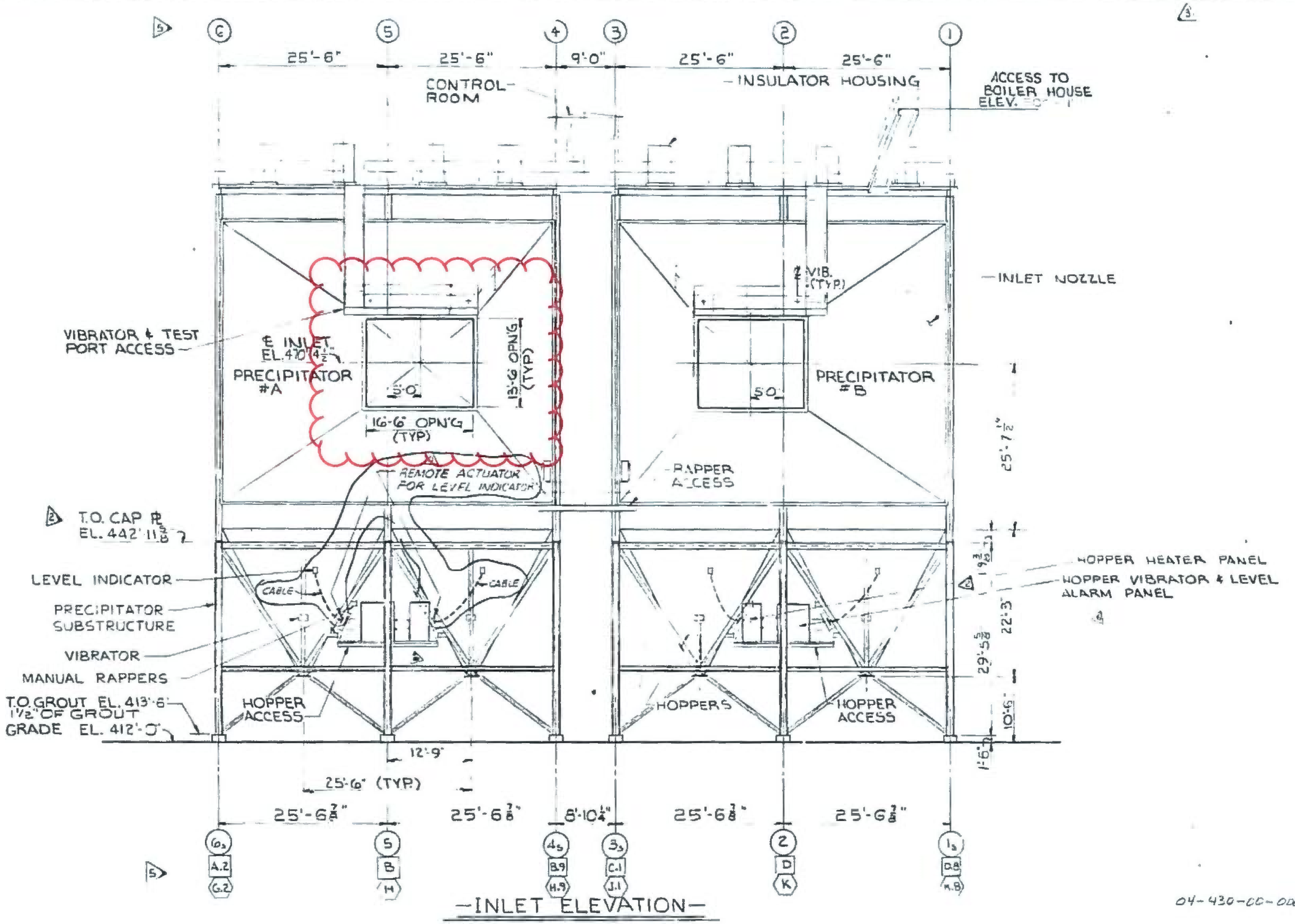
CODE	GROUP	SIZE	DWG NO.	REV
ER	0100	H	273105	A

SCALE NTS WT SHEET OF

4-401-02-3041


ELEVATION~INLET
ELEVATION~OUTLET
DETAIL "D"
DETAIL H
DETAIL "C"
DETAIL "E"
SECTION 1-1
SECTION 2-2
BIG RIVERS ELECTRIC CORPORATION
HENDERSON, KENTUCKY
REID STATION - UNIT NO. 2 & 3
American Air Filter
PERFORATED PLATES & DETAILS


ACCESS TO
BOILER HOUSE
FROM PRECIP B ONLY
CONTROL ROOM ACCESS
TEST PORT ACCESS
BY OTHERS
BY A.A.F
TEST PORTS
INLET NOZZLE
EXPAN JOINT
PERF. PL
PERF. PL VIB.
¢ AIR HEATER OUTLET ELEV. 463'-8"
FLOW
INSULATOR HOUSING
TRANSF./RECTIFIER
ROOF ACCESS
OUTLET NOZZLE
WP
EXPANSION JOINT
T.O. GRAT'G ELEV. 447'-0"
T.O. CAP PL ELEV. 442-11 3/8
HOPPER PANELS
T.O GRTG ELEV. 427'-7"
BOTT. OF HOPPER ELEV 422-6"
GRADE ELEV. 412'-0"
HOPPERS
HOPPER ACCESS
HOPPER BAFFLE
HP-1
HP-2
HP-3
POKE HOLE (TYP)
PRECIP SUBSTRUCTURE
RAPPER ACCESS
¢ FAN
BY OTHERS
A
B
C
D
E
F
G
H
20'-6 3/8"
10'-7 1/4"
10'-7 1/4"
10'-7 1/4"
10'-7 1/4"
10'-7 1/4"
10'-7 1/4"
9'-2"
39'-0 3/8"
21'-3 1/4"
21'-3 1/4"
21'-3 1/4"
9'-2 1/4"
17'-9 1/8"
1'-6"
1'-0"
10'-6"
7'-9"
11
12
14
16
18
19
04-430-00-0005
LEGEND:
PROJECT 82-1363 UNIT #2 PLANT COL. LINES
PROJECT 82-1379 UNIT #3 PLANT COL. LINES
AAF COL. LINES
CONTROL ROOM UNITS, HOPPER VIBRATORS & HOPPER LEVEL INDICATORS ARE NOT SHOWN FOR CLARITY.
REFERENCE DRAWINGS SEE DWG. LIST DWG. 100
PRINT DISTRIBUTION
RELEASED FOR CONSTRUCTION
PRELIMINARY PRINT
CUSTOMER APPROVAL
FOR QUOTATION ONLY
CAP PL ELEV. ADDED
PRELIMINARY
REVISED SUPPORT STEEL
CHECKED PRECIP. ONLY
REVISED ACCESS STAIRWAY
RFC
GENERAL REVISION
REID STATION - UNIT NO. 2 & 3
HENDERSON, KENTUCKY
American Air Filter
GENERAL ARRANGEMENT (PRECIP.) "SIDE" ELEVATION
82-1363/82-1379
EL-1363-102



—INLET ELEVATION—

LEGEND:

- □ PROJECT 82-1363 UNIT #2 PLANT COL. LINES
- ⬡ PROJECT 82-1379 UNIT #3 PLANT COL. LINES
- ○ AAF COL. LINES

NOTES:

1. INLET DUCT TRANSITION OMMITTED FOR CLARITY.

REFERENCE DRAWINGS: SEE DWG LIST DWG. 100

REDUCED PRINT DO NOT SCALE

04-430-00-0026

SYM	REVISIONS	DATE
A	PRELIMINARY	GLP 11-9-76
B	VIB. MOVED ACCESS REMOVED	11-12-76
C	CHECKED FOR PRECIP ONLY	
D	GEN. REV.	3-3-77
0	RFC	
1	GENERAL REVISION	

SYM	REVISIONS
2	REMOVED HOLDS ...
4	
5	

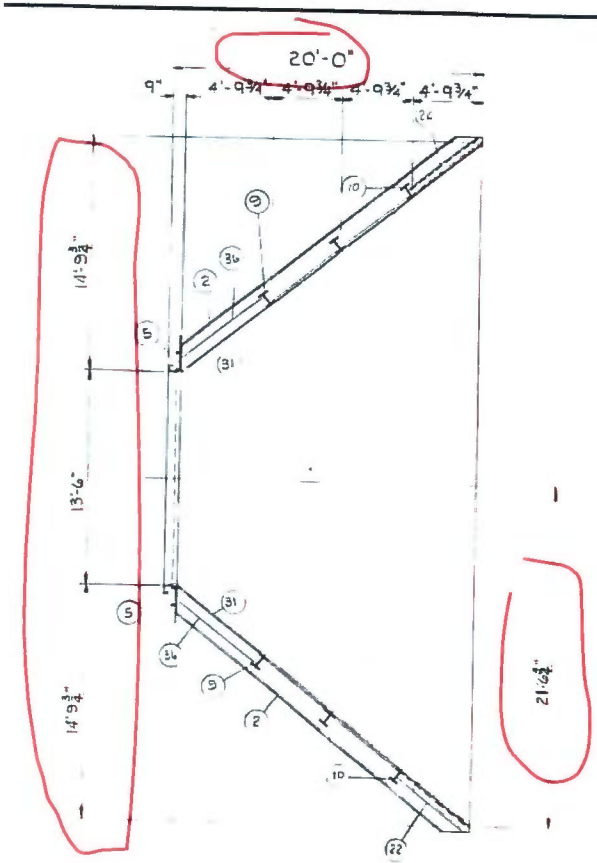
American Air Filter (AAF)

GENERAL ARRG'T - INLET ELEVATION

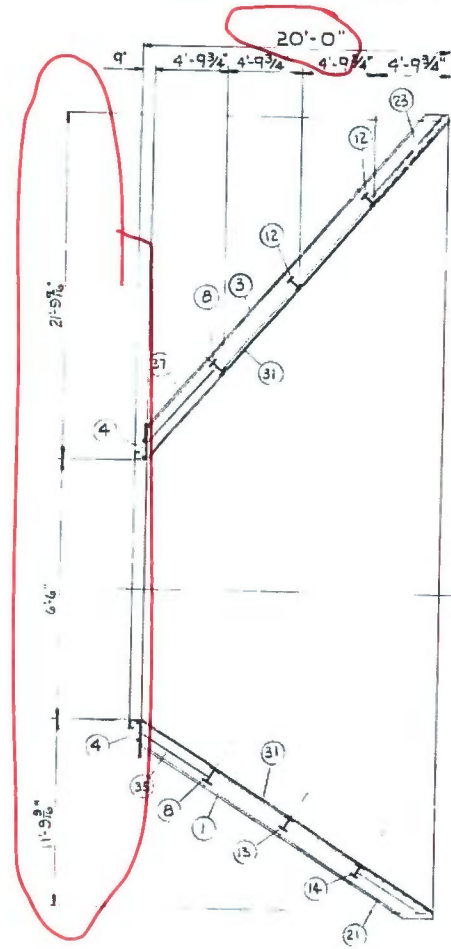
(PRECIP)

Inquiry or project number: 82-1363/82-1379

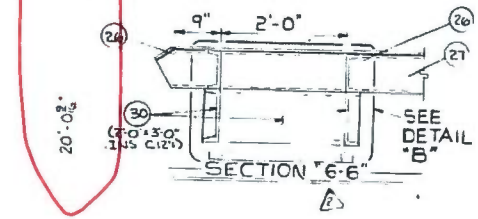
Drawing number: 82-1363-103



—SECTION "7-7"—
SCALE ¾"=1'-0"

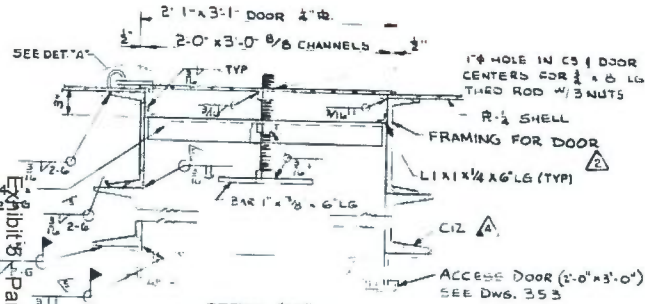


—SECTION "8-8"—
SCALE ¾"=1'-0"

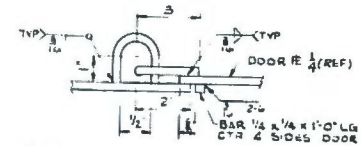


SECTION "6-6"

NOTE:
1) FOR GEN NOTES & FAB. SPECS, SEE DWG. 300
2) SECTIONS & DETAILS TAKEN FROM DWG 38



—DETAIL "B"—
NO SCALE



—DETAIL "A"—
NO SCALE

REFERENCE DRAWINGS
320, 381

REDUCED PRINT
DO NOT SCALE

SYM.	REVISIONS	DRWN BY	Date
0	RFC	K	11-9-77
1	REV. DESCRIPTION	LHG	9-23-77
2	REV. C1 ON DET. "B" & REV. SHT 66 60	LHG	9-23-77
3	REVISED TO MAKE ADJUSTABLE FOR P.T. 82-1363 & 82-1379	K	10-11Nov77
4	A: DET 5" ADD. C1Z TO DOOR FRAME RELOCATE WELDS IN DET E	K	11-16-78

DESCRIPTION
FOR SYSTEMS SELECTABE CORPORATION
HENDERSON, KENTUCKY
REID STATION - UNIT NO. 2 & 3

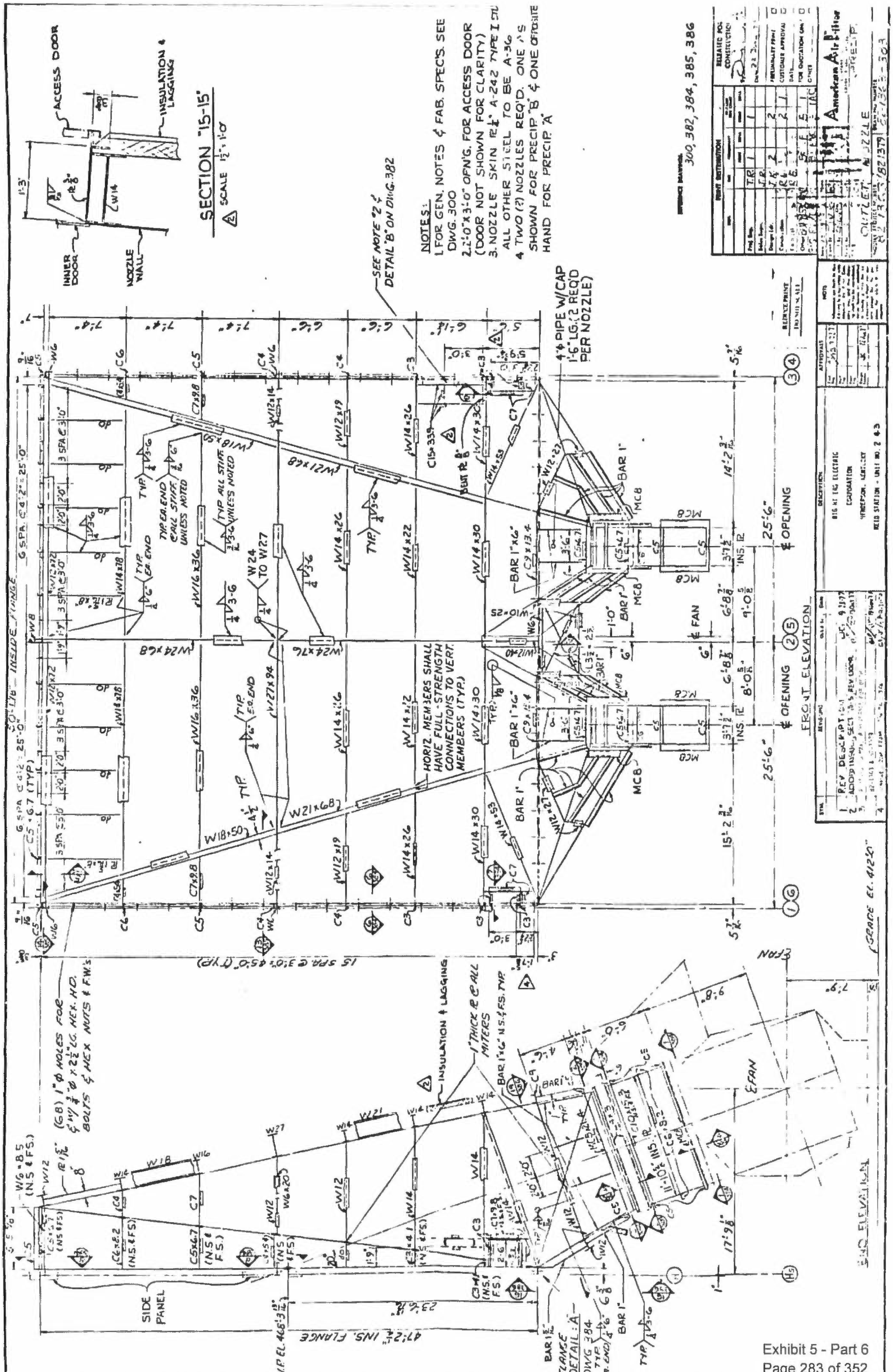
APPROVALS
Proj. Engr. TR 5-77
Sales Supv.
Design Ldr. J.K 2 2
Construction D.L 2 1
Electrical R.B
Other BURNS & RE 5 1 5 1
Bldg. RIVERS 5 I.A.C. 3 I.A.C.

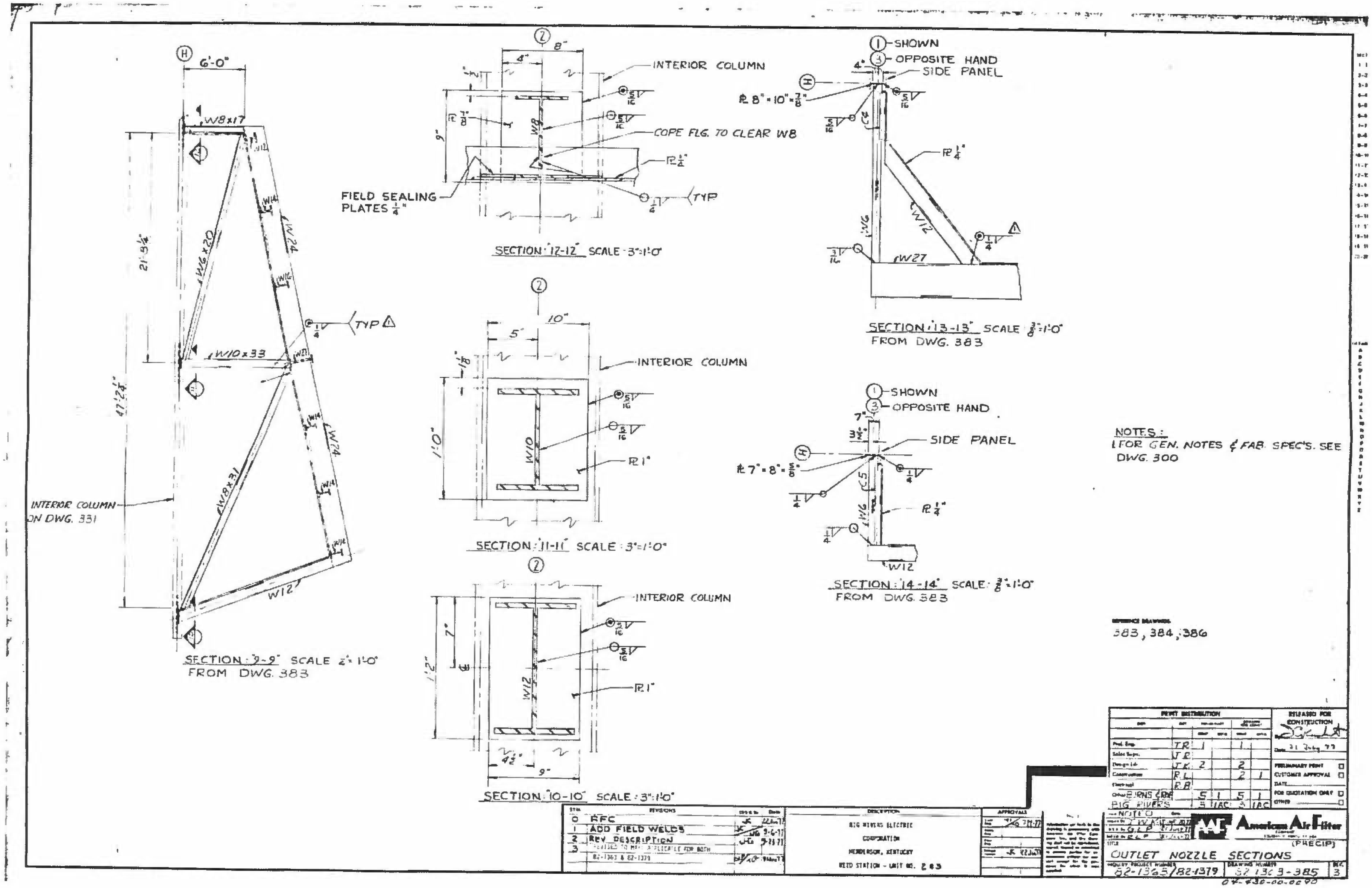
NOTE
Some NOTED Date 11-7-77
Some 1 & 2 11-9-77
Rev. to Det. 11-16-77

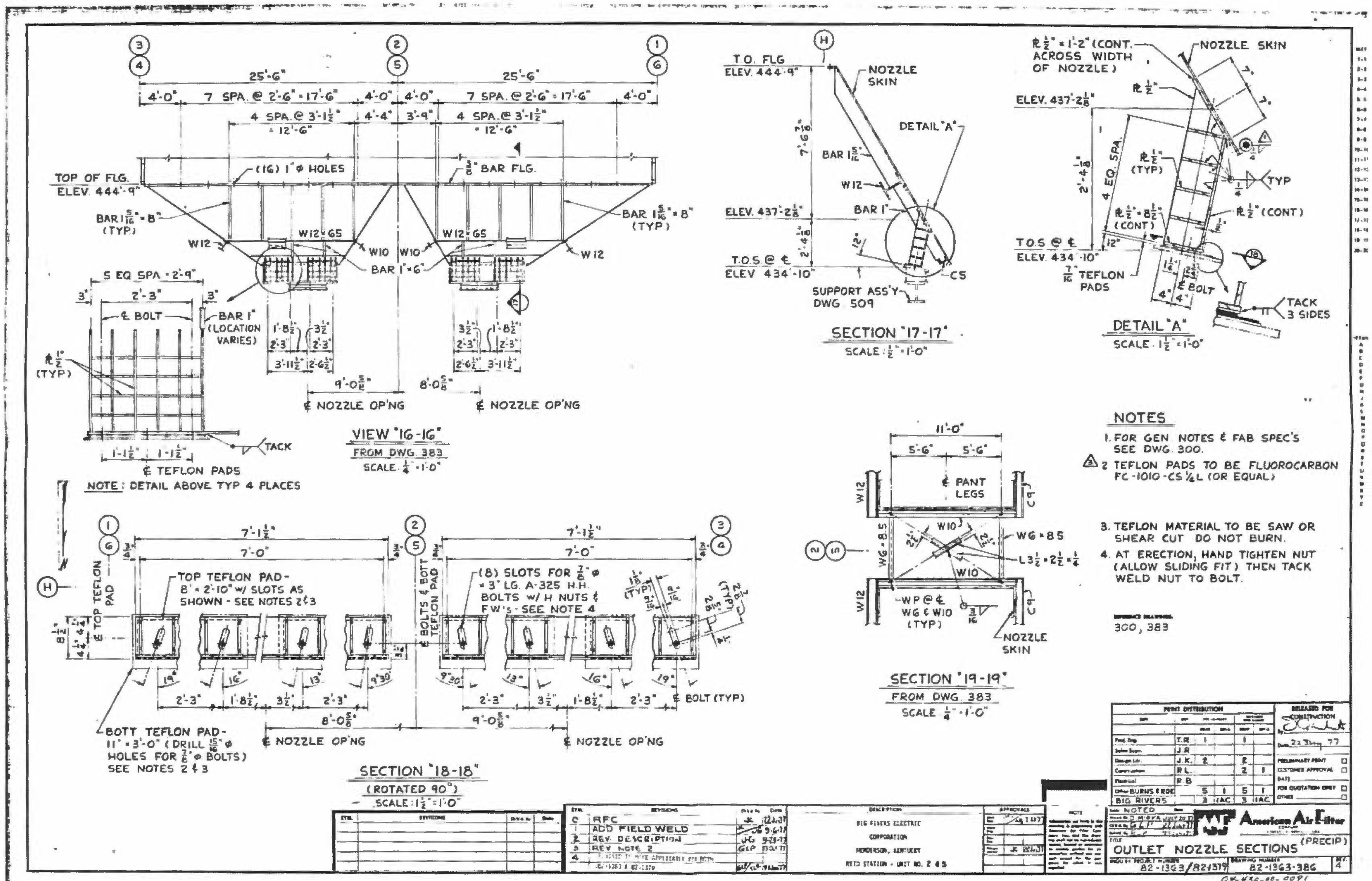
PRINT DISTRIBUTION
CONSTRUCTION
Date 16 January 77
PRELIMINARY PRINT
CUSTOMER APPROVAL
Date
FOR QUOTATION ONLY
OTHER

American Air Filter
INLET NOZZLE DETAILS (PRECIP)
WORK PROJECT NUMBER 82-1363 / 82-1379
DRAWING NUMBER 82-1362-382

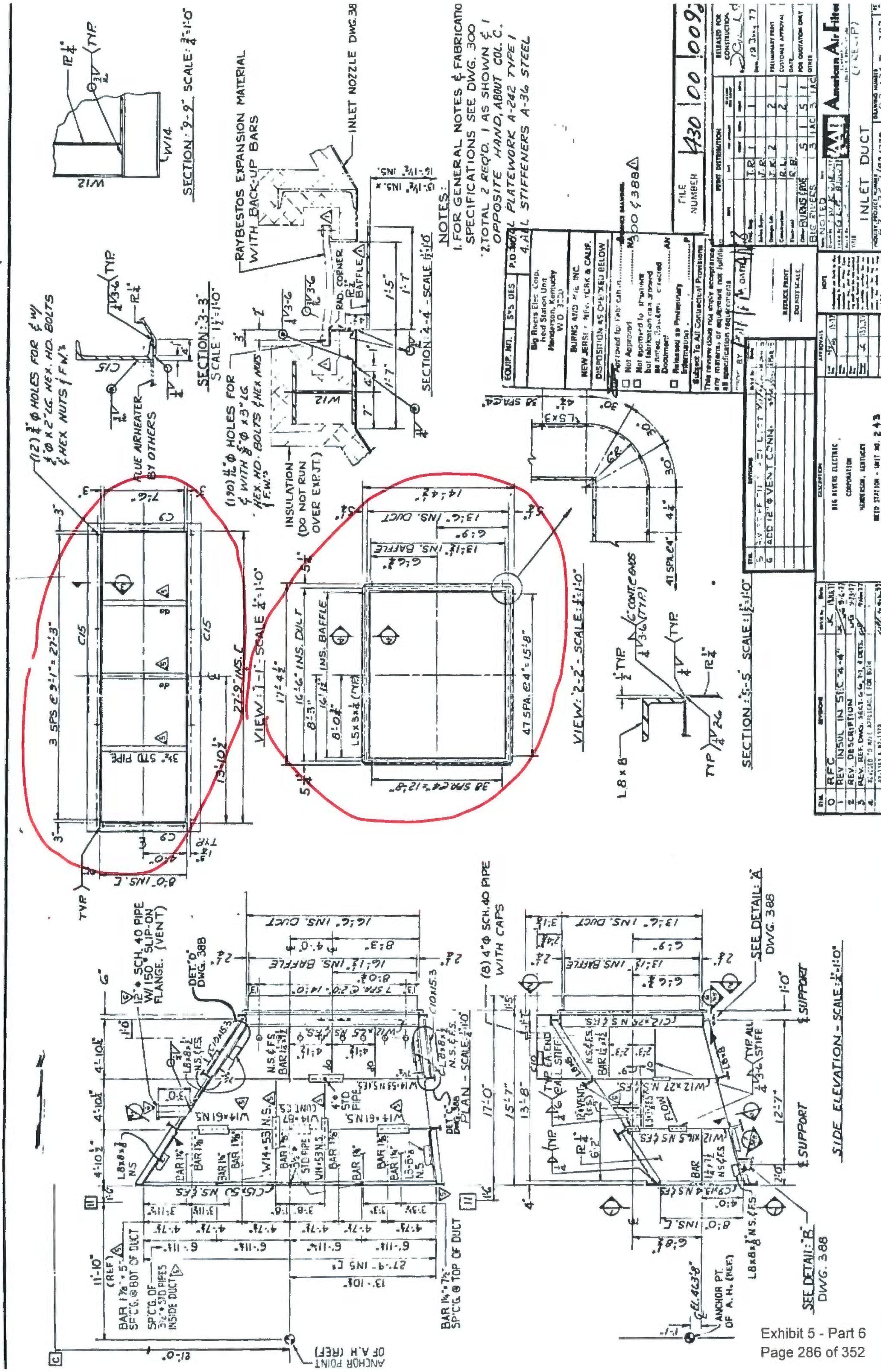
Exhibit 8, Part 6
Page 282 of 352


SECTION "15-15"
SCALE 1½" = 1'-0"
ACCESS DOOR
INSULATION & LAGGING
INNER DOOR
NOZZLE WALL
NOTES:
1. FOR GEN. NOTES & FAB. SPEC'S. SEE DWG. 300
2. 2'-0" X 3'-0" OPN'G. FOR ACCESS DOOR (DOOR NOT SHOWN FOR CLARITY)
3. NOZZLE SKIN PL ¼" A-242 TYPE I STL ALL OTHER STEEL TO BE A-36
4. TWO (2) NOZZLES REQ'D. ONE AS SHOWN FOR PRECIP. "B" & ONE OPPOSITE HAND FOR PRECIP. "A"
SEE NOTE "2" & DETAIL "B" ON DWG. 382
4" Φ PIPE W/CAP 1'-6" LG. (2 REQ'D PER NOZZLE)
HORIZ. MEMBERS SHALL HAVE FULL-STRENGTH CONNECTIONS TO VERT. MEMBERS (TYP.)
FRONT ELEVATION
℄ OPENING
℄ FAN
25'-6" OPENING
END ELEVATION
SIDE PANEL
(68) 1" Φ HOLES FOR ¾" Φ x 2½" LG. HEX. HD. BOLTS & HEX NUTS & F.W.'S
INSULATION & LAGGING
1" THICK PL @ ALL MITERS
FLANGE DETAIL "A" DWG 384
W.P. EL. 465'-3 1/16"
GRADE EL. 412'-0"
47'-2¼" INS. FLANGE
15 SPA. @ 3'-0" = 45'-0" (TYP.)
REFERENCE DRAWINGS 300, 382, 384, 385, 386
BIG RIVERS ELECTRIC CORPORATION
HENDERSON, KENTUCKY
REID STATION - UNIT NO. 2 & 3
American Air Filter
OUTLET NOZZLE
PRECIP.

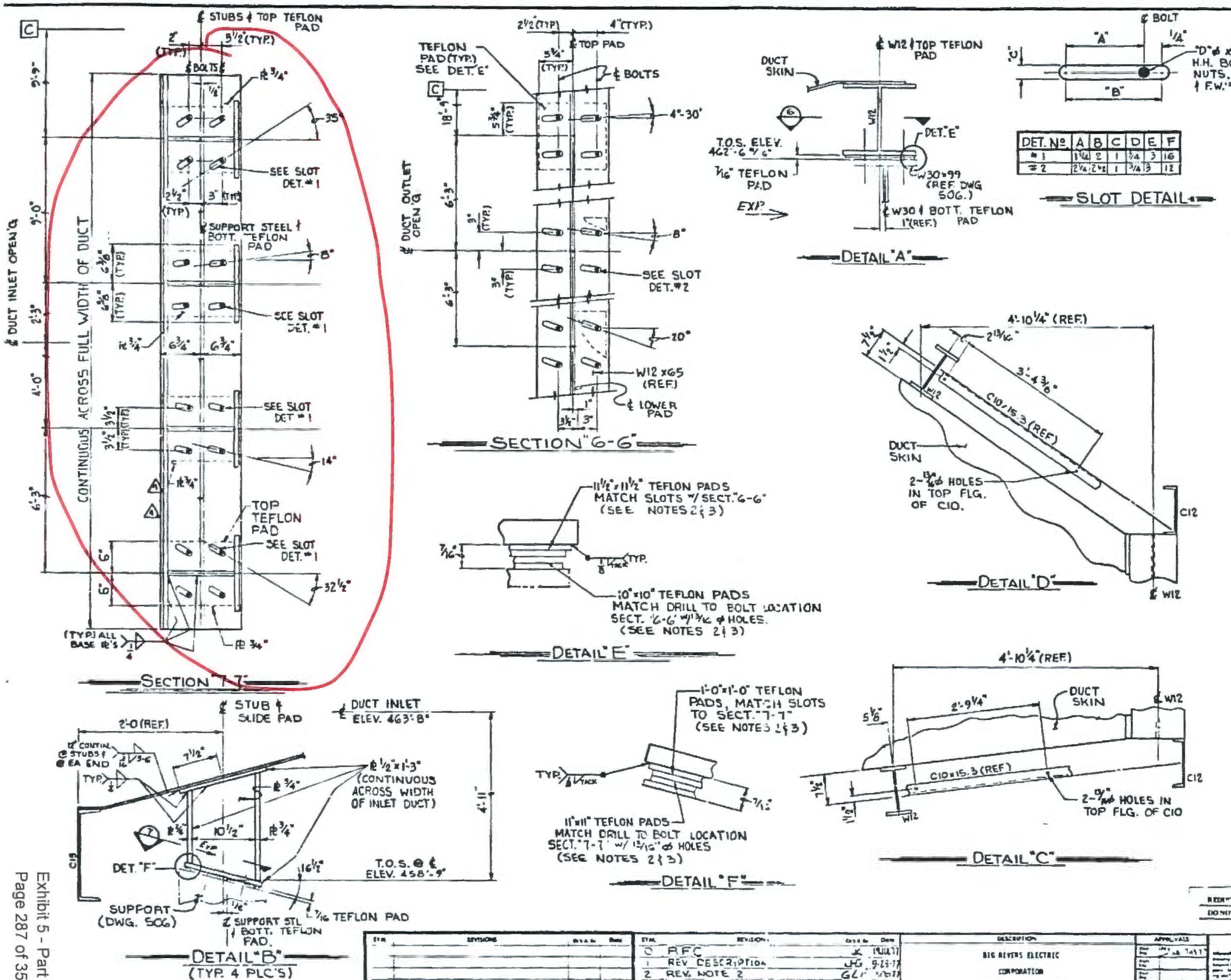

SECTION 9-9 SCALE 3/4"=1'-0"
FROM DWG. 383
SECTION 12-12 SCALE 3"=1'-0"
SECTION 11-11 SCALE 3"=1'-0"
SECTION 10-10 SCALE 3"=1'-0"
SECTION 13-13 SCALE 3/8"=1'-0"
FROM DWG. 383
SECTION 14-14 SCALE 3/8"=1'-0"
FROM DWG. 383
INTERIOR COLUMN
COPE FLG. TO CLEAR W8
FIELD SEALING PLATES 1/4"
SIDE PANEL
OPPOSITE HAND
SHOWN
INTERIOR COLUMN ON DWG. 331
NOTES:
1. FOR GEN. NOTES & FAB. SPEC'S. SEE DWG. 300
REFERENCE DRAWINGS
383, 384, 386
0 RFC
1 ADD FIELD WELDS
2 REV DESCRIPTION
BIG RIVERS ELECTRIC CORPORATION
HENDERSON, KENTUCKY
REID STATION - UNIT NO. 2 & 3
American Air Filter
(PRECIP)
OUTLET NOZZLE SECTIONS
82-1363/82-1379
82 1363-385
3



VIEW "16-16"
FROM DWG 383
SCALE 1/4" = 1'-0"
TOP OF FLG. ELEV. 444'-9"
(16) 1" φ HOLES
3/8" BAR FLG.
BAR 1 5/16" × 8" (TYP)
W12
W12 - 65
W10
BAR 1" × 6"
5 EQ SPA = 2'-9"
℄ BOLT
BAR 1" (LOCATION VARIES)
℄ NOZZLE OP'NG
TACK
℄ TEFLON PADS
NOTE: DETAIL ABOVE TYP 4 PLACES
SECTION "17-17"
SCALE 1/2" = 1'-0"
T.O. FLG ELEV. 444'-9"
NOZZLE SKIN
DETAIL "A"
ELEV. 437'-2 1/8"
T.O.S @ ℄ ELEV 434'-10"
SUPPORT ASS'Y DWG 509
DETAIL "A"
SCALE 1 1/2" = 1'-0"
TEFLON PADS
TACK 3 SIDES
SECTION "18-18"
(ROTATED 90°)
SCALE 1 1/2" = 1'-0"
TOP TEFLON PAD - 8" × 2'-10" w/ SLOTS AS SHOWN - SEE NOTES 2 & 3
(8) SLOTS FOR 7/8" φ × 3" LG. A-325 H.H. BOLTS w/ H NUTS & FW'S - SEE NOTE 4
BOTT TEFLON PAD - 11" × 3'-0" (DRILL 15/16" φ HOLES FOR 7/8" φ BOLTS) SEE NOTES 2 & 3
℄ BOLT (TYP)
SECTION "19-19"
FROM DWG 383
SCALE 1/4" = 1'-0"
℄ PANT LEGS
W6 × 8.5
L3 1/2 × 2 1/2 × 1/4
WP @ ℄ W6 & W10 (TYP)
NOZZLE SKIN
NOTES
1. FOR GEN NOTES & FAB SPEC'S SEE DWG. 300.
2. TEFLON PADS TO BE FLUOROCARBON FC-1010-CS 1/4 L (OR EQUAL)
3. TEFLON MATERIAL TO BE SAW OR SHEAR CUT. DO NOT BURN.
4. AT ERECTION, HAND TIGHTEN NUT (ALLOW SLIDING FIT) THEN TACK WELD NUT TO BOLT.
300, 383
RFC
ADD FIELD WELD
REV. DESCRIPTION
REV NOTE 2
BIG RIVERS ELECTRIC CORPORATION
HENDERSON, KENTUCKY
REID STATION - UNIT NO. 2 & 3
American Air Filter
OUTLET NOZZLE SECTIONS (PRECIP)
82-1363/821379
82-1363-386
04-430-00-0091



NOTES:
1. FOR GENERAL NOTES & FABRICATION SPECIFICATIONS SEE DWG. 300
2. TOTAL 2 REQ'D. 1 AS SHOWN & 1 OPPOSITE HAND, ABOUT COL. C.
3. PLATEWORK A-242 TYPE I
4. ALL STIFFENERS A-36 STEEL
RAYBESTOS EXPANSION MATERIAL WITH BACK-UP BARS
INLET NOZZLE DWG. 38
SECTION: 9-9 SCALE: 3/4"=1'-0"
SECTION: 3-3 SCALE 1 1/2"=1'-0"
SECTION 4-4 - SCALE 1/2"=1'-0"
VIEW: 1-1 - SCALE 1/4"=1'-0"
VIEW: 2-2 - SCALE: 1/4"=1'-0"
SECTION: 5-5 SCALE: 1 1/2"=1'-0"
PLAN - SCALE 1/4"=1'-0"
SIDE ELEVATION - SCALE: 1/4"=1'-0"
FLUE AIRHEATER BY OTHERS
INSULATION (DO NOT RUN OVER EXP. JT.)
ANCHOR POINT OF A.H. (REF)
BIG RIVERS ELECTRIC CORPORATION
HENDERSON, KENTUCKY
REID STATION - UNIT NO. 2 4 3
BURNS AND ROE INC.
INLET DUCT
American Air Filter



SLOT DETAIL

DET. Nº	A	B	C	D	E	F
#1	1¾	2	1	¾	3	16
#2	2¼	2½	1	¾	3	12

EQUIP. NO.	SYS. DES.	P.O. NO.

Big Rivers Elec. Corp.
Reid Station Unit
Henderson, Kentucky
W.O. 3280

BURNS AND ROE, INC.
NEW JERSEY, NEW YORK & CALIF.

DISPOSITION AS CHECKED BELOW
- ☐ Approved for Fabrication .... A
- ☐ Not Approved .... NA
- ☐ Not approved for shipment but fabrication can proceed as noted. Resubmit Corrected Document .... AN
- ☒ Released as Preliminary Information .... P

Subject To All Contractual Provisions
This review does not imply acceptance of any material or equipment not fulfilling all specification requirements
PROC. BY [illegible] DATE

NOTES:

1. FOR GEN. NOTES & FAB. SPEC'S, SEE DWG. 301
2. TEFLON PADS TO BE FLUOROCARBON FC-1010-CS¼L (OR EQUAL)
3. TEFLON MATERIAL TO BE SAW OR SHEAR CUT. DO NOT BURN
4. AT ERECTION- HAND TIGHTEN NUT (ALLOW SLIDING FIT) THEN TACK WELD NUT TO BOLT.
5. SECT.'S & DET.'S TAKEN FROM DWG. 386.

REFERENCE DRAWINGS 300, 506, 386

REDUCED PRINT DO NOT SCALE

SYM.	REVISION	Date
0	RFC	1 JUL 77
1	REV. DESCRIPTION	9-23-77
2	REV. NOTE 2	[illegible]
3	[illegible] 82-1363 & 82-1379	9 Aug 77
4	REV. SEC. "7-7" DET. "B"	[illegible]

BIG RIVERS ELECTRIC CORPORATION
HENDERSON, KENTUCKY
REID STATION - UNIT NO. 2 4 5

American Air Filter (FREGIR)
INLET DUCT DETAILS
82-1363/82-1379
82-1363-388

RELEASED FOR CONSTRUCTION
Date 16 June 77

Dry Sorbent Injection and Activated Carbon Injection Testing

Big Rivers Electric Corporation

Green, Wilson and Coleman Stations
Contract Number: 4346-010

Report Date
July 12th, 2013

Author: Mitch Lund

Table of Contents

Executive Summary

As part of PSC Order 2012-00063, Big Rivers Electric Corporation was required to conduct particulate tests on its 6 affected generating units while injecting activated carbon and hydrated lime for mercury removal.

This testing occurred during the months of March through June 2013. The successful results of these tests are summarized below:

TABLE E-1: AVERAGE RESULTS FROM GREEN, WILSON AND COLEMAN STATIONS

Unit	Number of Passing Paired Tests	Average FPM Result of Tests (lbs/MMBtu)	Average Hg Result of Tests (lb/TBtu)	Passed MATS Emission Limits for PM & Hg
Acceptable Limits		0.030	1.20	
Green 1	6	0.0029	0.92	Yes
Green 2	5	0.0029	1.09	Yes
Wilson	6	0.0153	0.50	Yes
Coleman 1	3	0.0247	0.93	Yes
Coleman 2	3	0.0217	0.83	Yes
Coleman 3	3	0.0143	0.98	Yes

Emission testing was performed by Clean Air Engineering and Airtech. Test methods used to determine compliance were USEPA Test Method 5 for Filterable Particulate Matter (FPM) and USEPA Test Method 30B for Mercury (Hg) Emissions.

Injection equipment was provided by Nol-Tec. Reagent suppliers were ADA-CS for activated carbon and Mississippi Lime for hydrated lime.

GREEN STATION: UNIT #1

Test Overview

Project Description

Objective: Big Rivers Electric Corporation (BREC) utilized dry sorbent injection (DSI) and activated carbon injection (ACI) technology to demonstrate simultaneous compliance for both mercury and particulate matter at Green 1. The stack level compliance limits for MATS are 1.2 lbs/TBtu for total Hg and 0.030 lbs/MMBtu for FPM.

Contracted Companies: Nol-Tec supplied injection related equipment and test system design. Mississippi Lime supplied calcium hydroxide (hydrated lime). ADA-Carbon Solutions supplied powdered activated carbon.

Monday, February 18th and Tuesday, February 19th

Baseline testing of mercury (Hg) and filterable particulate matter (FPM) were performed utilizing USEPA Method 30B and USEPA Method 5, respectively. A mercury CEMS installed in the stack was used to give a real time indication of mercury emission levels. A detailed account of these methods can be found in the section of the report labeled "Test Methods" beginning on page 49.

Results from these baseline tests are shown on the following page.

[illegible]

Date (2013)		Feb 19
Start Time (approx.)		06:53
Stop Time (approx.)		08:07
P[illegible]		
R_P	Unit Load (MW)	252
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780
[illegible]		
O_2	Oxygen (dry volume %)	8.4
CO_2	Carbon dioxide (dry volume %)	10.9
T_s	Sample temperature (°F)	120
B_w	Actual water vapor in gas (% by volume)	7.5
Gas Flow Rate		
Q_a	Volumetric flow rate, actual (acfm)	851,000
Q_{std}	Volumetric flow rate, dry standard (dscfm)	702,000
FPM Results		
C_{sd}	Particulate Concentration (lb/dscf)	2.92E-07
C_{sd}	Particulate Concentration (gr/dscf)	0.00204
C_{sd}	Particulate Concentration (mg/dscm)	4.67
$E_{lb/hr}$	Particulate Rate (lb/hr)	12.3
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.00477

a le G1-2 G ee tat o t 1
Me u Results - asel e

				e a e
Date (2013)		Feb 18	Feb 19	
Start Time (approx.)		10:02	07:16	
Stop Time (approx.)		11:02	08:16	
P o ess o to s				
R_P	nit Load (M)	252	252	**252**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	**9,780**
Gas o to s				
O_2	Oxygen (dry volume %)	8.5	8.4	**8.5**
T_s	Sample temperature (°F)	123	120	**121.5**
B_w	Actual water vapor in gas (% by volume)	12.8	11.8	**12.**
Q_{std}	Volumetric flow rate, dry standard (dscfm)		702,000	**702,000**
Me u Results - Mo e EP Met o 0				
C_{sw}	^{0} - Ele e tal Concentration (g/dscm)		2.37	**2. 7**
C_{sw}	^{2} - e Concentration (g/dscm)		0.29	**0.29**
C_{sw}	- e		10.9%	**10.9**
C_{sw}	^{t} - otal Concentration (g/dscm)	2.37	2.66	**2.52**
E_{Fd}	Rate - Fd-based (lb/TBtu)	2.44	2.71	**2.58**
E_{Rp}	Rate - Electrical Output-based (lb/ h)		0.0279	**0.0279**

Tuesday, March 26th- Thursday, March 28th

Simultaneous injection of lime and carbon was performed from March 26th through March 28th in order to demonstrate compliance of mercury and filterable particulate matter. Hydrated lime and powdered activated carbon were injected. Mississippi Lime supplied their FGT Hydrated Lime product and ADA-Carbon Solutions supplied ACS DEV 2012 BBB.

Hydrated Lime was injected using Nol-Tec's self erecting vertical silo and PAC was injected using Nol-Tec's stand alone bulk bag unloader. A more detailed description of the equipment and injection layout can be found in the "Equipment Description" section beginning on page 43.

Two (2) mercury samples and two (2) FPM samples were used for compliance confirmation on March 26th, March 27th, and March 28th. The results of these samples are shown on the following pages.

a le G1- G ee tat o t 1
FPM Results - 26 1

				e a e
Date (2013)		Mar 26	Mar 26	
Start Time (approx.)		12:40	14:32	
Stop Time (approx.)		14:16	15:40	
P o ess o to s				
R_P	nit Load (M)	231	231	**2 1**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	**9,780**
Gas o to s				
O_2	Oxygen (dry volume %)	7.6	7.7	**7.7**
CO_2	Carbon dioxide (dry volume %)	12.3	12.5	**12.4**
T_s	Sample temperature (°F)	119	118	**119**
B_w	Actual water vapor in gas (% by volume)	11.3	11.2	**11.**
Gas Flow Rate				
Q_a	Volumetric flow rate, actual (acfm)	848,100	845,300	**846,700**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	669,400	668,400	**668,900**
FPM Results				
C_{sd}	Particulate Concentration (gr/dscf)	0.00112	0.00078	**0.00095**
$E_{lb/hr}$	Particulate Rate (lb/hr)	6.42	4.46	**5.44**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.00245	0.00172	**0.00209**

□a□le G1-4□G□ee□ □tat□o□ □□t 1
FPM Results - □27□1□

				e a e
Date (2013)		Mar 27	Mar 27	
Start Time (approx.)		08:48	14:32	
Stop Time (approx.)		09:55	15:40	
P o ess o to s				
R_P	□nit Load (M□)	231	230	**2 1**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	**9,780**
Gas o to s				
O_2	Oxygen (dry volume %)	7.6	7.6	**7.6**
CO_2	Carbon dioxide (dry volume %)	12.5	12.3	**12.4**
T_s	Sample temperature (°F)	118	118	**118**
B_w	Actual water vapor in gas (% by volume)	11.1	11.1	**11.1**
Gas Flow Rate				
Q_a	Volumetric flow rate, actual (acfm)	848,900	855,400	**852,200**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	672,100	676,900	**674,500**
FPM Results				
C_{sd}	Particulate Concentration (gr/dscf)	0.00119	0.00117	**0.00118**
$E_{lb/hr}$	Particulate Rate (lb/hr)	6.85	6.81	**6.8**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.00261	0.00258	**0.00260**

□a□le G1-5□G□ee□ □tat□o□ □□t 1
FPM Results - □28□1□

				e a e
Date (2013)		Mar 28	Mar 28	
Start Time (approx.)		07:14	08:39	
Stop Time (approx.)		08:21	09:47	
P o ess o ' to s				
R_P	□nit Load (M□)	230	230	**2 0**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	**9,780**
Gas o to s				
O_2	Oxygen (dry volume %)	7.8	7.8	**7.8**
CO_2	Carbon dioxide (dry volume %)	12.2	12.2	**12.2**
T_s	Sample temperature (°F)	119	119	**119**
B_w	Actual water vapor in gas (% by volume)	11.3	11.6	**11.5**
Gas Flow Rate				
Q_a	Volumetric flow rate, actual (acfm)	856,200	855,100	**855,700**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	675,800	672,300	**674,100**
FPM Results				
C_{sd}	Particulate Concentration (gr/dscf)	0.00196	0.00172	**0.00184**
$E_{lb/hr}$	Particulate Rate (lb/hr)	11.4	9.91	**10.7**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.00435	0.00383	**0.00409**

a le G1-6 G ee tat o t 1
Me u Results - 26 1

				e a e
Date (2013)		Mar 26	Mar 26	
Start Time (approx.)		12:40	14:32	
Stop Time (approx.)		13:46	15:32	
	PAC Type	BBB	BBB	
P o ess o to s				
R_P	nit Load (M)	231	231	**2 1**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	**9,780**
Gas o to s				
O_2	Oxygen (dry volume %)	7.5	7.7	**7.6**
T_s	Sample temperature (°F)	119	118	**119**
B_w	Actual water vapor in gas (% by volume)	10.4	10.9	**10.7**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	669,400	668,400	**669,000**
Me u Results - EP Met o 0				
C_{sw}	t - otal Concentration (g/dscm)	1.03	0.717	**0.874**
E_{Fd}	Rate - Fd-based (lb/TBtu)	0.988	0.693	**0.841**
E_{Rp}	Rate - Electrical Output-based (lb/ h)	0.0112	0.0078	**0.0095**

□a□le G1-7□G□ee□ □tat□o□ □□t 1
Me□□u□□ Results - □27 1□

				e a e
Date (2013)		Mar 27	Mar 27	
Start Time (approx.)		08:48	10:34	
Stop Time (approx.)		09:55	11:41	
	PAC Type	BBB	BBB	
P o ess o tio s				
R_P	nit Load (M)	231	230	**2 1**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	**9,780**
Gas o tio s				
O_2	Oxygen (dry volume %)	7.6	7.6	**7.6**
T_s	Sample temperature (°F)	118	118	**118**
B_w	Actual water vapor in gas (% by volume)	9.5	10.2	**9.9**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	672,100	676,900	**675,000**
Me u Results - EP Met o 0				
C_{sw}	t - otal Concentration (g/dscm)	0.975	0.977	**0.976**
E_{Fd}	Rate - Fd-based (lb/TBtu)	0.935	0.938	**0.9 7**
E_{Rp}	Rate - Electrical Output-based (lb/ h)	0.0106	0.0108	**0.0107**

a le G1-8 G ee tat o t 1
Me u Results - 28 1

				e a e
Date (2013)		Mar 28	Mar 28	
Start Time (approx.)		07:14	08:39	
Stop Time (approx.)		08:14	09:39	
	PAC Type	BBB	BBB	
P o ess o to s				
R_P	Init Load (M)	230	230	**2 0**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	**9,780**
Gas o to s				
O_2	Oxygen (dry volume %)	7.8	7.8	**7.8**
T_s	Sample temperature (°F)	119	119	**119**
B_w	Actual water vapor in gas (% by volume)	11.3	11.6	**11.5**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	675,800	672,300	**674,000**
Me u Results - EP Met o 0				
C_{sw}	t - otal Concentration (g/dscm)	1.11	0.890	**1.00**
E_{Fd}	Rate - Fd-based (lb/TBtu)	1.08	0.865	**0.97**
E_{Rp}	Rate - Electrical Output-based (lb/ h)	0.0122	0.0097	**0.0110**

GREEN STATION: UNIT #2

Test Overview

Project Description

Objective: Big Rivers Electric Corporation (BREC) utilized dry sorbent injection (DSI) and activated carbon injection (ACI) technology to demonstrate simultaneous compliance for both mercury and particulate matter at Green 2. The stack level compliance limits for MATS are 1.2 lbs/TBtu for total Hg and 0.030 lbs/MMBtu for FPM.

Contracted Companies: Nol-Tec supplied injection related equipment and test system design. Mississippi Lime supplied calcium hydroxide (hydrated lime). ADA-Carbon Solutions supplied powdered activated carbon.

Tuesday, March 5th and Monday, March 18th

Baseline testing of mercury (Hg) and filterable particulate matter (FPM) were performed utilizing USEPA Method 30B and USEPA Method 5, respectively. A mercury CEMS installed in the stack was used to give a real time indication of mercury levels. A detailed account of these methods can be found in the section of the report labeled "Test Methods" beginning on page 49.

Results from these baseline tests are shown on the following page.

Table G2-1 Green Station Unit 2
FPM Results - Baseline

Date (2013)		Mar 18
Start Time (approx.)		14:53
Stop Time (approx.)		16:02
Process Notes		
R_P	Unit Load (MW)	241
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780
Gas Notes		
O_2	Oxygen (dry volume %)	8.0
CO_2	Carbon dioxide (dry volume %)	11.2
T_s	Sample temperature (°F)	124
B_w	Actual water vapor in gas (% by volume)	10.7
Gas Flow Rate		
Q_a	Volumetric flow rate, actual (acfm)	851,000
Q_{std}	Volumetric flow rate, dry standard (dscfm)	667,000
FPM Results		
C_{sd}	Particulate Concentration (lb/dscf)	2.28E-07
C_{sd}	Particulate Concentration (gr/dscf)	0.00160
C_{sd}	Particulate Concentration (mg/dscm)	3.66
$E_{lb/hr}$	Particulate Rate (lb/hr)	9.14
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.00362

Table G2-2 Generation Station Unit 2
Method Results - Baseline

					e a e
Date (2013)		Mar 5	Mar 18	Mar 18	
Start Time (approx.)		07:48	10:46	13:43	
Stop Time (approx.)		08:18	11:16	14:43	
Process Conditions					
R_P	Unit Load (M)	238	241	241	**240**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	**9,780**
Gas Conditions					
O_2	Oxygen (dry volume %)	8.4	8.0	8.0	**8.1**
T_s	Sample temperature (°F)	120	125	124	**12**
B_w	Actual water vapor in gas (% by volume)	10.7	10.7	10.7	**10.7**
Q_{std}	Volumetric flow rate, dry standard (dscfm)		667,000	667,000	**667,000**
Method Results - Mode EP Method 0					
C_{sw}	- Elemental Concentration (g/dscm)	2.60	2.68	3.25	**2.84**
C_{sw}	- e Concentration (g/dscm)	0.043	0.035	0.104	**0.061**
C_{sw}	- e	0.0%	0.0%	3.1%	**1.0**
C_{sw}	- otal Concentration (g/dscm)	2.60	2.68	3.36	**2.88**
E_{Fd}	Rate - Fd-based (lb/TBtu)	2.66	2.65	3.32	**2.87**
E_{Rp}	Rate - Electrical Output-based (lb/ h)		0.0277	0.0348	**0.0 1**

Wednesday, March 20th and Thursday, March 21st

Simultaneous injection of lime and carbon was performed on March 20th and March 21st in order to demonstrate compliance of mercury and filterable particulate matter. Hydrated lime and powdered activated carbon were injected. Mississippi Lime supplied their FGT Hydrated Lime product and ADA-Carbon Solutions supplied ACS DEV 2012 BBB.

Hydrated Lime was injected using Nol-Tec's self erecting vertical silo and PAC was injected using Nol-Tec's stand alone bulk bag unloader. A more detailed description of the equipment and injection layout can be found in the "Equipment Description" section beginning on page 43.

A total of ten (10) samples (i.e. 5 mercury and 5 FPM) were used to demonstrate compliance at Green 2. The results of these samples are shown on the following pages.

a le G2- G ee tat o t 2
FPM Results - 20 1

					e a e
Date (2013)		Mar 20	Mar 20	Mar 20	
Start Time (approx.)		11:37	13:10	14:31	
Stop Time (approx.)		12:50	14:15	15:41	
P o ess o to s					
R_P	Production Rate (M)	241	241	241	**241**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	**9,780**
Gas o to s					
O_2	Oxygen (dry volume %)	7.8	8.9	8.0	**8.2**
CO_2	Carbon dioxide (dry volume %)	11.5	10.4	11.5	**11.1**
T_s	Sample temperature (°F)	123	123	124	**12**
B_w	Actual water vapor in gas (% by volume)	11.3	11.7	11.2	**11.4**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	846,000	848,000	846,000	**847,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	668,000	667,000	667,000	**667,000**
FPM Results					
C_{sd}	Particulate Concentration (lb/dscf)	1.58E-07	2.37E-07	1.91E-07	**1.96E-07**
C_{sd}	Particulate Concentration (gr/dscf)	0.0011	0.0017	0.0013	**0.0014**
C_{sd}	Particulate Concentration (mg/dscm)	2.54	3.79	3.07	**.1**
$E_{lb/hr}$	Particulate Rate (lb/hr)	6.35	9.47	7.67	**7.8**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.0025	0.0040	0.0030	**0.00 2**

Table G2-4 Generation Unit 2
FPM Results - 2111

				Average
Date (2013)		Mar 21	Mar 21	
Start Time (approx.)		13:13	16:23	
Stop Time (approx.)		14:23	17:29	
Process Notes				
R_P	Production Rate (MW)	241	241	**241**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	**9,780**
Gas Notes				
O_2	Oxygen (dry volume %)	7.6	7.6	**7.6**
CO_2	Carbon dioxide (dry volume %)	11.3	11.5	**11.4**
T_s	Sample temperature (°F)	124	122	**123**
B_w	Actual water vapor in gas (% by volume)	11.3	11.5	**11.4**
Gas Flow Rate				
Q_a	Volumetric flow rate, actual (acfm)	848,000	844,000	**846,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	666,000	668,000	**667,000**
FPM Results				
C_{sd}	Particulate Concentration (lb/dscf)	1.33E-07	1.88E-07	**1.61E-07**
C_{sd}	Particulate Concentration (gr/dscf)	0.00093	0.0013	**0.0011**
C_{sd}	Particulate Concentration (mg/dscm)	2.14	3.02	**2.58**
$E_{lb/hr}$	Particulate Rate (lb/hr)	5.34	7.55	**6.44**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.0021	0.0029	**0.0025**

Table G2-5. Green Station Unit 2
Mercury Results - (2013)

					Average
Date (2013)		Mar 20	Mar 20	Mar 20	
Start Time (approx.)		11:29	12:54	14:21	
Stop Time (approx.)		12:29	13:54	15:21	
	PAC Type	BBB	BBB	BBB	
Process Conditions					
R_P	Unit Load (MW)	241	241	241	**241**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	**9,780**
Gas Conditions					
O_2	Oxygen (dry volume %)	7.8	8.9	8.0	**8.2**
T_s	Sample temperature (°F)	121	122	122	**122**
B_w	Actual water vapor in gas (% by volume)	11.30	11.70	11.20	**11.4**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	668,000	667,000	667,000	**667,000**
Mercury Results - Modified EPA Method [illegible]0					
C_{sw}	Hg^{0} - Elemental Concentration (µg/dscm)	1.13	1.11	1.10	**1.11**
C_{sw}	Hg^{+2} - Oxidized Concentration (µg/dscm)	0.043	0.042	0.042	**0.042**
C_{sw}	[illegible]	0.0%	0.0%	0.0%	**0.0**
C_{sw}	Hg^{T} - Total Concentration (µg/dscm)	1.13	1.11	1.10	**1.11**
E_{Fd}	Rate - Fd-based (lb/TBtu)	1.10	1.18	1.09	**1.12**
E_{Rp}	Rate - Electrical Output-based (lb/MWh)	0.0117	0.0115	0.0114	**0.0115**

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Me u Results - 21 1

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Date (2013)		Mar 21	Mar 21	
Start Time (approx.)		13:04	16:02	
Stop Time (approx.)		14:04	17:02	
	PAC Type	BBB	BBB	
P o ess o to s				
R_P	nit Load (M)	241	241	**241**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	**9,780**
Gas o to s				
O_2	Oxygen (dry volume %)	7.6	7.6	**7.6**
T_s	Sample temperature (°F)	124	121	**122**
B_w	Actual water vapor in gas (% by volume)	11.3	11.5	**11.4**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	666,000	668,000	**667,000**
Me u Results - Mo e EP Met o 0				
C_{sw}	^{0} - Ele e tal Concentration (g/dscm)	1.20	0.984	**1.09**
C_{sw}	^{12} - e Concentration (g/dscm)	0.042	0.042	**0.042**
C_{sw}	- e	0.0%	0.0%	**0.0**
C_{sw}	^{t} - otal Concentration (g/dscm)	1.20	0.984	**1.09**
E_{Fd}	Rate - Fd-based (lb/TBtu)	1.16	0.944	**1.05**
E_{Rp}	Rate - Electrical Output-based (lb/ h)	0.0125	0.0102	**0.011**

WILSON GENERATING STATION

Test Overview

Project Description

Objective: Big Rivers Electric Corporation (BREC) utilized dry sorbent injection (DSI) and activated carbon injection (ACI) technology to demonstrate simultaneous compliance for both mercury and particulate matter at Wilson Station. The stack level compliance limits for MATS are 1.2 lbs/TBtu for total Hg and 0.030 lbs/MMBtu for FPM.

Contracted Companies: Nol-Tec supplied injection related equipment and test system design. Mississippi Lime supplied calcium hydroxide (hydrated lime). ADA-Carbon Solutions supplied powdered activated carbon.

Wednesday, April 3rd and Friday, April 12th

Baseline testing of mercury (Hg) and filterable particulate matter (FPM) were performed utilizing USEPA Method 30B and USEPA Method 5 , respectively. A mercury CEMS installed in the stack was used to give a real time indication of mercury levels. A detailed account of these methods can be found in the section of the report labeled "Test Methods" beginning on page 49.

Results from these baseline tests are shown on the following page.

Table 5-1 Isokinetic Test 1
FPM Results - Baseline

Date (2013)		Apr 12
Start Time (approx.)		15:17
Stop Time (approx.)		16:23
Process Data		
R_P	Unit Load (MW)	443
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780
Gas Data		
O_2	Oxygen (dry volume %)	8.0
CO_2	Carbon dioxide (dry volume %)	11.4
T_s	Sample temperature (°F)	125
B_w	Actual water vapor in gas (% by volume)	13.8
Gas Flow Rate		
Q_a	Volumetric flow rate, actual (acfm)	1,680,000
Q_{std}	Volumetric flow rate, dry standard (dscfm)	1,250,000
FPM Results		
C_{sd}	Particulate Concentration (lb/dscf)	1.34E-06
C_{sd}	Particulate Concentration (gr/dscf)	0.0094
C_{sd}	Particulate Concentration (mg/dscm)	21.4
$E_{lb/hr}$	Particulate Rate (lb/hr)	100
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.0212

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Me u Results - asel e

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Date (2013)		Apr 3	Apr 3	
Start Time (approx.)		15:07	16:25	
Stop Time (approx.)		16:07	17:25	
P o ess o to s				
R_P	nit Load (M)	444	442	**44**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	**9,780**
Gas o to s				
O_2	Oxygen (dry volume %)	8.2	8.4	**8.**
T_s	Sample temperature (°F)	124	125	**125**
B_w	Actual water vapor in gas (% by volume)	13.2	13.6	**1 .4**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	1,230,000	1,210,000	**1,220,000**
Me u Results - Mo e EP Met o 0				
C_{sw}	^{0}- Ele e tal Concentration (g/dscm)	0.182	0.206	**0.194**
C_{sw}	^{2}- e Concentration (g/dscm)	0.324	0.301	**0. 1**
C_{sw}	- e	64.0%	59.5%	**61.7**
C_{sw}	^{t}- otal Concentration (g/dscm)	0.505	0.501	**0.50**
E_{Fd}	Rate - Fd-based (lb/TBtu)	0.507	0.511	**0.509**
E_{Rp}	Rate - Electrical Output-based (lb/ h)	0.0093	0.0091	**0.0092**

Saturday, April 13th and Sunday, April 14th

Simultaneous injection of lime and carbon was performed on April 13th and April 14th in order to demonstrate compliance of mercury and filterable particulate matter. Hydrated lime and activated carbon were injected. Mississippi Lime supplied their FGT Hydrated Lime product and ADA-Carbon Solutions supplied ACS DEV 2012 BBB.

Hydrated Lime was injected using Wilson Station's existing hydrated lime injection system and PAC was injected using Nol-Tec's dual bulk bag unloader. A more detailed description of the equipment and injection layout can be found in the "Equipment Description" section beginning on page 43.

Three (3) Method 30B and three (3) Method 5 tests were used on both days to demonstrate compliance with MATS emission limitations. The results of these samples are shown on the following pages.

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FPM Results - 4[illegible]1[illegible]1[illegible]

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Date (2013)		Apr 13	Apr 13	Apr 13	
Start Time (approx.)		08:07	11:16	15:05	
Stop Time (approx.)		10:16	13:32	17:13	
P[illegible]o[illegible]ess [illegible]o[illegible] [illegible]t[illegible]o[illegible]s					
R_P	[illegible]nit Load (M[illegible])	445	445	445	**445**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	**9,780**
Gas [illegible]o[illegible] [illegible]t[illegible]o[illegible]s					
O_2	Oxygen (dry volume %)	8.2	8.7	8.1	**8.[illegible]**
CO_2	Carbon dioxide (dry volume %)	11.2	10.6	11.4	**11.1**
T_s	Sample temperature (°F)	124	124	125	**125**
B_w	Actual water vapor in gas (% by volume)	13.1	13.3	13.5	**1[illegible]**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	1,670,000	1,660,000	1,670,000	**1,670,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	1,260,000	1,260,000	1,260,000	**1,260,000**
FPM Results					
C_{sd}	Particulate Concentration (lb/dscf)	5.75E-07	7.54E-07	1.39E-06	**9.05E-07**
C_{sd}	Particulate Concentration (gr/dscf)	0.00402	0.00528	0.00970	**0.006[illegible]**
C_{sd}	Particulate Concentration (mg/dscm)	9.20	12.1	22.2	**14.5**
$E_{lb/hr}$	Particulate Rate (lb/hr)	43.6	57.0	105	**68.4**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.00925	0.0126	0.0221	**0.0147**

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FPM Results - 4 14 1

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Date (2013)		Apr 14	Apr 14	Apr 14	
Start Time (approx.)		07:17	10:23	14:48	
Stop Time (approx.)		09:24	12:54	17:00	
P o ess o to s					
R_P	nit Load (M)	445	445	445	**445**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	**9,780**
Gas o to s					
O_2	Oxygen (dry volume %)	8.1	8.2	8.3	**8.2**
CO_2	Carbon dioxide (dry volume %)	11.1	10.9	11.2	**11.1**
T_s	Sample temperature (°F)	126	126	126	**126**
B_w	Actual water vapor in gas (% by volume)	13.3	13.8	14.1	**1 .7**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	1,660,000	1,640,000	1,660,000	**1,650,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	1,250,000	1,220,000	1,230,000	**1,2 0,000**
FPM Results					
C_{sd}	Particulate Concentration (lb/dscf)	9.91E-07	1.34E-06	6.52E-07	**9.96E-07**
C_{sd}	Particulate Concentration (gr/dscf)	0.00694	0.00940	0.00456	**0.00697**
C_{sd}	Particulate Concentration (mg/dscm)	15.9	21.5	10.4	**15.9**
$E_{lb/hr}$	Particulate Rate (lb/hr)	74.1	98.7	48.2	**7 .7**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.0158	0.0216	0.0106	**0.0160**

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Me u Results - 4 1 1

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Date (2013)		Apr 13	Apr 13	Apr 13	
Start Time (approx.)		08:43	11:54	15:38	
Stop Time (approx.)		11:16	13:55	17:38	
	PAC Type	BBB	BBB	BBB	
P o ess o to s					
R_P	Init Load (M)	445	445	445	**445**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	**9,780**
Gas o to s					
O_2	Oxygen (dry volume %)	8.2	8.7	8.1	**8.**
T_s	Sample temperature (°F)	130	129	129	**129**
B_w	Actual water vapor in gas (% by volume)	13.1	13.3	13.5	**1**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	1,260,000	1,260,000	1,260,000	**1,260,000**
Me u Results - Mo e EP Met o 0					
C_{sw}	^{0} - Ele e tal Concentration (g/dscm)	0.165	0.184	0.160	**0.170**
C_{sw}	^{12} - e Concentration (g/dscm)	0.234	0.283	0.346	**0.288**
C_{sw}	- e	58.6%	60.6%	68.5%	**62.6**
C_{sw}	^{t} - otal Concentration (g/dscm)	0.399	0.467	0.506	**0.457**
E_{Fd}	Rate - Fd-based (lb/TBtu)	0.401	0.488	0.504	**0.465**
E_{Rp}	Rate - Electrical Output-based (lb/ h)	0.00423	0.00495	0.00536	**0.00485**

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Me u Results - 4 14 1

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Date (2013)		Apr 14	Apr 14	Apr 14	
Start Time (approx.)		07:50	10:21	15:23	
Stop Time (approx.)		09:51	12:21	17:23	
	PAC Type	BBB	BBB	BBB	
P o ess o to s					
R_P	nit Load (M)	445	445	445	**445**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	**9,780**
Gas o to s					
O_2	Oxygen (dry volume %)	8.1	8.2	8.0	**8.1**
T_s	Sample temperature (°F)	134	132	129	**1 2**
B_w	Actual water vapor in gas (% by volume)	13.3	13.8	13.8	**1 .6**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	1,250,000	1,220,000	1,250,000	**1,240,000**
Me u Results - Mo e EP Met o 0					
C_{sw}	^{0} - Ele e tal Concentration (g/dscm)	0.155	0.247	0.135	**0.179**
C_{sw}	^{2} - e Concentration (g/dscm)	0.339	0.349	0.364	**0. 51**
C_{sw}	- e	68.7%	58.5%	73.0%	**66.7**
C_{sw}	^{t} - otal Concentration (g/dscm)	0.494	0.596	0.499	**0.5 0**
E_{Fd}	Rate - Fd-based (lb/TBtu)	0.492	0.599	0.494	**0.528**
E_{Rp}	Rate - Electrical Output-based (lb/ h)	0.00519	0.00612	0.00525	**0.00552**

Coleman Generating Station

Test Overview

Project Description

Objective: Big Rivers Electric Corporation (BREC) utilized dry sorbent injection (DSI) and activated carbon injection (ACI) technology to demonstrate simultaneous compliance for both mercury and particulate matter at Coleman 1, Coleman 2 and Coleman 3. The stack level compliance limits for MATS are 1.2 lbs/TBtu for total Hg and 0.030 lbs/MMBtu for FPM.

Contracted Companies: Nol-Tec supplied injection related equipment and test system design. Mississippi Lime supplied calcium hydroxide (hydrated lime). ADA-Carbon Solutions supplied powdered activated carbon.

Baseline filterable particulate matter and baseline mercury stack runs were not performed.

Monday, April 29th, Friday, May 31st, Saturday, June 8th and Monday, June 10th, 2013

Simultaneous injection of lime and carbon was performed in order to demonstrate compliance of mercury and filterable particulate matter. Hydrated lime and activated carbon were injected. Mississippi Lime supplied their HR Hydrate product and ADA-Carbon Solutions supplied ACS DEV 2012 BBB. Each of the three units were isolated at the common stack during testing; Unit 3 testing was performed on 4/29, Unit 1 testing was performed on 5/31 and Unit 2 testing was performed on 6/8 and 6/10.

Hydrated Lime was injected using Nol-Tec System's self erecting vertical silo and PAC was injected using Nol-Tec's dual bulk bag unloader. A more detailed description of the equipment and injection layout can be found in the "Equipment Description" section beginning on page 43.

Three (3) paired Method 30B and Method 5 traps were obtained to demonstrate compliance at each isolated unit. The results of these samples are shown on the following pages.

Table 5-1 Boiler Station Unit 1
FPM Results - 5/31/13

Date (2013)		May 31	May 31	May 31	
Start Time (approx.)		09:18	16:04	19:15	
Stop Time (approx.)		10:39	17:25	20:35	
Process Conditions					
R_P	Unit Load (MW)	163	163	163	**163**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	**9,780**
Gas Conditions					
O_2	Oxygen (dry volume %)	8.5	8.2	8.9	**8.5**
CO_2	Carbon dioxide (dry volume %)	10.4	10.9	10.1	**10.5**
T_s	Sample temperature (°F)	130	131	131	**131**
B_w	Actual water vapor in gas (% by volume)	15.6	16.0	15.9	**15.8**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	579,000	584,000	590,000	**584,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	426,000	427,000	432,000	**428,000**
FPM Results					
C_{sd}	Particulate Concentration (lb/dscf)	1.64E-06	1.35E-06	1.49E-06	**1.49E-06**
C_{sd}	Particulate Concentration (gr/dscf)	0.0114	0.00948	0.0104	**0.01045**
C_{sd}	Particulate Concentration (mg/dscm)	26.2	21.7	23.9	**24.9**
$E_{lb/hr}$	Particulate Rate (lb/hr)	41.8	34.7	38.6	**38.4**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.0270	0.0218	0.0254	**0.0247**

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FPM Results □6□8□1□

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Date (2013)		un 8	un 8	
Start Time (approx.)		16:18	20:25	
Stop Time (approx.)		17:28	21:36	
P o ess o to s				
R_P	nit Load (M)	160	160	**160**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	**9,780**
Gas o to s				
O_2	Oxygen (dry volume %)	8.2	7.7	**8.0**
CO_2	Carbon dioxide (dry volume %)	10.9	11.3	**11.1**
T_s	Sample temperature (°F)	129	129	**129**
B_w	Actual water vapor in gas (% by volume)	14.5	14.2	**14.**
Gas Flow Rate				
Q_a	Volumetric flow rate, actual (acfm)	567,000	583,000	**575,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	424,000	434,000	**429,000**
FPM Results				
C_{sd}	Particulate Concentration (lb/dscf)	1.51E-06	1.87E-06	**1.69E-06**
C_{sd}	Particulate Concentration (gr/dscf)	0.0106	0.0131	**0.0118**
C_{sd}	Particulate Concentration (mg/dscm)	24.2	29.9	**27.0**
$E_{lb/hr}$	Particulate Rate (lb/hr)	38.5	48.6	**4 .6**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.0243	0.0289	**0.0266**

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Date (2013)		un 10
Start Time (approx.)		14:47
Stop Time (approx.)		15:02
P o ess o to s		
R_P	)nit Load (M)	159
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780
Gas o to s		
O_2	Oxygen (dry volume %)	7.8
CO_2	Carbon dioxide (dry volume %)	10.9
T_s	Sample temperature (°F)	130
B_w	Actual water vapor in gas (% by volume)	15.3
Gas Flow Rate		
Q_a	Volumetric flow rate, actual (acfm)	571,000
Q_{std}	Volumetric flow rate, dry standard (dscfm)	419,000
FPM Results		
C_{sd}	Particulate Concentration (lb/dscf)	7.61E-07
C_{sd}	Particulate Concentration (gr/dscf)	0.00533
C_{sd}	Particulate Concentration (mg/dscm)	12.2
$E_{lb/hr}$	Particulate Rate (lb/hr)	19.1
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.0119

Table 4-Sample Location and Test Data
FPM Results 4/29/13

					Average
Date (2013)		Apr 29	Apr 29	Apr 29	
Start Time (approx.)		12:44	15:34	17:45	
Stop Time (approx.)		14:00	16:55	19:01	
Process Conditions					
R_P	Unit Load (MW)	165	165	156	**162**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	**9,780**
Gas Conditions					
O_2	Oxygen (dry volume %)	7.9	8.2	7.9	**8.0**
CO_2	Carbon dioxide (dry volume %)	11.2	10.9	11.3	**11.1**
T_s	Sample temperature (°F)	126	126	126	**126**
B_w	Actual water vapor in gas (% by volume)	13.1	13.3	13.7	**13.4**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	540,000	539,000	515,000	**531,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	415,000	414,000	394,000	**408,000**
FPM Results					
C_{sd}	Particulate Concentration (lb/dscf)	8.10E-07	8.69E-07	1.04E-06	**9.06E-07**
C_{sd}	Particulate Concentration (gr/dscf)	0.00567	0.00608	0.00726	**0.00634**
C_{sd}	Particulate Concentration (mg/dscm)	13.0	13.9	16.6	**14.5**
$E_{lb/hr}$	Particulate Rate (lb/hr)	20.2	21.6	24.5	**22.1**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.0127	0.0140	0.0163	**0.014**

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Date (2013)		May 31	May 31	May 31	
Start Time (approx.)		09:18	16:04	19:15	
Stop Time (approx.)		10:18	17:04	20:15	
	PAC Type	BBB	BBB	BBB	
P o ess o tto s					
R_P	nit Load (M)	163	163	163	**16**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	**9,780**
Gas o tto s					
O_2	Oxygen (dry volume %)	8.5	8.2	8.9	**8.5**
T_s	Sample temperature (°F)	130	131	131	**1 1**
B_w	Actual water vapor in gas (% by volume)	15.5	14.5	15.8	**15.**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	426,000	433,000	432,000	**4 0, 00**
Me u Results - Mo e EP Met o 0					
C_{sw}	- Ele e tal Concentration (g/dscm)	0.748	0.832	0.628	**0.7 6**
C_{sw}	- e Concentration (g/dscm)	0.154	0.163	0.168	**0.162**
C_{sw}	- e	17.1%	16.4%	21.1%	**18.2**
C_{sw}	- otal Concentration (g/dscm)	0.903	0.995	0.796	**0.898**
E_{Fd}	Rate - Fd-based (lb/TBtu)	0.929	1.00	0.846	**0.925**
E_{Rp}	Rate - Electrical Output-based (lb/ h)	0.00883	0.00990	0.00790	**0.00888**

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Date (2013)		un 8	un 8	
Start Time (approx.)		16:35	20:43	
Stop Time (approx.)		17:35	21:43	
P o ess o tio s				
R_P	nit Load (M)	160	152	**156**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	**9,780**
Gas o tio s				
O_2	Oxygen (dry volume %)	8.2	7.7	**8.0**
T_s	Sample temperature (°F)	133	133	**1**
B_w	Actual water vapor in gas (% by volume)	14.6	15.0	**14.8**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	400,000	400,000	**400,000**
Me u Results - Mo e EP Met o 0				
C_{sw}	- Ele e tal Concentration (g/dscm)	0.475	0.618	**0.546**
C_{sw}	- e Concentration (g/dscm)	0.217	0.228	**0.222**
C_{sw}	- e	31.3%	26.9%	**29.1**
C_{sw}	- otal Concentration (g/dscm)	0.692	0.846	**0.769**
E_{Fd}	Rate - Fd-based (lb/TBtu)	0.695	0.817	**0.756**
E_{Rp}	Rate - Electrical Output-based (lb/ h)	0.00647	0.00833	**0.00740**

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Date (2013)		un 10
Start Time (approx.)		15:11
Stop Time (approx.)		16:11
P o ess o tio s		
R_P	nit Load (M)	159
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780
Gas o tio s		
O_2	Oxygen (dry volume %)	7.9
T_s	Sample temperature (°F)	134
B_w	Actual water vapor in gas (% by volume)	15.3
Q_{std}	Volumetric flow rate, dry standard (dscfm)	418,600
Me u Results - Mo e EP Met o 0		
C_{sw}	^{0} - Ele e tal Concentration (g/dscm)	0.910
C_{sw}	^{2} - e Concentration (g/dscm)	0.095
C_{sw}	- e	9.4%
C_{sw}	^{t} - otal Concentration (g/dscm)	1.00
E_{Fd}	Rate - Fd-based (lb/TBtu)	0.986
E_{Rp}	Rate - Electrical Output-based (lb/ h)	0.00990

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Me□□u□□ Results - 4□29□1□

					e a e
Date (2013)		Apr 29	Apr 29	Apr 29	
Start Time (approx.)		12:44	15:34	17:44	
Stop Time (approx.)		13:44	16:34	18:44	
	PAC Type	BBB	BBB	BBB	
P o ess o to s					
R_P	nit Load (M)	165	165	164	**165**
F_d	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	**9,780**
Gas o to s					
O_2	Oxygen (dry volume %)	7.9	8.2	7.9	**8.0**
T_s	Sample temperature (°F)	127	127	127	**127**
B_w	Actual water vapor in gas (% by volume)	13.1	13.3	13.7	**1 .4**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	415,000	414,500	394,000	**407,800**
Me u Results - Mo e EP Met o 0					
C_{sw}	- Ele e tal Concentration (g/dscm)	0.829	0.783	0.714	**0.775**
C_{sw}	- e Concentration (g/dscm)	0.180	0.264	0.213	**0.219**
C_{sw}	- e	17.9%	25.2%	23.0%	**22.0**
C_{sw}	- otal Concentration (g/dscm)	1.01	1.05	0.927	**0.994**
E_{Fd}	Rate - Fd-based (lb/TBtu)	0.991	1.05	0.910	**0.984**
E_{Rp}	Rate - Electrical Output-based (lb/ h)	0.00950	0.00984	0.00834	**0.0092**

Equipment Description

Green #1 and Green #2 Set Up

Unit Description

Robert D. Green Station is located near Robards, KY and has two generating units with a combined net capacity of 454 MW.

Green Unit 1 has a Babcock Wilcox boiler with a General Electric turbine generator that went commercial in 1979. It has a gross capacity of 250 MW with a net capacity of 231 MW. The B&W boiler is a balanced draft front and rear wall fired boiler with 24 B&W burners. Each wall has 12 burners arranged in a 3 column by 4 row configuration. It has four vertical spindle coal pulverizers with each pulverizer feeding six burners. The steam flow rating (MCR) is 1,930,000 lb/hr with a turbine throttle pressure of 1800 PSIG at 1005 F. The reheat design temperature is 1005 F. Green Unit 1 was supplied with an American Air Filter wet hydrated lime inhibited oxidation twin absorber spray tower flue gas desulfurization (FGD) system. The FGD system removes 96 - 98% of the inlet SO2. Also, Green 1 has a General Electric Energy and Environmental Research (GEER) coal reburn system installed.

Green Unit 2 has a Babcock Wilcox boiler with a Westinghouse turbine generator that went commercial in 1981. It has a gross capacity of 242 MW with a net capacity of 223 MW. The B&W boiler is a balanced draft front and rear wall fired boiler with 24 B&W burners. Each wall has 12 burners arranged in a 3 column by 4 row configuration. It has four vertical spindle coal pulverizers with each pulverizer feeding six burners. The steam flow rating (MCR) is 1,930,000 lb/hr with a turbine throttle pressure of 1800 PSIG at 1005 F. The reheat design temperature is 1005 F. Green Unit 2 was supplied with an American Air Filter wet hydrated lime inhibited oxidation twin absorber spray tower flue gas desulfurization (FGD) system. The FGD system removes 96 - 98% of the inlet SO2. Also, Green 2 has a General Electric Energy and Environmental Research (GEER) coal reburn system installed.

Lime Injection System Description

Material is unloaded from a PD blower truck directly into a 1,600 cu. Ft. silo. The top of the silo is fitted with filters and a vent for removing displaced air. The bottom of the silo has aeration pistons and pneumatic vibrators that are used for promoting material flow. A butterfly valve sits below the aerators that discharge into a 2-way refill system.

Below the silo rests two identical weigh hoppers that can hold up to 25 cu. Ft. of material. Each weigh hopper feeds two drop through rotary airlocks. From the airlocks, material is then metered into the pneumatic convey line.

Lime Convey/Injection Set Up

Each weigh hopper discharged material to a 4" convey line. Each line had its own 40 HP PD blower capable of generating up to 500 CFM of air. These two 4" convey lines ran from the silo (ground level, east side of Green Unit 2) to a catwalk sitting above the airheaters on the 7th floor of Unit 1.

Here, each 4" convey line was split into four (4) 2" convey hoses. These convey hoses were connected to 5' long injection lances that were installed in 4" diameter ports resting above the air preheater.

Carbon Injection System Description

The carbon was supplied in super sacks weighing 750 lbs each. The supersacks were lifted with an electric hoist to an unloading platform. Mechanical agitators are installed on this platform to assist in getting material out of the bags.

The material falls out of the bag into a confinement hopper. The bottom of the confinement hopper has aeration jets installed on it to influence material flow. Material flows out of the confinement hopper into a loss in weight feeder hopper through an air operated butterfly valve.

Once in the feeder hopper, a screw feeder controlling the injection rate feeds into a drop through rotary airlock. Both the feeder hopper and the airlock have dust filters mounted on top of them.

Carbon Convey/Injection Set Up

The discharged material fell into a 4" convey line. The material in the convey line was carried using an identical blower package as the silo unit. The 4" convey line went from the bulk bag unloader (ground floor between units 1 and 2) to the ESP inlet on the 3rd floor. From here, the line split into two (2) 3" convey lines. Each 3" convey line split to four (4) 1.5" hoses. These hoses were connected to 18' injection lances sitting at the inlet to the ESP.

Wilson Set Up

Unit Description

D. B. Wilson Station is located near Centertown, KY and has one generating unit with a net capacity of 417 MW.

Wilson Unit 1 has a Foster Wheeler boiler with a Westinghouse turbine generator that went commercial in 1986. It has a gross capacity of 440 MW with a net capacity of 417 MW. The Foster Wheeler boiler is a balanced draft front and rear wall fired boiler with 25 FW low NOx burners. Each burner row has five burners and there are three rows of burners (15 burners) on the front wall and two rows of burners (10 burners) on the rear wall. It has five vertical spindle coal pulverizers with each pulverizer feeding five burners. The steam flow rating (MCR) is 3,484,000 lb/hr with a turbine

throttle pressure of 2400 PSIG at 1005 F. The reheat design temperature is 1005 F. Wilson Unit 1 has a MW Kellogg horizontal wet limestone inhibited oxidation flue gas desulfurization (FGD) system. The FGD system removes 90% of the inlet SO2. Also, it has a Babcock Borsig delta wing design selective catalytic reduction (SCR) system.

Lime Injection System Description

Material is unloaded from a PD blower truck directly into a horizontal storage bin. The bottom of the silo has aeration pistons and pneumatic vibrators that are used for promoting material flow. A butterfly valve sits below the aerators that discharge into a 2-way refill system.

Below the silo rests two identical weigh hoppers that can hold up to 25 cu. Ft. of material. Each weigh hopper feeds two drop through rotary airlocks. From the airlocks, material is then metered into the pneumatic convey line.

Lime Convey/Injection Set Up

Each weigh hopper discharged material to a 4'' convey line. Each line had its own 40 HP PD blower capable of generating up to 500 CFM of air. These two 4'' convey lines ran from the silo (ground level, east side of Wilson Station) to a catwalk sitting above the airheaters on the 9th floor of the Unit.

Here, each 4'' convey line was split into four (4) 2'' convey hoses. These convey hoses were connected to 6' long injection lances that were installed in 4'' diameter ports resting above the air preheater.

Carbon Injection System Description

The carbon was supplied in super sacks weighing 750 lbs each. The supersacks were lifted with an electric hoist to an unloading platform. Mechanical agitators are installed on this platform to assist in getting material out of the bags.

The material falls out of the bag into a confinement hopper. The bottom of the confinement hopper has aeration jets installed on it to influence material flow. Material flows out of the confinement hopper into a loss in weight feeder hopper through an air operated butterfly valve.

Once in the feeder hopper, a screw feeder controlling the injection rate feeds into a drop through rotary airlock. Both the feeder hopper and the airlock have dust filters mounted on top of them.

Carbon Convey/Injection Set Up

The discharged material fell into a 4'' convey line. The material in the convey line was carried using an identical blower package as the silo unit. The 4'' convey line went from the bulk bag unloader (ground floor on west side of Unit) to the ESP inlet on the 3rd floor. From here, the line split into two

(2) 3" convey lines. Each 3" convey line split to four (4) 1.5" hoses. These hoses were connected to 5.5' injection lances sitting at the inlet to the ESP.

Coleman 1, 2 and 3 Set Up

Unit Description

Coleman Station is located near Hawesville, KY and has three generating units with a combined net capacity of 443 MW. All three units combine and feed a common Wheelabrator (now Siemens) wet limestone flue gas desulfurization (FGD) system. The single absorber tower with dual flow trays and 5 recycle spray headers remove 95 – 97% of the inlet SO2. The absorber has forced oxidation and produces market grade gypsum. The auxiliary power (12 MW) for the FGD is usually fed from Coleman Unit 2.

Coleman Unit 1 has a Foster Wheeler boiler with a Westinghouse turbine generator that went commercial in 1969. It has a gross capacity of 160 MW with a net capacity of 150 MW. The Foster Wheeler boiler is a positive pressure front walled fired boiler with 8 low NOx B&W burners arranged in a 4 column by 2 row configuration. It has four vertical spindle coal pulverizers with each pulverizer feeding two burners. The steam flow rating (MCR) is 1,160,000 lb/hr with a turbine throttle pressure of 1800 PSIG at 1005 F. The reheat design temperature is 1005 F. Also, Coleman Unit 1 has a MoboTec rotating over fire air (ROFA) system installed.

Coleman Unit 2 is a sister unit to Coleman Unit 1; it has a Foster Wheeler boiler with a Westinghouse turbine generator that went commercial in 1970. It has a gross capacity of 160 MW with a net capacity of 138 MW. The Foster Wheeler boiler is a positive pressure front walled fired boiler with 8 low NOx B&W burners arranged in a 4 column by 2 row configuration. It has four vertical spindle coal pulverizers with each pulverizer feeding two burners. The steam flow rating (MCR) is 1,160,000 lb/hr with a turbine throttle pressure of 1800 PSIG at 1005 F. The reheat design temperature is 1005 F. Also, Coleman Unit 2 has a General Electric over fire air (OFA) system installed.

Coleman Unit 3 has a Riley boiler with a General Electric turbine generator that went commercial in 1972. It has a gross capacity of 165 MW with a net capacity of 155 MW. The Riley boiler is a positive pressure rear wall fired boiler with 8 low NOx B&W burners arranged in a 3 x 3 x 2 array. It has two coal ball mills with each ball mill feeding four burners. The steam flow rating (MCR) is 1,160,000 lb/hr with a turbine throttle pressure of 1800 PSIG at 1005 F. The reheat design temperature is 1005 F. Also, Coleman Unit 3 has a Foster Wheeler over fire air (OFA) system installed.

Lime Injection System Description

Material is unloaded from a PD blower truck directly into a 1,600 cu. Ft. silo. The top of the silo is fitted with filters and a vent for removing displaced air. The bottom of the silo has aeration pistons

and pneumatic vibrators that are used for promoting material flow. A butterfly valve sits below the aerators that discharge into a 2-way refill system.

Below the silo rests two identical weigh hoppers that can hold up to 25 cu. Ft. of material. Each weigh hopper feeds two drop through rotary airlocks. From the airlocks, material is then metered into the pneumatic convey line.

Lime Convey/Injection Set Up

The lime injection system was staged in the courtyard between Coleman Units 2 and 3.

Unit 1: A 4" diameter convey hose ran from the silo to the walkway at the air heater inlet on the 4th floor of the generating unit. An 8 way splitter was used to go to eight 1.25" diameter lance hoses. Each lance hose connected to a 1.25" diameter, 8' long injection lance that was installed vertically in the existing ports at the air heater inlet. The lances had two 4' sections to them that had to be threaded together during the installation due to limited vertical access. Two of the eight lances were installed 4' into the duct due to a plate obstruction resting below the two existing ports in the middle of the duct.

Unit 2: A 4" diameter convey hose ran from the silo to the walkway at the air heater inlet on the 4th floor of the generating unit. An 8 way splitter was used to go to eight 1.25" lance hoses. Each lance hose connected to a 1.25" diameter injection lance. Four of the eight lances were 8' long and installed horizontally in the economizer outlet. The other four lances were 4' long and installed vertically in the existing ports above the air heater inlet. These lances could not be extended to 8' due to turning vanes obstructing the installation below the air heater inlet ports.

Unit 3: A 4" diameter convey hose ran from the silo to the walkway at the air heater inlet on the 4th floor of the generating unit. An 8 way splitter was used to go to eight 1.25" lance hoses. Each lance hose connected to a 1.25" diameter injection lance. Four of the eight lances were 5.5' long and the other four were 3.5' long; all eight were installed horizontally and alternated in length when installed.

Carbon Injection System Description

The carbon was supplied in super sacks weighing 750 lbs each. The supersacks were lifted with an electric hoist to an unloading platform. Mechanical agitators are installed on this platform to assist in getting material out of the bags.

The material falls out of the bag into a confinement hopper. The bottom of the confinement hopper has aeration jets installed on it to influence material flow. Material flows out of the confinement hopper into a loss in weight feeder hopper through an air operated butterfly valve.

Once in the feeder hopper, a screw feeder controlling the injection rate feeds into a drop through rotary airlock. Both the feeder hopper and the airlock have dust filters mounted on top of them.

Carbon Convey/Injection Set Up

Unit 1/Unit 2: The discharged material fell into a 4'' diameter convey line. This line split into eight 1.25'' diameter hoses near the existing vertical ports on the ground floor of the unit. Each 1.25'' diameter hose connected to a 5.5' long, 1.25'' diameter injection lance installed vertically into the existing ports.

Unit 3: The discharged material fell into a 4'' diameter convey line. This line split into eight 1.25'' diameter hoses near the 6' long ports at the ESP inlet on the 3rd floor of the unit. Each 1.25'' diameter hose connected to a 18' long, 1.25'' diameter injection lance installed diagonally into the existing ports.

Test Methods

EPA METHOD 30B FOR MERCURY SPECIATION

Mercury measurements were made using sorbent trap technology and EPA Reference Method 30B procedures, modified for the use of speciated 5-section sorbent traps (Modified EPA 30B). In addition to the use of speciated sorbent traps, other sampling parameters, hardware, QA/QC requirements and analytical methods were revised from EPA 30B procedures and specifications. The following sections highlight the modifications to EPA 30B in order to allow speciation of the mercury flue gas constituents.

Complete procedures and requirements of EPA 30B can be found at
http://www.epa.gov/ttn/emc/promgate/Meth30B.pdf

EPA Method 30B sampling procedures, modified for the use of multi-section speciation sorbent traps, were used for the sorbent trap mercury measurements. Sorbent traps were supplied by Ohio Lumex. Known volumes of flue gas were extracted from a single point and passed through mercury sorbent traps utilizing potassium chloride-coated quartz (KCl) and iodated powdered activated carbon. The KCl and the iodated activated carbon provide for speciation of gaseous oxidized and elemental mercury, respectively. All sampling was performed using simultaneous, collocated, paired sampling systems as per EPA 30B specifications.

The sorbent trap sampling system consisted of a single heated sample probe and external heated compartment capable of maintaining the sample gas in the range 200ºF -250ºF. After passing through the sorbent traps the sample gas was transferred through flexible heated Teflon sample lines and water knockout vessels and silica gel to remove flue gas moisture. After conditioning the sample gas volume for each sample system was measured using dry gas meters. The two independent sampling systems are identified as A and B.

Sample flow rate and system operating parameters were controlled and recorded during each test run. The target sample flow rate was determined based on the expected flue gas concentration and the sample duration. Typical flow rates range from 0.1 to 0.6 lpm for speciation sorbent traps. A constant flow rate was maintained (+/- 10%) for each sample run. Average sampling data was recorded every 5 minutes during each sample run.

Sorbent traps were analyzed using direct thermal desorption. Analysis was on-site by CleanAir using an Ohio Lumex Lumex RA-915+ analyzer and RP 324 detector.

1.1 Sampling System

Figure 30B-1 contains a diagram of the sampling system used for Modified EPA 30B sampling. The following sections describe key components to the system as well as modifications for mercury speciation testing.

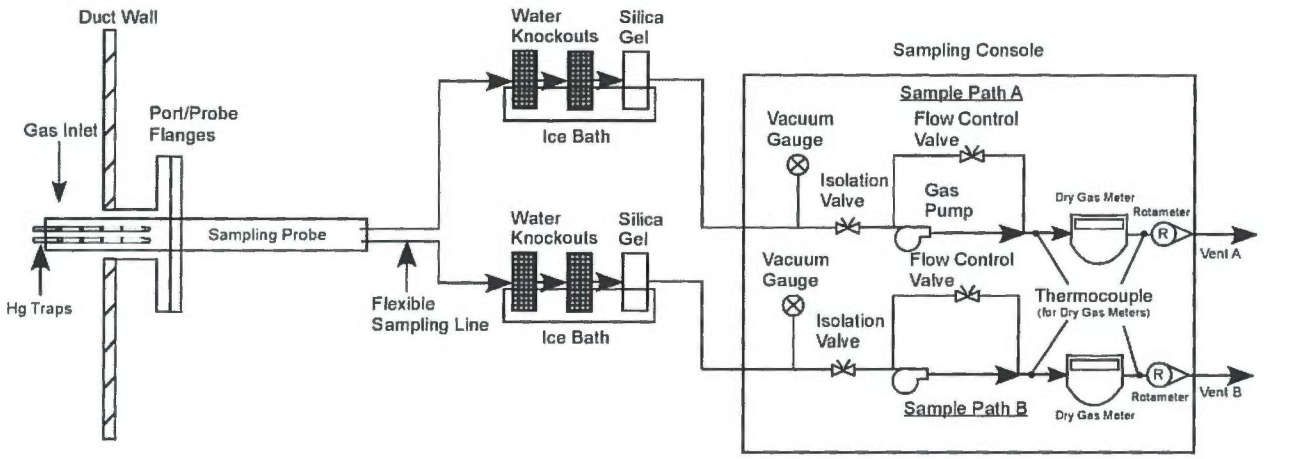

Figure 30B-1: Modified EPA 30B Sampling System

1.1.1 Speciated Sorbent Traps

EPA 30B, Section 6.1.1, includes the specification for mercury sampling using sorbent traps that contain at least two sections and are capable of capturing gaseous total vapor phase mercury. In order to speciate mercury composition, sorbent traps containing 5 sections are used. The 5 sections of speciated sorbent traps including applicable sorbent material are identified in Table 30B-1. Gas flow is through Section 1 and then each subsequent section. Each section is separated by quartz wool.

Table 30B-1:
Summary of Modified EPA 30B Speciation Sorbent Trap Construction

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A diagram of the sorbent traps used during the test program is shown in Figure 30B-2

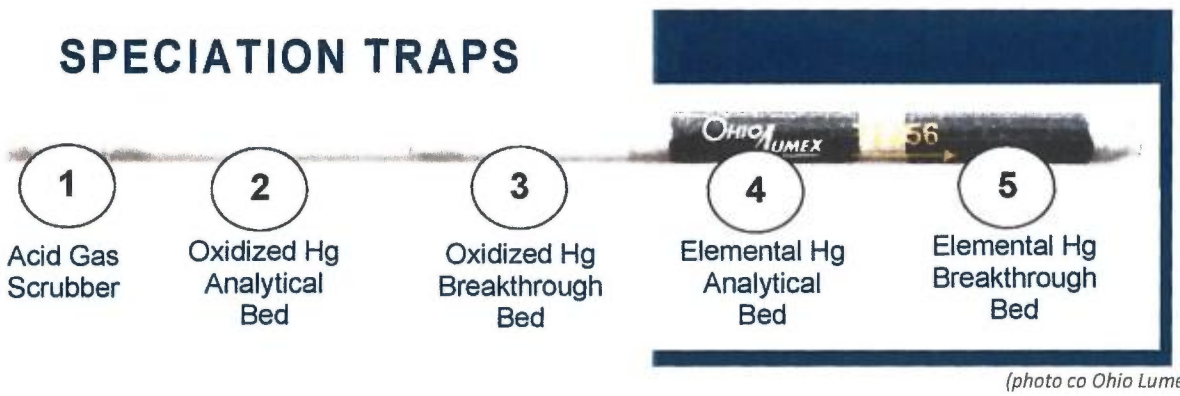


Figure 30B-2: Modified EPA 30B Speciation Sorbent Trap

1.1.2 Heated Sorbent Trap Compartment

EPA 30B requires sorbent traps to be operated in direct contact with the flue gas at a temperature sufficient to prevent moisture condensation. Due to the physical properties of the KCl sorbent material, the mercury capture mechanism and breakthrough considerations, EPA 30B procedures are modified in order to maintain the sorbent traps at approximately 200 ºF (95ºC) and no higher than 250 ºF during sampling. Due to the flue gas temperature and saturated moisture content at 125 ºF, the sample temperature was monitored and controlled by an automated control system at approximately 225 ºF for all test runs.

1.2 Sampling Procedures

Sampling was performed using EPA Method 30B procedures modified for the requirements of speciated mercury sorbent trap sampling. The operational details of the sampling procedures are shown in Table 30B-2.

Table 30B-2:
Summary of Modified EPA 30B Operational Parameters

Method	Modified EPA Method 30B (Speciation)
Analyte Measured by Method	Total vapor-phase mercury (Hg^0 + Hg^{+2})
Length of Runs	30 – 120 minutes
Reference Method Traverse Points	One (1) point in one (1) port
Reference Method Time per Point	30 – 120 minutes
Reference Method Sampling Rate	0.1 - 0.5 lpm (nominal) for Mod. 30B
Number of RM Samples per Run	Two (paired samples), identified as samples A and B
Sorbent Trap Manufacturer	Ohio Lumex Inc.
Number of Sections in Sorbent Trap	5
Sorbent Material	Quartz Wool, AG Scrubber, KCL and Iodinated, activated charcoal
Sorbent Trap Tube Material	Glass
Spiked Section in Sorbent Trap	Spike section not included
Spike Level	30 (if applicable)
Sample Line Material	PTFE

Table 30B-2:
Summary of Modified EPA 30B Operational Parameters (Continued)

Method	Modified EPA Method 30B (Speciation)
Probe Temperature Control	225F +/- 5 ºF
Gas Dryer Device	Water knockouts immersed in ice bath followed by silica gel
Temperature of Gas Dryer Device	≤ 68ºF
Source of Moisture Measurement	Saturated vapor pressure at flue gas temperature
Frequency of Moisture Measurement	Concurrent with mercury runs – EPA Method 5 testing

1.3 EPA Method 30B Revisions

QA/QC specifications for EPA Method 30B are summarized in Table 9-1 of the method (Table 30B-3). These specifications range from hardware and sampling procedures to analytical requirements. Modification of EPA Method 30B for speciation traps is not a published reference method, but based on the technology developed by Frontier Geosciences (i.e Flue Gas Adsorbent Mercury Speciation or FAMS). The sampling approach used by CleanAir was based fundamentally on EPA Method 30B and the FAMS method with the following revisions:

1. Spike traps were used during several sampling runs throughout the test program. EPA Method 30B includes a spike comparison between at least three concurrent spiked and unspiked sorbent traps. Only sample runs that met Method 30B spike recovery QA/QC criteria were considered valid test runs.
2. Sampling was not performed isokinetically (FAMS)
3. Sorbent traps were located in-situ.
4. KCl breakthrough determination is not a requirement but was measured and evaluated.
5. Minimum sample mass requirements of 10ng were targeted and based on the total mercury collected on the sorbent trap.

1.4 EPA Method 30B QA/QC

QA/QC specifications for EPA Method 30B are summarized in Table 9-1 of the method (Table 30B-3).

Table 30B-3:
EPA Method 30B – Table 9-1 QA/QC Criteria

Table 9-1. Quality Assurance/Quality Control Criteria for Method 30B

QA/QC Test or Specification	Acceptance Criteria	Frequency	Consequences if Not Met
Gas flow meter calibration (At 3 settings or points)	Calibration factor (Y_i) at each flow rate must be within ± 2% of the average value (Y)	Prior to initial use and when post-test check is not within ± 5% of Y	Recalibrate at 3 points until the acceptance criteria are met
Gas flow meter post-test calibration check (Single-point)	Calibration factor (Y_i) must be within ± 5% of the Y value from the most recent 3-point calibration	After each field test. For mass flow meters, must be done on-site, using stack gas	Recalibrate gas flow meter at 3 points to determine a new value of Y. For mass flow meters, must be done on-site, using stack gas. Apply the new Y value to the field test data
Temperature sensor calibration	Absolute temperature measured by sensor within ± 1.5% of a reference sensor	Prior to initial use and before each test thereafter	Recalibrate; sensor may not be used until specification is met
Barometer calibration	Absolute pressure measured by instrument within ± 10 mm Hg of reading with a mercury barometer	Prior to initial use and before each test thereafter	Recalibrate; instrument may not be used until specification is met
Pre-test leak check	≤ 4% of target sampling rate	Prior to sampling	Sampling shall not commence until the leak check is passed
Post-test leak check	≤ 4% of average sampling rate	After sampling	Sample invalidated*

Table 30B-3:
EPA Method 30B – Table 9-1 QA/QC Criteria (Continued)

QA/QC Test or Specification	Acceptance Criteria	Frequency	Consequences if Not Met
Analytical matrix interference test (wet chemical analysis, only)	Establish minimum dilution (if any) needed to eliminate sorbent matrix interferences	Prior to analyzing any field samples; repeat for each type of sorbent used	Field sample results not validated
Analytical bias test	Average recovery between 90% and 110% for Hg^0 and $HgCl_2$ at each of the 2 spike concentration levels	Prior to analyzing field samples and prior to use of new sorbent media	Field samples shall not be analyzed until the percent recovery criteria has been met
Multipoint analyzer calibration	Each analyzer reading within $\pm$ 10% of true value and $r^2 \geq 0.99$	On the day of analysis, before analyzing any samples	Recalibrate until successful
Analysis of independent calibration standard	Within $\pm$ 10% of true value	Following daily calibration, prior to analyzing field samples	Recalibrate and repeat independent standard analysis until successful
Analysis of continuing calibration verification standard (CCVS)	Within $\pm$ 10% of true value	Following daily calibration, after analyzing $\leq$ 10 field samples, and at end of each set of analyses	Recalibrate and repeat independent standard analysis, reanalyze samples until successful, if possible; for destructive techniques, samples invalidated
Test run total sample volume	Within $\pm$ 20% of total volume sampled during field recovery test	Each individual sample	Sample invalidated

Table 30B-3:
EPA Method 30B – Table 9-1 QA/QC Criteria (Continued)

QA/QC Test or Specification	Acceptance Criteria	Frequency	Consequences if Not Met
Sorbent trap section 2 breakthrough	≤ 10% of section 1 Hg mass for Hg concentrations > 1 µg/dscm; ≤ 20% of section 1 Hg mass for Hg concentrations ≤ 1 µg/dscm	Every sample	Sample invalidated*
Paired sorbent trap agreement	≤ 10% Relative Deviation (RD) mass for Hg concentrations > 1 µg/dscm; ≤ 20% RD or ≤ 0.2 µg/dscm absolute difference for Hg concentrations ≤ 1 µg/dscm	Every run	Run invalidated*
Sample analysis	Within valid calibration range (within calibration curve)	All Section 1 samples where stack Hg concentration is ≥ 0.5 µg/dscm	Reanalyze at more concentrated level if possible, samples invalidated if not within calibrated range
Sample analysis	Within bounds of Hg^0 and $HgCl_2$ Analytical Bias Test	All Section 1 samples where stack Hg concentration is ≥ 0.5 µg/dscm	Expand bounds of Hg^0 and $HgCl_2$ Analytical Bias Test; if not successful, samples invalidated
Field recovery test	Average recovery between 85% and 115% for Hg^0	Once per field test	Field sample runs not validated without successful field recovery test

* And data from the pair of sorbent traps are also invalidated.

Continuous Mercury Monitoring – Hg CEMS (Ohio Lumex IRM-915)

In addition to Modified EPA 30B measurements, CleanAir used the Ohio Lumex IRM-915 Mercury Stack Monitor for the semi-continuous monitoring of total and elemental mercury. This instrument is designed for temporary installation and provides real-time continuous measurement capability.

The IRM-915 includes a dual path sample mode that allows either measurement of total vapor phase mercury or elemental mercury. Flue gas is withdrawn using a heated probe and heated filter with dilution/conversion assembly (30:1). Depending on the sample mode selected, the sample gas either passes through a high temperature convertor for measurement of total mercury, or bypasses the convertor for measurement of elemental mercury only. The probe/filter assemblies included an automated air blow-back system to prevent sample paths from becoming plugged with particulate matter. Blowback events occur for 5minutes each hour. During each blowback the zero response was checked and the data from previous hour adjusted for any analyzer drift.

The sample gas is transferred from the probe assembly to the analyzer detector through a 25' heated umbilical line. Mercury concentration is determined using Zeeman atomic absorption (AA) spectroscopy. This approach includes no pre-concentration and uses a multipath cell combined with a "dry" converter (700°C) to minimize interferences from the flue gas matrix.

A diagram of the Hg CEMS system used for testing is shown in Figure CEMS-1.

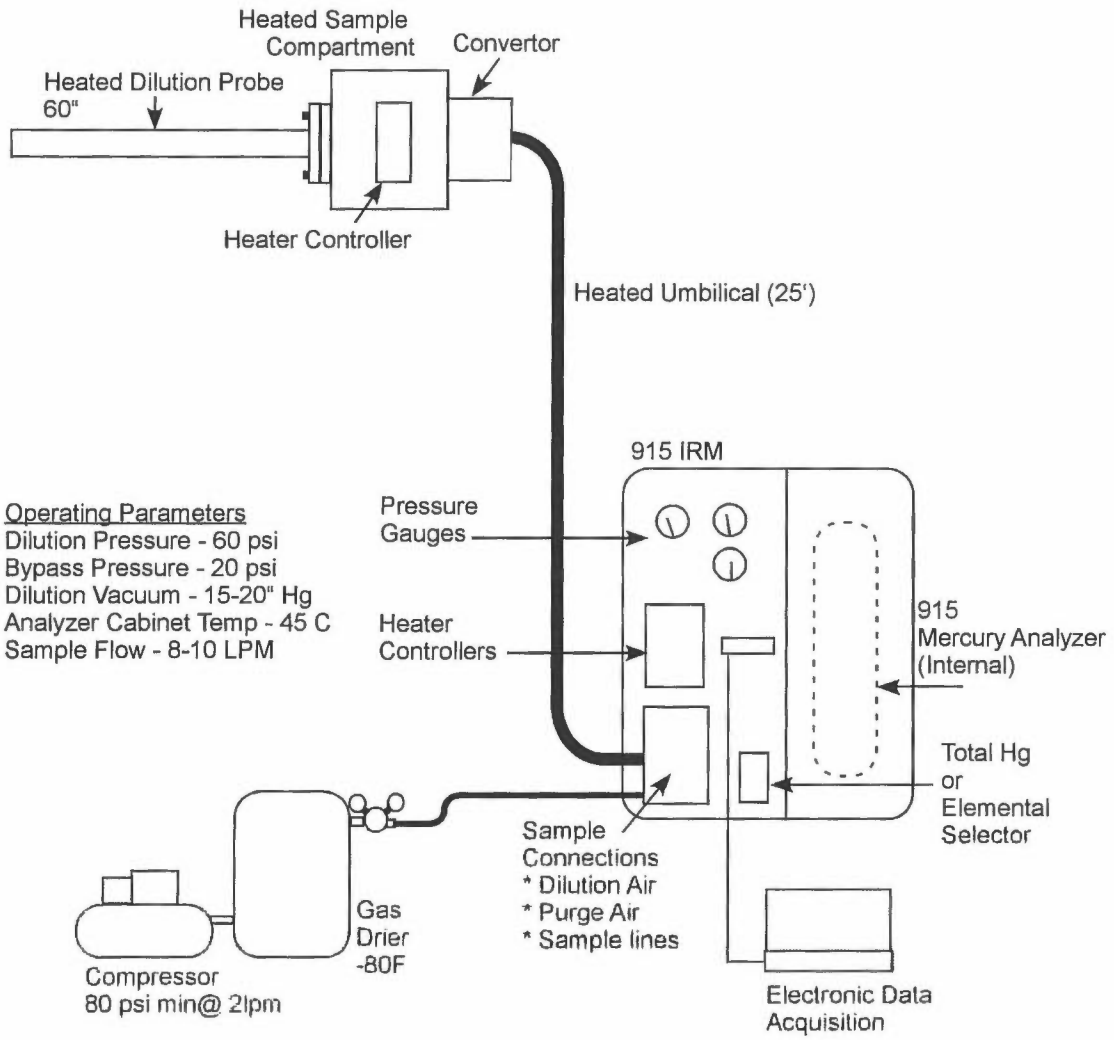


Figure CEMS-1: Hg CEMS Sampling System

All sample components prior to analysis are heated and automatically controlled to the following setpoints

- Sample Probe – 230°C
- Sample Frit - 180°C
- Sample Convertor - 560°C
- Sample Line - 100°C
- M324 Analyzer - 45°C

IRM-915 mercury concentrations were measured on a wet basis in microgram per standard cubic meter (µg/scm) units. Data can be viewed in real time as shown in Figure CEMS-2.

Figure CEMS-2: Hg CEMS Real-Time Data Acquisition Screen

Concentrations were converted to a dry basis using moisture content determined though EPA Method 5 testing. Emission rates were calculated using EPA Method 19 and equations included in Appendix A of the MATS rule.

Specification Sheet for EPA Method 5

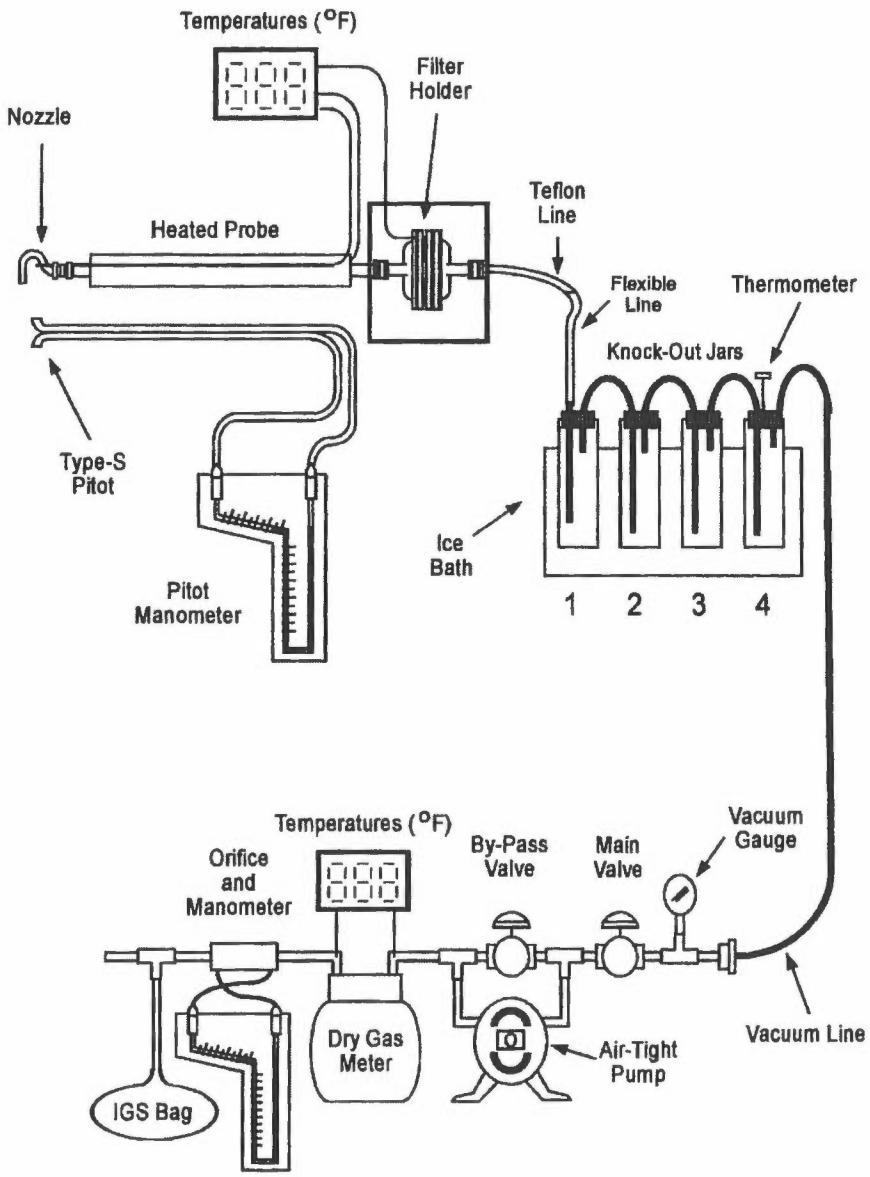
Source Location Name(s)	Green 1 and 2, Wilson 1 and Coleman 3
Pollutant(s) to be Determined	Particulate Matter (PM)
Other Parameters to be Determined from Train	Gas Density, Moisture, Flow Rate

	Standard Method Specification	Actual Specification Used
Pollutant Sampling Information		
Duration of Run	N/A	60 minutes
No. of Sample Traverse Points	N/A	12
Sample Time per Point	N/A	2.5 or 5
Sampling Rate	Isokinetic (90-110%)	Isokinetic (90-110%)
Sampling Probe		
Nozzle Material	Stainless Steel or Glass	Borosilicate Glass / Stainless Steel (12' probe)
Nozzle Design	Button-Hook or Elbow	Button-Hook
Probe Liner Material	Borosilicate or Quartz Glass	Borosilicate Glass / Stainless Steel (12' probe)
Effective Probe Length	N/A	6, 10 or 12
Probe Temperature Set-Point	248°F±25°F	320°F±25°F
Velocity Measuring Equipment		
Pitot Tube Design	Type S	Type S
Pitot Tube Coefficient	N/A	varied
Pitot Tube Calibration by	Geometric or Wind Tunnel	Wind-Tunnel
Pitot Tube Attachment	Attached to Probe	Attached to Probe
Metering System Console		
Meter Type	Dry Gas Meter	Dry Gas Meter
Meter Accuracy	±2%	±1%
Meter Resolution	N/A	0.01 cubic feet
Meter Size	N/A	0.1 dcf/revolution
Meter Calibrated Against	Wet Test Meter or Standard DGM	Wet Test Meter
Pump Type	N/A	Rotary Vane
Temperature Measurements	N/A	Type K Thermocouple/Pyrometer
Temperature Resolution	5.4°F	1.0°F
ΔP Differential Pressure Gauge	Inclined Manometer or Equivalent	Inclined Manometer
ΔH Differential Pressure Gauge	Inclined Manometer or Equivalent	Inclined Manometer
Barometer	Mercury or Aneroid	Digital Barometer calibrated w/Mercury Aneroid
Filter Description		
Filter Location	After Probe	Exit of Probe
Filter Holder Material	Quartz	Borosilicate Glass
Filter Support Material	Glass Frit	Teflon
Cyclone Material	N/A	None
Filter Heater Set-Point	248°F±25°F	320°F±25°F
Filter Material	Glass Fiber	Quartz Fiber
Other Components		
Description	N/A	N/A
Location	N/A	N/A
Operating Temperature	N/A	N/A

Specification Sheet for EPA Method 5

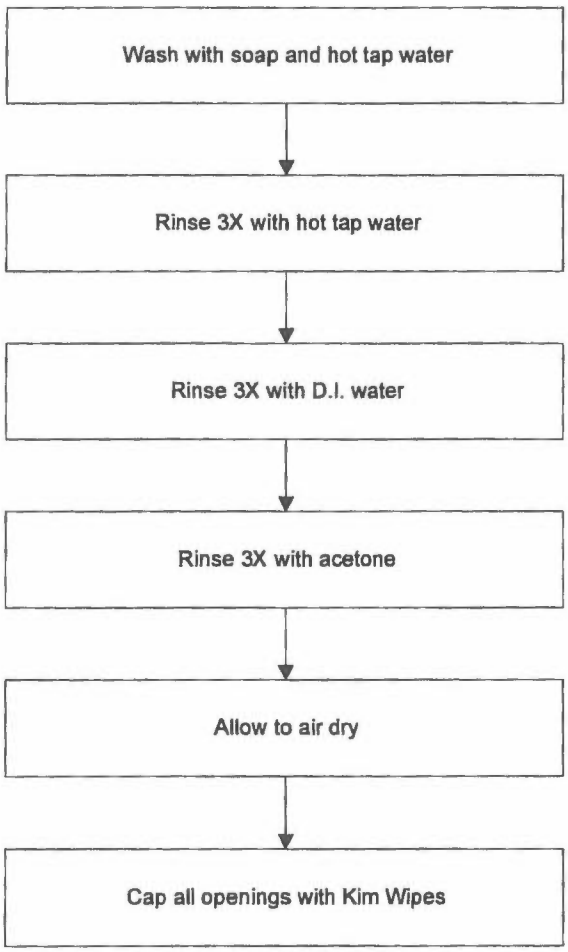
	Standard Method Specification	Actual Specification Used	
Impinger Train Description			
Type of Glassware Connections	Ground Glass or Equivalent	Screw Joint with Silicone Gasket	
Connection to Probe or Filter by	Direct Glass Connection	Direct Glass Connection	
Number of Impingers	4	4	
Impinger Stem Types			
Impinger 1	Modified Greenburg-Smith	Knock-Out	
Impinger 2	Greenburg-Smith	Knock-Out	
Impinger 3	Modified Greenburg-Smith	Knock-Out	
Impinger 4	Modified Greenburg-Smith	Knock-Out	
Impinger 5			0
Impinger 6			0
Impinger 7			0
Impinger 8			0
Gas Density Determination			
Sample Collection	Multi-point integrated	Multi-Point Integrated	
Sample Collection Medium	Flexible Gas Bag	Vinyl Bag	
Sample Analysis	Orsat or Fyrite Analyzer	CEM	
Sample Recovery Information			
Probe Brush Material	Nylon Bristle	Nylon Bristle	
Probe Rinse Reagent	Acetone	Acetone	
Probe Rinse Wash Bottle Material	Glass or Polyethylene	Teflon	
Probe Rinse Storage Container	Glass or Polyethylene	Glass	
Filter Recovered?	Yes	Yes	
Filter Storage Container	N/A	Polystyrene	
Impinger Contents Recovered?	Provision	Archived	
Impinger Rinse Reagent	Deionized Distilled Water	N/A	
Impinger Wash Bottle	Glass or Polyethylene	N/A	
Impinger Storage Container	Glass or Polyethylene	N/A	
Analytical Information			
Method 4 H_2O Determination by	Volumetric or Gravimetric	Gravimetric and Volumetric	
Filter Preparation Conditions	Dessicate 24 hours minimum at ambient temperature	Dessicate 24 hours minimum at ambient temperature	
Front-Half Rinse Preparation	Evaporate at ambient temperature and pressure	Evaporate at ambient temperature and pressure	
Back-Half Analysis	N/A	N/A	
Additional Analysis	N/A	None	

EPA Method 5
Sampling Train Configuration



Knock Out Jar Contents	
Knock Out Jar 1	100 ml H_2O
Knock Out Jar 2	100 ml H_2O
Knock Out Jar 3	Empty
Knock Out Jar 4	Silica gel

EPA Method 5
Glassware Preparation Procedures



EPA Method 5
Sample Recovery Flowchart

- Tare all sample containers before sample collection
- Mark all liquid levels and final weights on the outside of each sample container
- Seal all sample containers with Teflon tape
- If recycling, bake silica gel for two hours at 350 degrees F (175 degrees C)

Container 1
Quartz Filter
Petri Dish

Remove with tweezers to original container. Brush any loose particulate or filter fibers into sample container

If necessary fold in half and place into container

Visual Inspection

Container 2
Front Half (FH) Rinse
500 ml Glass

Probe liner, nozzle, cyclone or cyclone bypass and filter FH

Brush/rinse 3X with acetone (6X for metal components)

Visual Inspection

Label container and measure volume by weight

Container 3
Silica Gel

Measure volume by weight, note any color change

Recycle silica gel

*Containers 4 and 7 are required when the testing includes a back half analysis

Container 4*
Back Half (BH) Rinse
500 ml Plastic

BH filter housing, Z-piece, impingers 1, 2, 3 and U-Bends

Measure volume by weight

Empty contents into labeled container

Rinse with water

Visual Inspection

Label container and measure volume by weight

Blanks

Container 5
Filter Blank
Plastic Petri Dish

Clean, unused tared filter

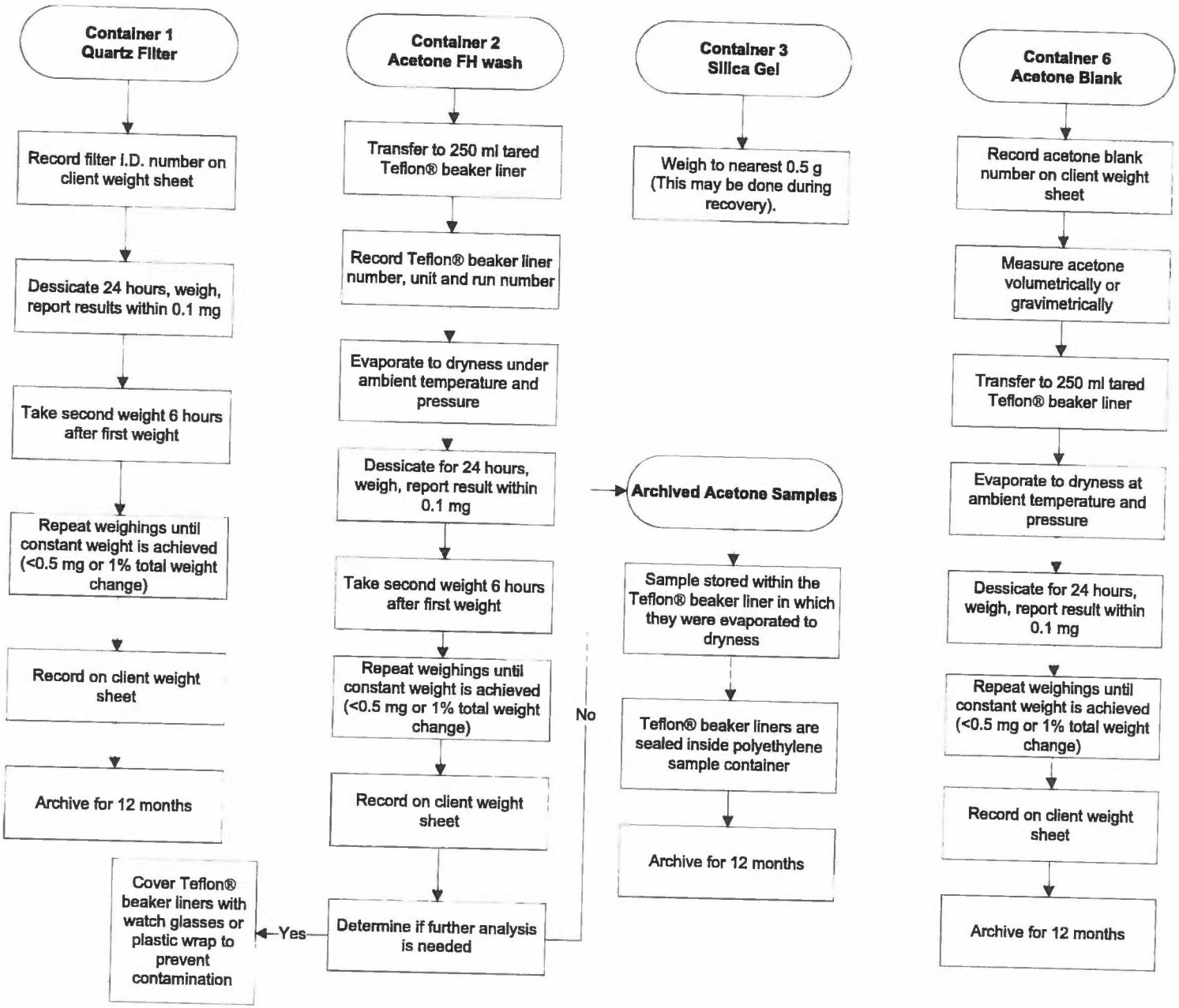
Container 6
Acetone Blank
500 ml Glass

200 ml of acetone from rinse bottle. Record lot number

Container 7*
D.I. Water Blank
250 ml Plastic

200 ml of water from rinse bottle

EPA Method 5
Analytical Flowchart



EPA Method 30B
Sampling Train Configuration