System Descriptions

Common System Descriptions

Unit 1 System Descriptions

Unit 2 System Descriptions

Unit 3 System Descriptions

System Description

1.1 System Identification

- Unit Designation Common
- System Name Grounding
- System Code EEB
- File Number 41.0804.3.BC01

1.2 Function

The station electrical system is susceptible to ground faults, lightning, and switching surges that could result in high potentials and constitute a hazard to station personnel and electrical equipment. The function of the Grounding System shall be to provide an adequate path to permit the dissipation of ground fault currents from system faults and lightning preventing the buildup of voltages that may result in hazard to personnel. Proper grounding also provides protection from ground potential rise and noise on control and instrument circuits.

1.3 Process Description

The existing ground grid at Brown shall be expanded for the additions associated with the new air quality control system (AQCS). Structures and equipment that shall be grounded shall include buildings, new PAC Silos and transfer equipment, and PJFFs for Units 1, 2 and 3, plus the new sorbent injection silos and transfer equipment at Units 1 and 2. Existing Unit 3 Common WFGD system raceways, structural support steel transformers, and electrical equipment shall be grounded. Each grounded equipment and structure shall be connected to the grounding grid. Ground rods shall be installed for each perimeter grounding system. Perimeter grounding systems shall be connected to adjacent existing grounding systems by at least two parallel conductors.

1.3.1 Buildings and Structures

The ground grid system addition shall consist of bare copper stranded cable buried in the soil below structures and ground floor concrete slabs in a suitable grid pattern. Each junction of the grid shall be securely bonded together by exothermic connection, with the exception for equipment grounds that can be compression connectors or copper strap. Copper-clad ground rods shall be installed and attached to the ground grid system at various locations.

The pattern for the ground grid addition, and the length and number of ground rods, shall be determined during detailed design using soil resistivities obtained by measurements taken at the station site along with generation ground grid calculations for safe touch and step voltage potentials performed by a grounding software program.

Ground stingers shall be run from the ground grid to at least every other building column and to every utility bridge support. These stingers shall be bare copper cable connected to the columns or supports with compression lugs.

To ensure a station low-impedance ground-fault return path and to interconnect new remote ground grids to the main station grid, two bare copper conductors shall be buried with all new duct banks. These conductors shall be connected to the station ground grid system, outlying building ground grids, existing switchyard ground grid, and all manhole grounding systems along the duct banks.

1.3.2 Raceway

All new metallic raceway, including, but not limited to, cable trays, conduits, wireway, and racks, shall be bonded to the ground grid by ground conductors. This raceway ground shall also form a bonding path from electrical equipment to the supply source while at the same time bonding both to the ground grid.

1.3.3 Electrical Equipment

All electrical equipment shall be grounded.

1.3.4 Cathodic Protection

All underground metallic piping, underground steel tanks, and pad-mounted steel tanks shall be dielectrically separated from the station ground grid to prevent corrosion caused by electrolytic reaction of the structures with copper grounding material. Pad-mounted steel storage tanks shall be grounded with copper ground rods and insulated ground conductors. The tank ground rods shall be completely isolated from the station ground grid and cathodically protected along with the associated tank bottom. In cases where the station ground grid must pass close to tank copper ground rods, insulated ground conductors shall be used to maintain adequate isolation.

Buried or submerged equipment, and their foundation bolts or piping to which cathodic protection may be applied, shall not be in contact with reinforcing rods, metallic conduit, grounding cable, or other piping. Insulating flanges, unions, or couplings may be required in the pipe risers just above ground elevation.

1.3.5 Cranes and Hoists

Cranes and hoists shall be grounded through their rails. Rails shall be electrically bonded together and connected to the grounding system at each end. However, grounding of equipment shall be primarily through the ground conductor on the cable reel.

1.3.6 Switchyard

The plant ground grid addition shall be interconnected with the existing switchyard ground grid with at least two separate conductors.

1.3.7 Lightning Protection

The design of the lightning protection system for the AQCS additions shall include determination of the overall lightning hazard for the geographic location of the project and for the structures, the selection of Class I and/or Class II materials, the need of corrosion protection for the copper and/or aluminum components used, and consideration of other pertinent factors. The design shall produce a zone of protection from lightning to prevent personal injury, structural damage, and equipment downtime. For purposes of the estimate, the estimated cost of the new Unit 4 chimney includes the cost of and integral lightning protection system.

Lightning protection systems shall be bonded to grounding electrode systems in accordance with the National Electrical Code.

1.3.8 Control System

The Distributed Control System (DCS) shall be grounded with dedicated insulated ground conductors attached to the main ground grid in accordance with manufacturer's recommendations. All control panels and cabinets shall be connected to the ground grid by ground stingers.

System Description

1.1 System Identification

- Unit Designation — Common
- System Name — Site Fire Protection
- System Code — STG
- File Number — 41.0804.3.BC02

1.2 Function

The Site Fire Protection System provides fixed water suppression systems, carbon dioxide suppression systems, fire extinguishers, and independent fire detection systems. The Site Fire Protection System also provides manual firefighting capability with hose streams at the site facilities as required by code. These systems provide for the protection of the new plant enclosures and equipment in the event of fire.

1.3 Process Description

The Site Fire Protection System includes various fixed detection and suppression systems. The E.W. Brown systems are listed in Table 1. The basic operation of each type of system is as follows:

- Automatic Water Spray (Preaction) System. The automatic preaction sprinkler system utilizes spot type heat detectors installed throughout the protected area. When high temperature is detected, an alarm is activated, which opens the preaction valve to admit water to the system piping. The sprinklers/spray nozzles are closed and will discharge water only when individual heads open due to excessive heat. The systems are used where it is particularly important to prevent the accidental discharge of water and where an alarm in advance of sprinkler/spray nozzle operation is desired.

- Automatic / Manual Carbon Dioxide (CO2) system. Automatic CO2 systems utilize heat detection or carbon monoxide detectors to detect a fire condition and activate the system. Manual system use manual pulls to active the system. The piping from the releasing valve to the protection area is empty until a detector or pull station is activated. Upon activation of system, the area is inerted or flooded with CO2 via the open nozzles. The system is monitored by the local fire panel and will annunciate an alarm locally and back in the control room when activated.

The fixed water suppression systems are supplied water via the existing underground yard distribution piping.

The Powder Activated Carbon (PAC)'s silos include a low-pressure CO_2 system to address fires that can occur in the silo. The PAC is a combustible material. The protection system in the PAC silo is similar to that used in coal silos.

Portable, hand-held fire extinguishers are provided at key locations in accordance with the requirements of NFPA 10. The extinguishing agent will be either dry chemical or carbon dioxide. The agent used will be selected based on the fire hazards encountered in the immediate area.

Fire detection equipment consists of fixed temperature heat detectors, rate-compensated heat detectors, and ionization type smoke detectors. Smoke detectors will consist of ionization detectors which respond to both visible and invisible products of combustion.

A Fire Protection Signaling System is provided to monitor the new fixed fire protection systems, and will transmit the system status to the U1/U2 or U3 Control Rooms via the existing Main Fire Alarm Annunciator Panels. The Fire Protection Signaling System includes a local panel at each unit. Audible fire and trouble alarms will also be provided at the local supervisory panels for local annuciation. All of the new fire protection systems will communicate their alarm information to the existing main fire alarm annuicator panel located in U1/U2 or U3 Control Rooms.

An existing underground yard distribution system supplies fire protection water throughout the main plant area and may be extended to the new AQCS areas for fire protection systems. The fire main supplies water to the new fire hydrants and new fixed water suppression systems. The yard distribution piping may not be looped around the plant and if feasible, should be expanded to provide a loop as called out in NFPA. The addition of the loop will allow for multiple flow paths such that if one path fails, other piping paths can supply sufficient fire protection water to the system. The necessity of additional piping to complete a fire protection loop will be determined during detailed design. Valves (post indicator or curb valve box type for underground lines) will be provided at each connection to the existing piping. These valves enable isolation of any failed piping section. Isolation valves are also provided at each additional fire hydrant. Fire hydrants are typically spaced approximately 300 feet apart around the loop and additional hydrants may need.

Existing pumps are sufficient to provide the amount of pressure and flow needed for the additional systems. Pump information was taken from the P&ID. There will need to be one new 100,000 gallon tank added to ensure sufficient water supply per NFPA.

The new water suppression systems tie into the existing plant underground fire main pipe. Approximate tap locations are shown on the process flow diagram 168908-BCSTG-M2547. Each tap will be provided with an isolation valve for the new system.

Suppression systems for the E.W. Brown Project are listed in Table 1.

1.4 Pulse Jet Fabric Filter (PJFF) Fire Protection

Fire protection for PJFFs is a growing concern in the industry, especially when PAC is used and captured for reducing emissions. Therefore, recommendations and requirements for PJFF fire protection are currently evolving. Currently NFPA states that fires have been caused in bag houses by incomplete combustion in the boiler resulting in carryover of burning particulate igniting the filter media or in this case the combustible material covering the bags or hoppers. The combustible material covering the bags has primarily been attributed to the injection of powder activated carbon (PAC) into the flue gas upstream of the PJFF, which is used to reduce the pollutants like mercury and others present in the exhaust. The PAC and unburned carbon are combustible materials collected on the bags and hoppers during normal operation. Current industry opinions and recommendations recognized by B&V fire protection experts are that there is a need for suppression systems in PJFFs due to the fire hazard introduced by the collection of PAC. As research and studies continue, it may ultimately be determined that the hazard could be reduced if the PAC concentration in the PJFF is low enough when collected with other inert materials like sorbent and or fly ash. However, at this point if PAC is injected upstream of a PJFF, it is recommended to include installation of a suppression system to minimize damage in an event of fire. The basis of the cost estimate includes suppression systems in the PJFFs.

Two types of suppression systems may be utilized for PJFFs, a preaction spray system or a CO_2 gas system. Each of these systems has its own advantages and disadvantages. The preaction spray system is less costly to install, but is typically not recommended by the manufacturers due to the damage water can cause if the system is activated. If water is sprayed into the PJFF, the affected bags and possibly cages will need to be replaced or repaired in that compartment. The CO_2 gas system is more expensive to install, takes up more real estate, and has some personnel safety concerns with discharge, but CO_2 suppression system does not damage the bags and cages when discharged.

The cost estimate includes each PJFF being provided with a preaction spray system. An optional price to use CO_2 instead of the spray system can be provided if desired.

Table 1
Brown Station
Fire Protection System Design Conditions

System Designation	**Area or Equipment Protected**	**System Type**	**Detection or Actuation Device**
Common			
STG	Electrical Equipment Area (Common for U1 and U2)	Early Warning Detection	Smoke Detectors
STG	Ash Handling Equipment Area (Common for U1 and U2)		Fire Extinguishers
STG	Pac Silos (Common for U1 and U2)	Low Pressure Carbone Dioxide	Carbon Monoxide Detector

Unit 1

System Designation	Area or Equipment Protected	System Type	Detection or Actuation Device
STG1-1	PJFF *	Automatic Water Spray (PreAction)	Spot Heat.

Unit 2

System Designation	Area or Equipment Protected	System Type	Detection or Actuation Device
STG2-1	PJFF *	Automatic Water Spray (PreAction)	Spot Heat.

Unit 3

System Designation	Area or Equipment Protected	System Type	Detection or Actuation Device
STG3-1	PJFF*	Automatic Water Spray (PreAction)	Spot Heat.
STG3-2	Fly Ash Handling Equipment Area		Fire Extinguishers
STG3-3	AQCS Electrical Building	Early Warning Detection	Smoke Detectors
STG3-4	PAC Silos	Low Pressure Carbone Dioxide	Carbon Monoxide Detector

*Optional CO2 system pricing can be provided if requested.

System Description

1.1 System Identification

- Unit Designation — Common
- System Name — Site
- System Code — STA
- File Number — 41.0804.3.BC03

1.2 Function

The Site System shall provide a stable well-drained site and vehicular access to all added structures as well as maintain acceptable access to existing facilities.

1.3 Process Description

The Roads and Parking System shall include the following major components:

Excavations and backfills

Road and parking area subgrades

Plant loop road and access roads

Reagents and sorbents unloading and containment stations

Pipe bollards at corners of buildings adjacent to roads, adjacent to truck access doors, at pipe stub-ups such as at chemical unloading stations and at fire hydrants and similar facilities

Site drainage works including inlets, culverts, catch basins, detention facilities, etc.

A site-wide storm water drainage system already exists at Brown station. To a major extent, the additions and modifications proposed by the Phase II study will not result in significant changes to the amounts and locations of concentration of storm water runoff occurring onsite.

The addition of individual structures will locally increase the impervious area, generating additional runoff, and this additional runoff will be taken into account during detailed design. To the extent practical, the existing system of ditches, trenches, and culverts, inlets, and storm sewers will be used as is to collect and convey runoff in the manner in which it is currently controlled. Erosion protection will be provided at the edges of ditches and elsewhere where concentrations of flow may occur and lead to scouring.

Selective storm drains, surface swales, and storm sewers will be added or modified to handle additional flow generated by the design storm event due to the Phase II modifications. Any overall change in site-wide runoff quantities due to the Phase II modifications is expected to be minimal.

Major construction envisioned in Phase II will in general lie in open areas next to existing roads. During construction, portions of those roads may be impacted and temporary detours or alternates will be required to maintain access through the site. Upon completion of the Phase II modifications all major existing roads will be re-established in place. A secondary connecting road between the existing parking area east of Unit 1 and the Unit 1 cooling tower will be incorporated into the service road to the Unit 2 ID fan. Asphalt paved roads and parking areas will be provided as indicated on the General Arrangement Drawing to access and maintain new equipment. Truck parking or turnouts will be provided near the bulk materials unloading areas to maintain traffic flow around those areas. Suggested locations of roads are shown on the Site Plot Plan 168908-BCDS-1000 and Site Arrangement Drawings 168908-BCDS-!001 and 1002. Final routing of the road will be determined during detailed design. Asphalt paved roads and parking areas will be provided as indicated on the General Arrangement Drawing to access and maintain new equipment.

Installation of the Phase II AQCS modifications at Units 1 and 2 will occupy and eliminate a significant portion of the existing parking lot east of Unit 1. The remaining parking area will be evaluated and reapportioned to maximize the number of parking spots east of Unit 1. Initial investigation indicated that a minimum of 60 to 70 parking spots were required to support normal and most maintenance outage traffic at Brown. It is expected that the remaining east parking lot area can be reconfigured to accommodate the required 60 to 70 parking spots in addition to offering access and truck unloading to the PAC and sorbent silos at Units 1 and 2. Should additional permanent parking be required for larger onsite projects, it can be established northeast of the Unit 3 WFGD area. Parking requirements will be finalized during detailed design.

System Description

1.1 System Identification

Unit Designation	Common
System Name	AQCS Common / Reserve Power Supply
System Codes	APB--AC Power Supply (120/208 Volts)
	APC--AC Power Supply (480 Volts)
	APD -- AC Power Supply (4160 Volts)
	APF--AC Power Supply (13,200 Volts)
	APH--DC Power Supply
	API--Uninterruptible Power Supply
File Number	41.0804.3.BC04

1.2 Function

The function of the AQCS Common Unit 1 / 2 Power Supply System shall be to distribute primary and backup electrical power to the various pieces of equipment, devices, and cabinets, and to provide overcurrent and fault protection for the Unit 1 / 2 AQCS modifications.

1.3 Process Description

1.3.1 AC Power Supply (120/208V) (APB)

Power shall be provided to 120V single-phase and 208V three-phase loads by ac panelboards rated 120/208V, three-phase, four-wire. The panelboards shall also provide branch circuit protection and a means of disconnect for the branch circuit loads through manually operated thermal magnetic circuit breakers. Power shall be provided to the panelboards by low voltage transformers, with 480V three-phase primary (APC) and 120/208V secondary with directly grounded neutral. The system shall be designed to provide 100 percent of the required continuous loads with 20 percent spare kVA.

1.3.2 AC Power Supply (480V) (APC)

Power shall be provided to 480V three-phase loads by the following major power system components, in general:

> 13,200V to 480V dry type secondary unit substation (SUS) transformers with high resistance grounded wye secondary grounding.
>
> 480V, 3-phase, 3-wire, metal enclosed double-ended SUS switchgear.
>
> 480V, 3-phase, 3-wire, motor control centers (MCCs).
>
> 480V, 3-phase, 3-wire, panelboards.
>
> 480V to 480Y/277V and 120/208V dry type transformers for lighting and receptacle loads.
>
> 480Y/277V and 120/208V, 3-phase, 4-wire panelboards for lighting and receptacle loads.

The 480V secondary of the SUS transformers shall be connected high resistance grounded wye. All SUS transformers shall be indoor, dry type transformers furnished with AN or ANAF cooling rating and a 150 ^{o}C temperature rise.

The AC Power Supply (480 V) System will be designed to feed the facility's low voltage loads. Each SUS transformer and associated low voltage switchgear line-up will be sized to serve its maximum coincidental operation load. All SUS, MCCs and panelboards will be initially designed with a minimum of 20 percent spare circuit breakers.

1.3.3 AC Power Supply (13,200V) (APF)

The 13.2 kV system shall consist of the following major components:

> One (1) two-winding delta primary, resistance grounded wye AQC Reserve Auxiliary Transformers. The high voltage rating shall be 25 kV. The low voltage side shall be 13.2 kV. The 25 kV primary feed will be supplied from the existing Unit 3 generator terminals via an isolated phase bus tap. The 13.2 kV secondary winding shall serve Unit 1 / 2 Common 13.2 kV switchgear bus A and B.
>
> One neutral grounding resistor on the secondary winding of the AQC Common Unit 1 / 2 Auxiliary Transformer.
>
> Nine (9), single vertical section, arc resistant 13.2 kV metal-clad, switchgear with a main/feeder breaker on each bus. The 13.2 kV switchgear shall be of single-high construction.
>
> The 13.2 kV switchgear shall be located within the Common Unit 1 / 2 AQC Electrical Equipment Building.

15 kV cable bus connection from the Common Unit 1 / 2 AQC Auxiliary Transformer to the Common Unit 1 / 2 AQC switchgear bus A and B.

The existing 13,200V system:

The existing FGD 13.2 kV metal-clad, switchgear bus A contains a spare 1200A breaker that will be used to supply reserve power to the Common Unit 1 / 2 switchgear bus A and B. Refer to LG&E drawing BRO-E-00100-001, Rev F. The spare breaker is located in section A6 of switchgear OAPO1E-A-SWGR.

15 kV cable bus will connect the existing 13.2kV switchgear to the Common Unit 1 / 2, 13.2 kV switchgear.

1.3.4 AC Power Supply (4,160 V) (APD)

The 4160V system shall also consist of the following major components:

Four (4), single vertical section, arc resistant 4160V metal-clad, switchgear with a main breaker on each bus. The 4160V switchgear shall be of double-high construction.

The 4160V switchgear shall be located within the Common Unit 1 and 2 AQC Electrical Equipment Building.

Two (2), 13.2 kV – 4.16 kV, Unit 1 / 2 Common 4/16 kV transformers A and B.

One neutral grounding resistor on the secondary winding of each AQC Common Unit 1 / 2, 4.16 kV Auxiliary Transformer.

1.3.5 DC Power Supply (APH)

The DC Power Supply System will consist of 125VDC lead acid station batteries, two (2) full-capacity redundant solid-state chargers per battery and a Main distribution panel.

The DC Power Supply System will consist of a station battery system located in a dedicated battery room. The system will utilize flooded type batteries with trays under the batteries. These batteries will provide DC power to the plant DCS, critical FGD System loads, and control power for the auxiliary electrical system equipment. The battery will be connected to a main distribution panel and continuously charged by two fully redundant battery chargers.

Under normal conditions, the battery chargers supply dc power to the dc loads. The battery chargers receive 480VAC power from the motor control centers. The chargers will continuously float-charge the battery while supplying power to the dc loads. Under abnormal or emergency conditions when 480VAC power is not available, the battery supplies dc power to the dc loads. Recharging of discharged batteries occurs whenever 480VAC power becomes available. The rate of charge is dependent upon the characteristics of the battery, battery chargers, and the connected dc load during charging.

Each station battery charger shall be capable of charging the fully discharged battery within 8 hours with battery load present.

The battery will be located in a dedicated battery room that is a space conditioned area so that suitable temperatures can be maintained, thus helping to ensure long battery life. Battery temperature for sizing calculations shall be 77^{o} F. The battery shall be sized in accordance with IEEE 485. An exhaust fan(s) shall be furnished for limiting the concentration of hydrogen gas in each battery room. The equalizing voltage shall be used to determine the hydrogen gas emission for fan sizing. Climate control and exhaust fans shall be provided that are suitable for the environment.

1.3.6 Uninterruptible Power Supply (API)

A UPS shall be provided in the Common AQC Electrical Building for Unit 1 and Unit 2. The UPS shall provide reliable power to the control system equipment, other equipment needing a regulated power supply, and other critical equipment needing a reliable power supply. . The UPS system shall be able to handle full load capacity for four (4) hours.

One (1) 120V AC Main UPS Distribution Panel shall be mounted with the chargers and UPS inverter. The panels shall be mounted within the AQS Electrical Building.

A120-208V AC distribution panel for the instrumentation shall be located in the AQC Electrical Building. This distribution panel shall be fed from a 480V:120-208V isolation transformer. The isolation/regulating transformer will regulate the output voltage and provide isolation and noise attenuation based on normal AC input. The voltage regulation shall be + - 1% with -10% to +20% input variation.

Each transformer will be fed from an automatic transfer switch (ATS) which will be fed from each of the 480V MCCs in the building. The ATS shall consist of a double throw power transfer switch mechanism and microprocessor controller of the same manufacturer to provide automatic operation. The ATS shall be switched automatically via voltage sensing and have the capacity to be transferred manually both locally and remotely. The distribution panels shall include circuit breakers in series with fast acting fuses for branch circuit protection.

Each UPS and isolation/regulating transformer shall include 20% spare capacity and distribution panelboards shall have 20% spare branch breakers/fuses for future use by the Purchaser.

1.4 Reference Drawing

- B&V Conceptual Overall One Line – Unit 1 / 2 Common AQCS
  168908-BCDE-E1004
- Existing FGD 13.2 kV Switchgear One Line – LG&E BRO-E-00100-001, Rev F

System Description

1.1 System Identification

- Unit Designation Unit 1
- System Name AQCS Power Supply
- System Codes APE--AC Power Supply (2400 Volts)
- File Number 41.0804.3.B101

1.2 Function

The function of the Auxiliary Power Supply System shall be to distribute electrical power to various pieces of equipment, devices, and cabinets, and to provide overcurrent and fault protection.

1.3 Process Description

1.3.1 AC Power Supply (2400V) (APE)

The Existing Unit 1 2,400 V systems consists of the following major components:

One two-winding delta primary, delta secondary. 10 MVA Main Auxiliary Transformer. The high voltage rating is 13.2 kV and the low voltage rating is 2.4 kV. The low side of the transformer supplies power to Unit 1 switchgear bus 1A & 1B.

Reserve power is supplied to switchgear bus 1A & 1B by a two-winding 10MVA, 138 kV to 2.4 kV transformer .

The de-commissioning of the Unit 2 ID Fan Motors:

The existing Unit 2 ID fan motors will be de-commissioned. One of the Unit 2 ID fan motors will be used to drive a new Unit 1 FD fan. The Unit 2 ID fan motor is a two speed motor. The Unit 2 ID fan motor and speed control equipment will be relocated so that it can drive the new Unit 1 FD fan. The power source for the new Unit 1 FD fan motor will be the existing Unit 1, 2.4 kV switchgear. The Unit 1 ID fan fed from Unit 1, section 1A11 has been decommissioned. The Unit 1 ID fan motor was rated 900 hp. The new FD fan is rated 2500/800 hp. It is expected that the under normal operating conditions the fan motor will deliver 700 hp to the new FD fan shaft. It expected, but will need to be confirmed during detailed design, that the existing Unit 1, 2.4 kV switchgear feeder breaker is section 1A11 will need minimum modification.

1.4 Reference Drawings

- Conceptual Overall One Line – Unit 1: 168908-B1DE-E1001
- Existing Unit 1 2.4 kV One Line – Client Drawing BR-E-01005

System Description

1.1 System Identification

- Unit Designation — Unit 1
- System Name — Communication
- System Code — CMA
- File Number — 41.0804.3.B102

1.2 Function

The function of the Communication System shall be to provide station personnel with a reliable and convenient means of plant paging and party line communications, and to provide raceway and other provisions for telephone/LAN wiring and equipment.

1.3 Process Description

The Communication System shall include microprocessor-based page/party equipment, raceway, and page/party communication cable as manufactured by GAI-Tronics Corporation. The new microprocessor-based system shall be fully adaptable to the existing system installed at Brown Unit 1 and shall provide self-diagnostic monitoring of the new system for system integrity. The page/party equipment shall provide two-way voice communication on each party line and shall utilize a page line for voice transmission over a plant-wide speaker system. While a conversation is taking place on a party line, other conversations may be held on other party lines or the page line. Each page/party handset station shall have five party lines and one page line. Page/party handset stations and speakers shall be strategically located throughout the plant site. The power supply for the page/party equipment shall be 120 volts ac, from the normal AC System.

The new system shall interface with the existing Brown Unit 1 system.

Raceway and space provisions for telephone/LAN equipment shall be provided. Base equipment shall be located in the common control room and peripheral equipment shall be strategically located.

System Description

1.1 System Identification

• Unit Designation	Unit 1
• System Name	Control and Monitoring
• System Code	COA
• File Number	41.0804.3.B103

1.2 Function

The existing Foxboro I/A Series Distributed Control System (DCS) will be expanded to incorporate control and monitoring of the new AQCS equipment. The resulting DCS shall provide a means to control in manual and automatic the AQCS equipment individually, as well as in coordination with other plant systems. The DCS shall be central to all plant operations and control the various systems and subsystems, including those required for the new AQCS equipment. The existing DCS will be the central location in the plant for alarm management, historical data archiving, report generation, and data trending. The primary operator interface to the DCS shall be the existing Unit 1 workstations located in the Unit 1 and Unit 2 Brown Control Room. The existing combustion control and unit protection systems will be retained in the existing Unit 1 DCS to protect critical plant equipment, including critical FD fan and draft system interlocks.

New local operator stations are included in the conceptual design for the AQCS areas.

- The new AQCS DCS shall consist of the extending existing Unit 1 and FGD mesh network, and the addition of new redundant controllers to control the new AQCS common unit equipment. The AQCS DCS equipment shall communicate by means of redundant network data highways.

The AQCS DCS equipment shall include the following major components:

- AQC Network Cabinet/Fiber Optic Patch Panel.
- Redundant Controllers.
- DCS system cabinets and input/output (I/O) cabinets.

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1.3 Process Description

The AQCS DCS control processors shall contain the control logic for the AQCS equipment. Analog control loop logic and discrete logic shall be implemented in the redundant control processors. The Unit 1 Main Control Room DCS operator interface equipment shall be used as the means to control and monitor plant AQCS processes and process equipment. The DCS configuration will provide interface to all AQCS processes and equipment from either the Unit 1 designated operator workstations.

The AQCS DCS equipment shall interface with the existing DCS to allow retrieval of historic plant data, trend process parameters, and to develop specialized displays of plant information. The operator graphics shall be developed based on the AQCS systems to be controlled, and displayed in a hierarchical format.

The configuration of the AQCS DCS equipment shall take into account redundancy wherever the failure or loss of a component could cause plant upset or loss of generation capacity. Total control processor loading for all required control parameters and communication functions shall be limited to no more than 80 percent loading on each redundant pair. . Each input/output cabinet shall contain 20 percent installed spare modules to allow for future expansion.

DCS processor and I/O cabinets shall be located in space-conditioned rooms in the following locations to allow control and instrument cabling to be managed within buildings, minimizing the amount of cable installed between buildings:

- Common Unit 1 and 2 AQCS Electrical Building.

Control processors, power supplies, input/output cards, and other associated hardware shall be a common form factor to provide flexibility of mounting individual control system devices on common rack or carrier. Process controllers, input/output modules, mounting racks or carriers, communication hardware, power supplies, ventilation fans, and other required accessories shall be housed in industrial enclosures with NEMA rating appropriate for the mounting location of the cabinet.

System Description

1.1 System Identification

- Unit Designation — Unit 1
- System Name — Lighting
- System Code — LTA
- File Number — 41.0804.3.B104

1.2 Function

The function of the Lighting System is to provide station personnel with illumination for station operation under normal conditions, egress under emergency conditions, and emergency operational lighting to perform tasks during a power outage of the normal source. The permanent lighting may be used for construction lighting in areas where early installation is practical. Additional construction lighting shall be provided using temporary luminaires and construction power distribution grid. The system also provides 120 volt convenience outlets for portable lamps and tools.

1.3 Process Description

Luminaires for areas with finished acoustical ceilings, if any, shall be fluorescent static troffers. The lighting system for continuously occupied control rooms shall utilize the same type static troffer, except with a dimming ballast and 1/2 inch square louvered low iridescent parabolic diffuser for glare control. Fluorescent lamps shall be energy effiicent 3000K, T8 and not exceed four feet and shall be low mercury content. Ballasts shall be energy efficient electronic type with less than 10 percent harmonic content.

Low bay, wall and stanchion mount luminaires shall be used in outdoor areas and unfinished, hazardous and non-hazardous, enclosed areas of the station. Metal halide luminaires shall be used in the industrial and high bay areas of the plant. Metal halide luminaires shall comply with the Energy Independence and Security Act of 2007, and therefore, all metal halide ballasts and lamps 400 watts and under shall be pulse start metal halide type. Except for high bay areas, pulse start metal halide luminaires shall be enclosed and gasketed with threaded glass refractors. Luminaires located in hazardous areas shall be Underwriters Laboratories (UL), or other North American third party testing lab, listed for the National Electrical Code (NEC) classification. High bay luminaires shall be enclosed and have aluminum or glass reflectors. Luminaires in wet locations or in wash down areas shall be in National Electrical Manufacturers Association (NEMA) 4 enclosures. Approximately 25 percent of the non-hazardous industrial area metal halide luminaires shall be provided with a quartz auxiliary lamp option to provide immediate illumination upon starting and restrike conditions.

Emergency lighting shall be provided for interior building egress paths, interior stairways, selected areas around electrical equipment, and local control rooms. The emergency lighting luminaires for the plant areas shall be powered from individual battery pack units with halogen lamps. Emergency lighting shall provide 90 minutes of operation per the NFPA Life Safety Code 101. Emergency operational lighting for control room area lighting shall be powered by connecting selected fluorescent luminaires to the plant UPS system.

Exit light luminaires shall use light emitting diode (LED) lamps for most areas, with compact fluorescent lamps used in hazardous rated areas, and shall be located in the egress pathways and ground level exit doors of enclosed buildings. The exit luminaires shall be powered from normal ac power and integral batteries for emergency service.

Roadway luminaires shall be pulse start metal halide, cutoff cobra head type mounted on aluminum or galvanized steel poles with helix steel or concrete anchor foundations.

Power used to supply fluorescent and pulse start metal halide luminaires shall be 277 volt ac, except for the possible use of 120 volt ac power for some small remote buildings where 277 volt ac power is not readily available or economically feasible. Luminaires shall be powered from the panelboards, with alternate luminaires or rows of luminaires fed from alternate panelboard circuit breakers. Power used to supply convenience receptacles shall be 120 volts ac. Power used to supply roadway and area lighting shall be 480 or 277 volts ac.

Lighting is not required for roof top PRVs. However, one 120 volt ac ground fault current interrupter receptacle shall be installed on the roof and suitable for access to all the PRV's. A photoelectric controlled light fixture shall be installed near any roof top access doors.

Convenience receptacles shall be grounded duplex type and located throughout the station. The convenience receptacles shall be a minumum of 15 inches above the floor in office areas and 36 inches above the floor in industrial areas. The convenience outlets shall be spaced, at the same elevation, to provide access to any point in the industrial areas with a 100 foot extension cord. Convenience outlets for use without extension cords shall be located in finished areas such as offices, control room, and laboratory. Each outlet shall have the grounding pole located at the top of the device. Each office shall have a minimum of two receptacles on opposite walls. No more than eight receptacles shall be connected to a branch circuit breaker. Receptacles shall be circuited to alternating circuits within an area. Weatherproof snap action covers shall be installed on all receptacles located outdoors and in wet indoor areas. In general, receptacles for outdoor and plant indoor wet areas shall be standard 125 volt, 20 amp, 2-pole with ground, NEMA 5-20R type. Selected receptacles in finished and industrial areas shall have GFCI protection in accordance with the NEC. In areas with hazardous atmospheres, convenience outlets shall be suitable for the NEC class, division, and group requirements.

Operation of the Lighting System is dependent upon the visual requirements of the station operating personnel. The general lighting for interior process areas shall be manually switched on and off at panelboard circuit breakers. The lighting for smaller enclosed areas within the buildings shall be manually switched on and off at local light switches near personnel entrance doors. The OFF position of the toggle switch shall be in the downward position. The lighting for continuously occupied control rooms shall be controlled from dimmer switches. The exterior process area lighting shall be controlled through common contactors that automatically operate between sunset and sunrise via photoelectric controllers. The lighting contactors shall have a hand-off-auto (HOA) switch for daytime maintenance override. Luminaires with integral photocells shall be provided for roadway luminaires and luminaires at exterior personnel entrances only. Separate photo-electrically controlled electrically held lighting contactors with a HOA switch shall be provided for exterior lighting in different areas of the plant.

Luminaires shall be installed at a minimum height of 7 feet 0 inches above the floor to provide an unobstructed way of exit travel from any point in the buildings. Luminaires shall be designed and installed with consideration for maintenance and access. Luminaires shall be installed in locations where maintenance shall not be blocked by structural steel, piping, raceway, grating, etc.

Lighting cable powered from 277 volt ac and all branch circuits installed outdoors shall be XHHW-2 . All 120 volt ac branch circuits installed indoors in heated spaces shall be THHN cable. Pre-assembled and prewired cable assemblies shall be used only in finished environments.

Lighting and receptacle branch circuit voltage drop shall not exceed 3%. This shall include the voltage drop from the last outlet in the branch circuit to the lighting panelboard. In addition, 120 volt branch circuits longer than 75 feet shall use 10 AWG and 277 volt branch circuits longer than 200 feet shall use 10 AWG conductors.
General access interior structure lighting for permanent structures required during construction shall be provided using the permanent luminaires connected to the construction power grid, where practical. Any additional lighting required for construction operation shall be provided by the construction contractor.

The Lighting System shall comply with the regulatory requirements of Occupational Safety and Health Administration (OSHA) and applicable building codes.

Lighting shall be designed in accordance with the Illuminating Engineering Society of North America (IESNA) to provide the illumination levels recommended by the following standards and organizations:

- American National Standards Institute (ANSI)/IESNA RP-7, Industrial Lighting.
- ANSI/IESNA RP-8, Roadway Lighting.
- OSHA.

- National Fire Protection Association (NFPA), National Electric Code (NFPA 70).

- NFPA, Life Safety Code (NFPA 101).

- Local Building Code (latest adopted version).

The following criteria shall also be considered in the lighting system design:

- Illumination calculations shall be based upon the mean lumen output of the respective lamps (lamp lumen depreciation [LLD]).

- Illumination calculations shall be based upon a luminaire dirt depreciation (LDD) factor.

- Interior illumination calculations shall be based upon a room surface dirt depreciation (RSDD) factor.

- Illumination calculations shall be based upon the luminaire ballast factors of the light fixtures utilized in the design.

- The illumination calculations shall be determined at a 30 inch workplane height above the floor.

System Description

1.1 System Identification

- Unit Designation — Unit 1
- System Name — Buildings and Enclosures
- System Code — BSA
- File Number — 41.0804.3.B105

1.2 Function

The function of the Buildings and Enclosures System will be to provide support, enclosure, and access to the systems contained within each structure's boundaries.

1.3 Description

The various structures associated with the Buildings and Enclosures will generally consist of the following six components:

- Foundation--provides support and carries the loads to the subsurface.
- Structural frame--provides support for the contained systems and stability for the entire structure.
- Architectural--provides isolation of systems, enclosure, and protection from natural phenomena, where required, through walls, partitions, ceilings, and roofs.
- Access--provides means of ingress and egress and allow for access to the contained systems and equipment through doors, stairs, floors, cranes, and hoists.
- Space Conditioning -- provides the required heating, ventilating and air conditioning for the buildings.
- Drains and Plumbing--provides plumbing, floor and equipment drains and floor trenches and sumps for the enclosed equipment and facilities.

The buildings and structures will be designed to accommodate the function and arrangement of the systems they enclose. Building arrangements will take into consideration maintenance and operating access requirements as well as the equipment itself. Suitable design features will be provided to prevent or contain oil or chemical spills where appropriate. All occupied buildings will be designed to meet NFPA 100 Life

Safety egress requirements. Since no new or refurbished administrative areas are included within the scope of the Phase II Unit 1 modifications, the new structures will not require design in accordance with the Americans with Disability Act Accessibility Guidelines (ADAAG) requirements.

HVAC systems will be designed to maintain indoor conditions suitable for the equipment and operations enclosed under the design ambient conditions for the Project site in the Project Design Memorandum. Ventilation, heating, and cooling equipment will be located to ensure relatively uniform temperature distribution throughout the space. Air conditioning for control and electrical equipment will be designed to meet appropriate filtration levels and noise criteria.

Fire protection systems meeting appropriate NFPA and building code requirements will be provided for each building where required. Since none of the new buildings or structures intended for the Phase II Unit 1 modifications is expected to be manned on a continuous basis, and since existing facilities remain in the immediate area, no plumbing or toilets are intended for these structures.

1.3.1 Unit 1 SCR Support Structure

A 100%-capacity Unit 1 selective catalytic reduction module will be installed in the location noted on the arrangement drawings. The module will be elevated and will require a substantial support structure. The structure will be of braced frame structural steel construction mounted on deep foundations. In addition to the SCR module, the structure will house and support the new FD fan, air preheater, and air heater, plus associated ammonia injection equipment, planned for Unit 1.

The support structure will be enclosed with un-insulated metal wall panel to provide a windbreak and weather protection to the fan and air heater. HVAC is expected to include ventilation only unless the enclosed equipment requires heating or additional cooling. The structure will be served by an integral stairwell for personnel access and will support the necessary platforming and jib crane required for servicing the catalyst in the SCR.

1.3.2 Unit 1 PJFF Structure

The Unit 1 pulse jet fabric filter need not be installed at an elevation higher than grade. Accordingly, no separate superstructure beyond that supplied as part of the PJFF itself is required. A concrete foundation supported on auger-cast piles or drilled piers will be provided for the PJFF similar to any other piece of furnished “equipment” such as the FD fans. The area beneath the PJFF bag housing will be enclosed with un-insulated metal wall panel to provide a windbreak and weather protection to the area around the ash hoppers.

1.3.3. Unit 1/Unit 2 Common AQCS Electrical Building

A common AQCS Electrical Building will house additional electrical and control equipment serving the new PJFFs at both Unit 1 and Unit 2 and the new ID fan at Unit 2. The Common Electrical Building is intended as a single story pre-engineered metal building mounted to a small foundation with a floating interior slab. For purposes of the estimate, drilled piers were assumed under the columns of the building with a floating slab making up the interior floor. The superstructure will consist of steel framing enclosed with insulated metal panel walls and roof. The interior will be of unfinished construction and doors will be located and sized to access equipment for maintenance as well as provide personnel access. HVAC will be as required for the equipment enclosed, but will at minimum include heating and ventilation. The battery room and DCS equipment room within the building are expected to be air conditioned to provide the environment required for the equipment. The building is intended as a “dry” enclosure and floor drains will be minimized.

1.3.4 Unit 1/Unit 2 Common Fly Ash Handling Building

A Fly Ash Handling Building will house a common Unit 1/Unit 2 dry fly ash handling system serving both Units 1 and 2. This equipment, along with the air compressors and receivers required to perform the pulse jet cleaning of the PJFF bags for both units, will be housed in a building adjacent to the Common AQCS Electrical Building. The Fly Ash Handling Building is intended as a single story pre-engineered metal building on a concrete foundation. The concrete foundation will be supported on drilled piers and will contain equipment pads for mounting of equipment. The superstructure will consist of steel framing enclosed with insulated metal panel walls and roof. The interior will be of unfinished construction. Personnel and overhead doors will be located and sized to access equipment for maintenance as well as provide personnel access. HVAC will include heating and ventilation, except as otherwise required by specific equipment.

System Description

1.1 System Identification

- Unit Designation — Unit 1
- System Name — Fly Ash
- System Code — ASB
- File Number — 41.0804.3.B106

1.2 Function

At time of this report, installation is underway under separate contract of an onsite dry landfill for fly ash intended to serve all three units at Brown. It is assumed for purposes of this report that the new ash landfill will be completed and that landfilling of fly ash is in operation at the time Unit 1 AQCS modifications are made.

The Fly Ash System will pneumatically remove fly ash from the pulse jet fabric filter (PJFF) hoppers and transfer it to a new dry ash storage and loadout silo located in the general area of the landfill southwest of Unit 3. In addition, the ash handling system will transfer powdered activated carbon (PAC) and sorbent which is injected upstream of the PJFF and collected in the PJFF hoppers. The collected fly ash byproducts will be conveyed to the fly ash silo(s) for temporary storage. The stored ash will subsequently be conditioned and loaded into trucks for deposition in the landfill. The process is shown on drawing 168908-B1ASB-M2022: Unit 1 PFD - Fly Ash Handling.

1.3 Process Description

The Fly Ash System includes the following major equipment and components:

- Fly ash feed valves
- Fly ash filter separators
- Fly ash pressure transfer blowers and conveying equipment
- Common fly ash storage and loadout silos

The Fly Ash System will be essentially an entirely new dry system from the pickup points at the Unit 1 AQCS addition to the new common storage silo. Each collection point in the common Fly Ash System will be tied into a positive pressure conveying system, including filter separators, a collection and transfer tank, pressure pots, and 2 x 50% pressure transfer blowers, located adjacent to the PJFF. The new transfer system

will be sized to transfer all collected fly ash from the 100% capacity PJFF and any additional pickup points required within the ductwork upstream of the PJFFs. The Unit 1 System capacity and operating margin will be determined during detailed design.

Each PJFF hopper or ductwork pickup point will be equipped with a manual hopper isolation valve and new automatic feed valves. The automatic feed valves will isolate the hopper being emptied and provide a controlled flow of fly ash to the conveyor line. The conveying system will sequentially remove ash from the collection hoppers and transfer it to the filter separators and transfer tank. The transfer blowers will then provide the motive force to forward the ash to the common storage silos serving the landfill. Blowers and ancillary equipment for the Common Fly Ash System will be housed in the Unit 1/Unit 2 Common Fly Ash Handling Building.

System Description

1.1 System Identification

- Unit Designation — Unit 1
- System Name — Induced Draft
- System Code — CCE
- File Number — 41.0804.3.B107

1.2 Function

The Induced Draft System, in conjunction with the steam generator forced draft fan, provides the static pressure required to induce the flow of combustion gases from the steam generator furnace through the gas path to the stack. The system includes the capability of controlling the flue gas flow rate to maintain furnace draft over the specified load range.

1.3 Process Description

The Induced Draft System will consist of the following major components.

- One existing 100 percent capacity, centrifugal induced draft (ID) fan using a single-speed motor and inlet vanes as the primary means of flow control.
- Existing, direct-drive induction motor designed for the full ID fan capacity.
- Existing coupling to transmit the rotational energy from the new motors to the new fan.
- Existing ID fan lubricating oil unit.
- Existing ID fan inlet vanes and actuator.
- Existing ID fan discharge damper and damper drive.
- New economizer bypass ductwork, expansion joints, and modulating dampers.
- New economizer backpressure dampers
- New unit bypass ductwork to the old Unit 3 stack (through Unit 2 ID fan outlet ductwork) including expansion joints and a damper.

- Associated new and existing ductwork and expansion joints upstream and downstream of the ID fan.
- Associated new and existing piping, valves, instruments, controls, and accessories.

The existing ID fan will induce flow of the combustion gases through the steam generator, new selective catalytic reduction (SCR) system, new regenerative air heater, and new pulse jet fabric filter (PJFF). The ID fan will also provide sufficient pressure to exhaust the combustion gases through the wet flue gas desulfurization (WFGD) scrubber and the existing stack common to all Brown units. The ID fan could also be used during the steam generator and associated equipment and ductwork purging cycle prior to firing fuel in the furnace or after the steam generator is shut down. A new planned bypass to the old Unit 3 stack through Unit 2 ID fan outlet ductwork could be used in these startup and shutdown instances provided the new Unit 2 ID fan is online preventing flue gases from entering the Unit 2 draft system. If the new Unit 2 ID fan is offline and Unit 2 is utilizing its bypass to the old Unit 3 stack as a natural draft vent then Unit 1 must purge with its existing ID fan through the common WFGD scrubber or vent naturally through its existing old stack. The ductwork between the old Unit 1 stack and the existing ID fan would remain in operation.

The existing centrifugal ID fan will continue to use inlet vanes as the primary means of exhaust gas flow control over the unit operating load range. The inlet vanes will be used to control the flow of exhaust gases depending on the desired capacity from the plant control system. The system will control the ID fan to maintain the furnace pressure at a predetermined value. During a severe transient, such as a loss of fuel, the system will remain capable of responding to the commands from the Distributed Control System (DCS) in such a manner as to avoid any damage from a negative pressure transient in the steam generator and other draft system components.

In conjunction with the forced draft and primary air fans, combustion flue gas will flow from the PJFF outlet to the existing inlet duct of the ID fan. The 100 percent capacity ID fan will discharge into existing ductwork exhausting combustion flue gas to the existing common WFGD scrubber and stack to the atmosphere. Unit 1 could also operate with the common WFGD scrubber offline where the ID fan would exhaust flue gas to the existing Unit 3 bypass stack. However, Unit 1 and Unit 2 cannot simultaneously bypass to the Unit 3 bypass stack while each is at full load.

The economizer bypass ductwork and dampers would bypass flue gas around the economizer in the boiler to increase the overall temperature of the flue gas entering the new SCR system. The bypass ducts would exit the boiler back pass above the economizer and inject the higher temperature flue gas into the SCR system inlet duct. The proper reaction temperatures entering the SCR system would be maintained by the modulating dampers in the economizer bypass ducts. Should the flue gas pressure drop across the economizer decrease to a point that does not allow a suitable amount of flue gas to bypass the economizer, backpressure dampers would be modulated to correct this.

Expansion joints will be provided in the new ductwork where required to accommodate movements due to thermal expansion and contraction. This will prevent detrimental stresses in the ductwork, deformation, or failure of structures or equipment due to thermal expansion. Inlet and outlet isolation dampers and a forced lubrication oil unit are provided with the ID fan. The ID fan sound level is attenuated by the use of insulation and lagging of the ID fan casing.

The new and existing ductwork will continue to provide a flow path from the outlet of the steam generator to the new SCR system, the new air heater, the new PJFF, then to the existing ID fan. The flow path exiting the ID fan will enter the existing common WFGD scrubber and stack.

System Description

1.1 System Identification

• Unit Designation	Unit 1
• System Name	Pulse Jet Fabric Filter
• System Code	CCB
• File Number	41.0804.3.B108

1.2 Function

The Particulate Removal System will collect particulate matter from the boiler flue gas stream on filter bags. Particulate matter will also be collected from the powder activated carbon (PAC) and sorbent injection systems in ductwork upstream of the pulse jet fabric filter. The collected particulate will be stored in hoppers until removed by the Fly Ash Handling System.

1.3 Process Description

The Particulate Removal System will include the following major equipment and components:

- Pulse Jet Fabric Filter (PJFF) casing with inlet and outlet transition ducts and expansion joints.
- Fabric filter compartment inlet, outlet dampers, and casing bypass dampers along with seal air system.
- Fabric filters bags and cages.
- Air pulse cleaning system, including headers, valves, and controls.
- Compressors, air driers, and air receivers with 100 percent spare capacity
- Hoppers, including heaters, level detectors, and ports for hopper fluidizing system.
- Permanent and mobile pre-coating system
- Insulation and lagging of fabric filter housing.
- Walk-in or Top door plenum to allow access to the tube sheet for inspection, and maintenance.
- Weather enclosed penthouse with lighting and ventilation.
- Electric hoist on the exterior penthouse level to lift boxes of bags and cages to the penthouse level for maintenance purposes.
- Access provisions required for maintenance, including hoists.
- Associated piping, valves, instruments, controls, and accessories.

The Particulate Removal System consists of compartmentalized PJFF located between the sorbent injection lances and the inlet of the ID fan. The number of compartments is determined by economic compartment sizing, total flue gas flow rate, air-to-cloth ratio, and cleaning system design. The PJFF will be designed with a spare compartment.

Under normal operation, flue gas enters the fabric filter inlet plenum and is distributed to the individual compartments through inlet dampers at each fabric filter compartment. Flue gas will pass upwards through the filter bags where the particulates within the gas stream will collect on the outside of the filter bags and the clean gas exits each fabric filter compartment through an outlet damper into fabric filter outlet plenum. To prevent collapse of the bag, a metal cage is installed on the inside of the filter bags. Filter bags and cages are suspended from a tube sheet at the top of the compartment. Each individual compartment will be provided with inlet and outlet isolation dampers for access or maintenance.

The collected particulate will be cleaned from the filter bags by suddenly inflating the filter bags with a pulse of compressed air over several rows of filter bags, causing the dust on the outside to separate from the bags and drop into hoppers below. The pulsing system will have optimum flow geometry and will be designed with no mechanically actuated parts or acoustic systems that are required to operate for the pulse air cleaning process. The cleaning frequency will be regulated by the control system based on overall fabric filter pressure drop. Online or isolated mode of cleaning of fabric filter will also be regulated by the control system. The fabric filter will be pulse-cleaned utilizing clean, dry, oil free, compressed air supplied by pulse jet air compressors and associated air receivers and dryers.

The dust collected in the fabric filter discharge hoppers will be fluidized and removed by the Fly Ash Handling System. The flue gas from the outlet plenum of the fabric filter will flow through the ID fan and then to the Wet Flue Gas Desulfurization System.

The PJFF shall be designed to achieve particulate matter emissions of 0.01 lb/MBtu. The fabric filter shall be designed to allow for continuous, reliable operation of the boiler at the maximum flue gas flow rate and grain loading with one fabric filter compartment removed from service for maintenance with the fabric filter net cloth velocity not exceeding 4.0 ft/s.

System Description

1.1 System Identification

• Unit Designation	Unit 1
• System Name	Neural Network
• System Code	SGM
• File Number	41.0804.3.B109

1.2 Function

Neural networks utilize a DCS based computer system that obtains plant data such as load, firing rate, burner position, air flow, CO emissions, etc. The computer system analyzes the impact of various combustion parameters on CO emissions. The system then provides feedback to the control system to improve operation for lower CO emissions.

In addition to burner performance these monitoring systems also allow continuous indication of pulverizer, classifier and fuel delivery system performance to provide early indication of impending component failures or maintenance requirements. This system is also used to improve heat rate and often provides operational cost savings along with CO control.

1.3 Process Description

The Neural Network System uses real-time operational data extracted from the plant DCS to “learn” solutions from plant operational experience to achieve reductions in the emissions produced, while possibly improving the heat rate of the plant.

Neural network computing differs from traditional computing in that engineering, statistical, and first-law principles have been replaced by complex, time-varying, nonlinear relationships. Neural networks do not presume that a relationship is known between process inputs and outputs, but rather determines the relationships by analyzing datasets of input and output.

Neural network equipment will be minimal, consisting of a few computer servers that can be located in the same room as the DCS master equipment

System Description

1.1 System Identification

- Unit Designation — Unit 1
- System Name — AQCS Compressed Air
- System Code — CAB
- File Number — 41.0804.3.B110

1.2 Function

The Air Quality Control System (AQCS) Compressed Air Systems will provide the clean, dry, oil free compressed air at an adequate pressure and adequate capacity for the pulse jet fabric filter (PJFF), actuators, controls, instrumentation, and other air users in the AQCS addition.

1.3 Process Description

The AQCS Compressed Air System includes the following major equipment and components:

- Two full capacity air compressors.
- Two full capacity air filter/dryers.
- One air receiver.
- Distribution pipe, valve, and fittings
- Controls and instruments

Two full capacity air compressors will be provided to supply air to the air receiver. During normal operation, only one of the compressors will be in service at a time. Air from the compressors is routed to the air filter/dryers that will dry control air to a dew point of -40° F or lower before entering the air receiver. Air will be supplied from the receiver to the PJFF and other users upon demand.

Cross-ties with the existing station and control air systems will be installed. These will allow air from either existing system to be used to back-up the AQCS compressed air system. It will also allow AQCS compressed air to be used to back-up the existing systems. The equipment comprising the AQCS Compressed Air System is intended to be located in a room within the Unit1/Unit 2 Common Fly Ash Transfer Building.

System Description

1.1 System Identification

• Unit Designation	Unit 1
• System Name	AQCS Service Water
• System Code	WSC
• File Number	41.0804.3.B111

1.2 Function

The Air Quality Control System (AQCS) Service Water System will extend the existing service water systems for washdown, makeup, and seal water for equipment in the AQCS areas.

1.3 Process Description

The AQCS Service Water System will consist of the following major equipment and components:

- Washdown stations
- Distribution piping, valves, and fittings
- Controls and instruments

The source of service water will be from a branch connection from the existing service water distribution piping. Existing service water quality will be sufficient for the AQCS systems.

Service water distribution piping will supply seal and makeup water to washdown stations servicing all AQCS additions.

System Description

1.1 System Identification

- Unit Designation — Unit 1
- System Name — Powder Activated Carbon Injection
- System Code — CCH
- File Number — 41.0804.3.B112

1.2 Function

The function of the Powder Activated Carbon (PAC) Injection system is to remove mercury from the flue gas by injecting PAC into the flue gas ductwork between the air heater outlet and the pulse jet fabric filter inlet.

1.3 Process Description

The PAC Injection System will be common between Unit 1 and Unit 2 and will consist of the following equipment and components:

- Two (2) PAC storage silos with structural skirted enclosure with all necessary appurtenances.
- Two blower/feeder skid assemblies for each silo.
- Rotary valve and motors.
- Feed hoppers.
- Screw feeder and motors.
- Eductors.
- PAC distribution manifolds with isolation valves to each lance.
- Custom injection lances with flex hose connections.
- Associated piping, valves, instruments, and accessories.
- Controls and instrumentation.

The PAC Injection System will receive bulk PAC by truck. The PAC will be unloaded pneumatically into one of the storage silos through a stationary positive pressure dilute phase conveying system. The trucks will be equipped with their own pneumatic unloading system or by a secondary blower located at the silos.

The PAC will be fed from the silo by a rotary valve into a volumetric feeder hopper where it will be temporarily stored. The PAC will then be conveyed by the feeder screw into the drop tube. The variable speed motor for the screw feeder allows for adjustment of the PAC feed rate. The PAC will be fed through the drop tube directly into the eductor inlet, located below the feeder discharge.

The passing of motive air through the eductor nozzle will produce a vacuum in the eductor inlet, which will help draw the PAC and air into the mixing zone directly downstream of the mouth. The PAC will be transported through the piping system and is distributed to an array of injection lances to evenly distribute the carbon into the existing flue gas stream to maintain Hg emissions below 1 lb/TBtu based on the flue gas flow rate, temperature and upstream Hg concentration.

The injection lances are placed in the ductwork stream before the pulse jet fabric filter (PJFF). The number of injection lances will vary based on the width of the receiving duct and the required rate of injection. Each lance will contain valves and instrumentation for verifying flow out of each lance. A marshalling cabinet will allow plant operators to access data collected from the injection lances, flue gas analyzers and other instruments on the injection system. A long residence time for the flue gas, moving through straight sections of ductwork from the injection ports to the downstream filtering equipment, is essential to remove Hg. A retention time less than two seconds is unfavorable for a PAC injection system’s ability to remove Hg. The PJFF removes the activated carbon particles along with the adsorbed mercury.

System Description

1.1 System Identification

- Unit Designation — Unit 1
- System Name — Ammonia Supply
- System Code — CGE
- File Number — 41.0804.3.B113

1.2 Function

The Ammonia Supply System shall include the following major components:

- Two 34,000-gallon anhydrous ammonia storage tanks common for all Unit 1, 2, and 3, with adequate storage capacity to require refilling no more than one time per 11 days based on ammonia consumption of all three units.
- Two ammonia truck unloading skids common for all Unit 1, 2, and 3.
- Two full-capacity ammonia pumps common for all Unit 1, 2, and 3.
- One Unit 1 ammonia injection skid. The skid consists of two full capacity mass flow meters and ammonia flow control valve trains.
- Two full capacity ammonia dilution air blowers for Unit 1 SCR reactor.
- Two full capacity air pre-heaters for Unit 1 SCR reactor.

1.3 Process Description

The Ammonia Supply System provides a means of transferring anhydrous ammonia to the selective catalytic reduction (SCR) system

The anhydrous ammonia storage tanks, ammonia truck unloading skids, and Unit 3 ammonia pumps are currently being designed as a part of the Unit 3 SCR system. Liquid anhydrous ammonia from the common anhydrous ammonia storage tanks will be directed to Units 1, 2, and 3 ammonia injection skids by the common ammonia pumps.

Unit 1 ammonia injection system will consist of one ammonia injection skid and an ammonia dilution air system. The ammonia injection skid will consist of two 100% mass flow meters and ammonia flow control valve trains, pipe, valves, and instrumentations. The ammonia dilution air system will consist of two 100% ammonia dilution air blowers and two 100% air pre-heaters to provide hot dilution air. Air pre-heaters will be steam heater type. Steam will be provided from the existing plant auxiliary steam supply header.

Upon demand, ammonia flow rate will be controlled by the flow controllers and mixed with the hot dilution air stream to dilute the ammonia to a concentration of 5% by volume before introduced into Unit 1 SCR flue gas streams. Air flow rate will be measured by air flow meters located upstream of the air/ammonia mixing devices.

System Description

1.1 System Identification

- Unit Designation — Unit 1
- System Name — Selective Catalytic Reduction
- System Code — CCF
- File Number — 41.0804.3.B114

1.2 Function

The function of the NO_x Reduction system is to remove NO_x from the flue gas. The NO_x Reduction System uses the injection of ammonia (NH_3) into the flue gas and a Selective Catalytic Reduction (SCR) system to produce molecular nitrogen (N_2) and water vapor. These reactions take place in the SCR reactor in the presence of a catalyst with known cycle life under appropriate temperature conditions, pressure conditions and fuel characteristics.

1.3 Process Description

The Selective Catalytic Reduction System will include the following major equipment and components:

- SCR reactor.
- Catalyst.
- NO_x analyzers.
- Diluent (O_2 or CO_2) analyzers.
- Sonic horns and/or soot blowers
- Large Particle Ash (LPA) Screen
- Ammonia injection control valves
- Delta Wing Static Mixers and Guide Vanes
- Ductwork, dampers, and expansion joints.

The hot flue gas leaving the economizer section of the boiler will pass through a large particle ash (LPA) screen before proceeding to the ammonia injection site and to the SCR reactor. The LPA screen will be used to remove any ash particles that are larger than the pitch of the catalyst. The objective of the LPA screen is to avoid potential operating problems due to catalyst plugging. The primary ammonia mixers are located in the vertical section of the inlet duct to mix the incoming anhydrous ammonia into the flue gas. There are two 100% anhydrous ammonia injection control valves per reactor that flash the sub-cooled anhydrous ammonia and inject vaporized ammonia directly into a dilution air stream. An anhydrous ammonia storage area is currently being designed for the site as part of the Unit 3 SCR installation. It is assumed that this system will supply ammonia to the injection skid via two 100% anhydrous ammonia feed pumps. This ammonia-air vapor is introduced behind the Delta Wing static mixers where it is mixed with the flue gas to ensure uniform distribution of the NO_x and NH_3. The ammonia reacts with the NO_x in the presence of the catalyst to remove NO_x from the flue gas. The quantity of ammonia can be adjusted as it reacts with the NO_x in the presence of the catalyst to remove NO_x from the flue gas. The inlet duct continues onward to the reactor inlet. The elbow at the reactor inlet is fitted with small mixing plates, called homogenizers, which provide increased uniformity of ash distribution across the entire catalyst surface. The final turn downward into the catalyst utilizes a large array of turning vanes to guide the gas downward to the topmost layer of catalyst and minimize dust collection in the reactor cap

The guide vanes in the reactor inlet elbow are used to align the flue gas and ash particles to within the specified flow requirements of design standards required for high removal efficiency SCR systems. The mixing devices including Delta Wings static mixers, and guide vanes are necessary to ensure an optimal flow to the catalyst. The removable door sections on each catalyst layer are used to load and unload catalyst from the reactor. These door sections are seal welded in place to prevent leakage of flue gas or infiltration of air into the reactor. The temperature measurement connections at each catalyst layer and at the SCR inlet and outlet are used to monitor the temperature of the catalyst and reactor steel structure during start-up and operation. The sonic horn catalyst cleaning system on the reactor provides the required cleaning of the catalyst during normal operation. Inlet and outlet flue gas pressure transmitters are provided across the SCR reactor to continually measure and record SCR pressure loss. NOx measurement systems installed in each of the SCR inlet and outlet ducts are used to control ammonia injection to each reactor.

The flue gas leaves the reactor inlet turning vanes and enters the first layer of catalyst in a uniform manner. The flue gas is homogeneously distributed over the reactor cross-sectional area and passes through the catalyst face. This insures minimal erosion by ash impact on the catalyst. The flow continues through the second layer in the same manner. The flue gas exits the reactor and enters the air heater inlet duct. Turning vanes and plates are used, as required, ensuring acceptable distributions of ash, temperature and flow to the air heater.

The potential NO_x reduction is sensitive to the temperature of reaction and time available for the NO_x reducing reaction to occur. The catalyst is of vanadium/titanium dioxide based material. Sealing material is installed between catalyst blocks to prevent untreated flue gas leakage.

System Description

1.1 System Identification

- Unit Designation — Unit 1
- System Name — Sorbent Injection
- System Code — CCH
- File Number — 41.0804.3.B115

1.2 Function

The function of the Sorbent Injection System is to remove SO_3 from the flue gas by injecting sorbent into the flue gas ductwork between the air heater outlet and the pulse jet fabric filter (PJFF) inlet.

1.3 Process Description

The Sorbent Injection System will be common between Unit 1 and Unit 2 and will consist of the following equipment and components:

- Two (2) sorbent storage silos with structural skirted enclosure with all necessary appurtenances.
- Two blower/feeder skid assemblies for each silo.
- Rotary valve and motors.
- Feed hoppers.
- Screw feeder and motors.
- Eductors.
- Sorbent distribution manifolds with isolation valves to each lance.
- Custom injection lances with flex hose connections.
- Associated piping, valves, instruments, and accessories.
- Controls and instrumentation.

The Sorbent Injection System will receive bulk sorbent by truck. The sorbent will be unloaded pneumatically into one of the storage silos through a stationary positive pressure dilute phase conveying system. The trucks should be equipped with their own pneumatic unloading system.

The sorbent will be fed from the silo by a rotary valve into a volumetric feeder hopper where it will be temporarily stored. The sorbent will then be conveyed by the feeder screw into the drop tube. The sorbent will be fed through the drop tube directly into the eductor inlet, located below the feeder discharge.

The passing of motive air through the eductor nozzle will produce a vacuum in the eductor inlet, which will help draw the sorbent and air into the mixing zone directly downstream of the mouth. The sorbent will be transported through the piping system and is distributed to an array of injection lances and into the boiler exhaust gas stream to maintain H_2SO_4 emissions below 5 ppmvd @ 3% O_2 based on the flue gas flow rate, temperature and upstream H_2SO_4 concentration.

The number of injection lances will vary based on the width of the receiving duct and the required rate of injection. Each lance will contain valves and instrumentation for verifying flow out of each lance. A marshalling cabinet will allow plant operators to access data collected from the injection lances, flue gas analyzers and other instruments on the injection system. A long residence time for the flue gas, moving through straight sections of ductwork from the injection ports to the downstream filtering equipment, is essential to remove H_2SO_4. A retention time less than two seconds is unfavorable for a sorbent injection system's ability to remove H_2SO_4.

System Description

1.1 System Identification

- Unit Designation Unit 1
- System Name Air Preheat
- System Code SGC
- File Number 41.0804.3.B116

1.2 Function

The Air Preheat system provides preheating of the combustion air by using hot water from the Deaerator in combination with the preheat coil. The Air Preheat system is capable of supplying the necessary energy to preheat the combustion air over the specified load range to minimize flue gas acid gas condensation at the air heater gas outlet.

1.3 Process Description

The Air Preheat System will consist of the following major components.

- Two new 100% nominal capacity preheat coil pumps.
- One new 100% preheat coil.
- Associated new valves, instruments, controls, and accessories.

The new Air Preheat system will draw hot water from the Deaerator using the preheat coil pumps. The hot water will then return to the Deaerator for reheating. The hot water will be used in the preheat coil to preheat the incoming combustion air minimizing flue gas acid gas condensation at the air heater gas outlet. The new preheat coil will interface with the outlet of the new Forced Draft (FD) fan combustion air ductwork and the inlet ductwork of the new air heater. The preheat coil inlet will be downstream of the FD fan outlet damper and the outlet will be at the air heater air inlet. A suggested location of the new preheat coil pumps will be locate them on the ground floor to allow for enough suction head. Actual location of the preheat coil pumps will be determined during detailed design.

System Description

1.1 System Identification

- Unit Designation — Unit 1
- System Name — Combustion Air
- System Code — CCE
- File Number — 41.0804.3.B117

1.2 Function

The Combustion Air System, in conjunction with the induced draft fan, provides the static pressure required to force the flow of combustion air from the atmosphere through the combustion air path to the furnace. The system includes the capability of controlling the combustion air flow rate to maintain desired boiler outlet oxygen concentration over the specified load range.

1.3 Process Description

The Combustion Air System will consist of the following major components.

- One new 100 percent capacity, centrifugal forced draft (FD) fan using a two-speed motor and inlet vanes as the primary means of flow control.
- Direct-drive induction motor to drive the FD fan to its full capacity. One of the existing Unit 2 two-speed ID fan motors will be used for this service.
- New coupling to transmit the rotational energy from the motor to the new fan.
- New FD fan lubricating oil unit.
- New FD fan inlet vanes and actuator.
- New FD fan discharge damper and damper drive.
- New FD fan inlet silencer
- Associated new and existing ductwork and expansion joints upstream of the existing air heater air outlet ductwork.
- Associated new piping, valves, instruments, controls, and accessories.

The new FD fan will provide sufficient pressure to force the combustion air from the atmosphere through the new air preheat coil, new air heater, and to the steam generator. A portion of the combustion air will be diverted to the primary air system as well downstream of the new air heater. The FD fan would also be used during the steam generator and associated equipment and ductwork purging cycle prior to firing fuel in the furnace or after the steam generator is shut down.

The new centrifugal FD fan will use inlet vanes as the primary means of combustion air flow control over the unit operating load range. The existing Unit 2 ID Fan two-speed motor proposed to be used could also be used for gross flow control. The inlet vanes will be used to precisely control the flow of combustion air depending on the desired capacity from the plant control system. The system will control the FD fan to a predetermined boiler outlet oxygen concentration. During a severe transient, such as a loss of fuel, the system will remain capable of responding to the commands from the Distributed Control System (DCS) in such a manner as to avoid any damage from a positive pressure transient in the steam generator and other draft system components.

In conjunction with the induced draft fan, combustion air will flow from the atmosphere and silencer to the inlet of the FD fan. The 100 percent capacity FD fan will discharge into new ductwork forcing combustion air through the new air preheat coil and new regenerative air heater to the primary air system and steam generator.

Expansion joints will be provided in the new ductwork where required to accommodate movements due to thermal expansion and contraction. This will prevent detrimental stresses in the ductwork, deformation, or failure of structures or equipment due to thermal expansion. Inlet and outlet isolation dampers and a forced lubrication oil unit are provided with the FD fan. The FD fan sound level is attenuated by the use of a silencer in the FD fan inlet duct and insulation and lagging of the FD fan casing.

The new and existing ductwork will continue to provide a flow path from the atmosphere and inlet silencer of the FD fan to the new FD fan, new air preheat coil, new regenerative air heater, then to the existing primary air system and steam generator.

System Description

1.1 System Identification

- Unit Designation — Unit 1
- System Name — Air Heater
- System Code — CCE
- File Number — 41.0804.3.B118

1.2 Function

The Air Heater System provides the heat transfer required to increase the temperature of the incoming combustion air utilizing energy from the flue gas stream. An increase in boiler efficiency and the ability to drying fuel are the results. The system also includes the capability of maintaining the cleanliness of the system through multimedia sootblowers.

1.3 Process Description

The Combustion Air System will consist of the following major components.

- One new 100 percent capacity, bisector ljungstrom vertical shaft regenerative air heater.
- Integral duplex sealing system minimizing leakage
- New, induction motor and gear train to drive the air heater rotor.
- New drive system lubricating oil unit.
- New multimedia sootblowers.
- Associated new piping, valves, instruments, controls, and accessories.

The new air heater will provide sufficient heat transfer maximizing boiler efficiency and allowing for the drying of fuel while minimizing the flue gas outlet temperature's approach to the acid gas dew point. Heat transfer is accomplished through a rotating mass that continuously rotates in and out of the flue gas and combustion air streams. Rotational speed is typically around one revolution per minute. The rotating mass increases in temperature as it passes into the flue gas stream. Then as the mass rotates into the combustion air stream the mass releases the energy gained in the flue gas stream to the combustion air stream thereby increasing the combustion air temperature.

Typically the rotating mass is separated into equally spaced sectors which can be likened to sectors of a pie. Increasing the number of sectors aids in the reduction of leakage along with a duplex sealing system and other measures that are available. Placed in each of these sectors are the baskets that permit combustion air and flue gas to pass through in a turbulent fashion allowing the capture and release of energy.

The rotating mass is also separated vertically. For a selective catalytic reduction (SCR) system application, such as with this air heater, there are typically two sections, a hot section and a cold section. With only two sections the effectiveness of basket cleaning devices is maximized since there is only one open gap in the middle of the air heater for the cleaning media lose a significant amount of energy. The cleaning devices, or sootblowers, for SCR system applications are recommended to be multimedia capable where steam or compress air would be one media and high pressure water would be the other. Also aiding in cleaning ability is an enamel coating on all air heater baskets minimizing the ability of particulate and compounds in the flue gas stream to attach to the baskets. Altogether, these measures discussed here allow the Air Heater System to maintain cleanliness and maximize heat transfer while allow the corresponding unit to remain online.

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — AQCS Power Supply
- System Codes — APE--AC Power Supply (2400 Volts)
- File Number — 41.0804.3.B201

1.2 Function

The function of the Auxiliary Power Supply System shall be to distribute electrical power to various pieces of equipment, devices, and cabinets, and to provide overcurrent and fault protection.

1.3 Process Description

1.3.1 AC Power Supply (2400V) (APE)

The Existing Unit 2, 2.4 kV systems consists of the following major components:

> One two-winding delta primary, delta secondary. 10 MVA Main Auxiliary Transformer. The high voltage rating is 17.1 kV and the low voltage rating is 2.4 kV. The low side of the transformer supplies power to Unit 2 switchgear bus 2A & 2B.
>
> Reserve power is supplied to switchgear bus 2A & 2B by a two-winding 10MVA, 138 kV to 2.4 kV transformer .

The de-commissioning of the Unit 2 ID Fan Motors:

> The existing Unit 2 ID fan motors will be de-commissioned. One of the Unit 2 ID fan motors will be used to drive a new Unit 2 FD fan. The Unit 2 ID fan motor is a two speed motor. The Unit 2 ID fan motor and speed control equipment will be relocated so that it can drive the new Unit 2 FD fan. The power source for the new Unit 2 FD fan motor will be the existing Unit 2, 2.4 kV switchgear. The Unit 2 ID fan fed from Unit 2, section 13 now feeds ID Fan 2-1 which will be de-commissioned. The section 13 feeder will supply power to what will become the Unit 2 FD fan motor. It expected, but will need to be confirmed during detailed design, that the existing Unit 2, 2.4 kV switchgear

feeder breaker is section 13 will need no modification. The only change will be the abandonment of the existing cable and the new cable routed and terminated at the location of the new FD fan

1.4 Reference Drawings

- Conceptual Overall One Line – Unit 1: 168908-B2DE-E1002
- Existing Unit 2, 2.4 kV One Line – Client Drawing BR-E-02001

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — Communication
- System Code — CMA
- File Number — 41.0804.3.B202

1.2 Function

The function of the Communication System shall be to provide station personnel with a reliable and convenient means of plant paging and party line communications, and to provide raceway and other provisions for telephone/LAN wiring and equipment.

1.3 Process Description

The Communication System shall include microprocessor-based page/party equipment, raceway, and page/party communication cable as manufactured by GAI-Tronics Corporation. The new microprocessor-based system shall be fully adaptable to the existing system installed at Brown Unit 2 and shall provide self-diagnostic monitoring of the new system for system integrity. The page/party equipment shall provide two-way voice communication on each party line and shall utilize a page line for voice transmission over a plant-wide speaker system. While a conversation is taking place on a party line, other conversations may be held on other party lines or the page line. Each page/party handset station shall have five party lines and one page line. Page/party handset stations and speakers shall be strategically located throughout the plant site. The power supply for the page/party equipment shall be 120 volts ac, from the normal AC System.

The new system shall interface with the existing Brown Unit 2 system.

Raceway and space provisions for telephone/LAN equipment shall be provided. Base equipment shall be located in the common control room and peripheral equipment shall be strategically located.

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — Control and Monitoring
- System Code — COA
- File Number — 41.0804.3.B203

1.2 Function

The existing Foxboro I/A Series Distributed Control System (DCS) will be expanded to incorporate control and monitoring of the new AQCS equipment. The resulting DCS shall provide a means to control in manual and automatic the AQCS equipment individually, as well as in coordination with other plant systems. The DCS shall be central to all plant operations and control the various systems and subsystems, including those required for the new AQCS equipment. The existing DCS will be the central location in the plant for alarm management, historical data archiving, report generation, and data trending. The primary operator interface to the DCS shall be the existing Unit 2 workstations located in the Common Unit 1 and Unit 2 Brown Control Room. The existing combustion control and unit protection systems will be retained in the existing Unit 2 Bailey DCS to protect critical plant equipment, including critical FD/ID fans and draft system interlocks.

New local operator stations are included in the conceptual design for the AQCS areas.

- The new AQCS DCS shall consist of the extending existing Unit 1 and FGD Mesh Network, and the addition of new redundant controllers to control the new AQCS common unit equipment. The AQCS DCS equipment shall communicate by means of redundant network data highways.

The AQCS DCS equipment shall include the following major components:

- AQC Network Cabinet/Fiber Optic Patch Panel.
- Redundant Controllers.
- DCS system cabinets and input/output (I/O) cabinets.

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1.3 Process Description

The AQCS DCS control processors shall contain the control logic for the AQCS equipment. Analog control loop logic and discrete logic shall be implemented in the redundant control processors. The Unit 2 Main Control Room DCS operator interface equipment shall be used as the means to control and monitor plant AQCS processes and process equipment. The DCS configuration will provide interface to all AQCS processes and equipment from either the Unit 2 designated operator workstations.

The AQCS DCS equipment shall interface with the existing DCS to allow retrieval of historic plant data, trend process parameters, and to develop specialized displays of plant information. The operator graphics shall be developed based on the AQCS systems to be controlled, and displayed in a hierarchical format.

The configuration of the AQCS DCS equipment shall take into account redundancy wherever the failure or loss of a component could cause plant upset or loss of generation capacity. Total control processor loading for all required control parameters and communication functions shall be limited to no more than 80 percent loading on each redundant pair. . Each input/output cabinet shall contain 20 percent installed spare modules to allow for future expansion.

DCS processor and I/O cabinets shall be located in space-conditioned rooms in the following locations to allow control and instrument cabling to be managed within buildings, minimizing the amount of cable installed between buildings:

- Common Unit 1 & 2 AQCS Electrical Building.

Control processors, power supplies, input/output cards, and other associated hardware shall be a common form factor to provide flexibility of mounting individual control system devices on common rack or carrier. Process controllers, input/output modules, mounting racks or carriers, communication hardware, power supplies, ventilation fans, and other required accessories shall be housed in industrial enclosures with NEMA rating appropriate for the mounting location of the cabinet.

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — Lighting
- System Code — LTA
- File Number — 41.0804.3.B204

1.2 Function

The function of the Lighting System is to provide station personnel with illumination for station operation under normal conditions, egress under emergency conditions, and emergency operational lighting to perform tasks during a power outage of the normal source. The permanent lighting may be used for construction lighting in areas where early installation is practical. Additional construction lighting shall be provided using temporary luminaires and construction power distribution grid. The system also provides 120 volt convenience outlets for portable lamps and tools.

1.3 Process Description

Luminaires for areas with finished acoustical ceilings, if any, shall be fluorescent static troffers. The lighting system for continuously occupied control rooms shall utilize the same type static troffer, except with a dimming ballast and 1/2 inch square louvered low iridescent parabolic diffuser for glare control. Fluorescent lamps shall be energy effiicent 3000K, T8 and not exceed four feet and shall be low mercury content. Ballasts shall be energy efficient electronic type with less than 10 percent harmonic content.

Low bay, wall and stanchion mount luminaires shall be used in outdoor areas and unfinished, hazardous and non-hazardous, enclosed areas of the station. Metal halide luminaires shall be used in the industrial and high bay areas of the plant. Metal halide luminaires shall comply with the Energy Independence and Security Act of 2007, and therefore, all metal halide ballasts and lamps 400 watts and under shall be pulse start metal halide type. Except for high bay areas, pulse start metal halide luminaires shall be enclosed and gasketed with threaded glass refractors. Luminaires located in hazardous areas shall be Underwriters Laboratories (UL), or other North American third party testing lab, listed for the National Electrical Code (NEC) classification. High bay luminaires shall be enclosed and have aluminum or glass reflectors. Luminaires in wet locations or in wash down areas shall be in National Electrical Manufacturers Association (NEMA) 4 enclosures. Approximately 25 percent of the non-hazardous industrial area metal halide luminaires shall be provided with a quartz auxiliary lamp option to provide immediate illumination upon starting and restrike conditions.

Emergency lighting shall be provided for interior building egress paths, interior stairways, selected areas around electrical equipment, and local control rooms. The emergency lighting luminaires for the plant areas shall be powered from individual battery pack units with halogen lamps. Emergency lighting shall provide 90 minutes of operation per the NFPA Life Safety Code 101. Emergency operational lighting for control room area lighting shall be powered by connecting selected fluorescent luminaires to the plant UPS system.

Exit light luminaires shall use light emitting diode (LED) lamps for most areas, with compact fluorescent lamps used in hazardous rated areas, and shall be located in the egress pathways and ground level exit doors of enclosed buildings. The exit luminaires shall be powered from normal ac power and integral batteries for emergency service.

Roadway luminaires shall be pulse start metal halide, cutoff cobra head type mounted on aluminum or galvanized steel poles with helix steel or concrete anchor foundations.

Power used to supply fluorescent and pulse start metal halide luminaires shall be 277 volt ac, except for the possible use of 120 volt ac power for some small remote buildings where 277 volt ac power is not readily available or economically feasible. Luminaires shall be powered from the panelboards, with alternate luminaires or rows of luminaires fed from alternate panelboard circuit breakers. Power used to supply convenience receptacles shall be 120 volts ac. Power used to supply roadway and area lighting shall be 480 or 277 volts ac.

Lighting is not required for roof top PRVs. However, one 120 volt ac ground fault current interrupter receptacle shall be installed on the roof and suitable for access to all the PRV’s. A photoelectric controlled light fixture shall be installed near any roof top access doors.

Convenience receptacles shall be grounded duplex type and located throughout the station. The convenience receptacles shall be a minumum of 15 inches above the floor in office areas and 36 inches above the floor in industrial areas. The convenience outlets shall be spaced, at the same elevation, to provide access to any point in the industrial areas with a 100 foot extension cord. Convenience outlets for use without extension cords shall be located in finished areas such as offices, control room, and laboratory. Each outlet shall have the grounding pole located at the top of the device. Each office shall have a minimum of two receptacles on opposite walls. No more than eight receptacles shall be connected to a branch circuit breaker. Receptacles shall be circuited to alternating circuits within an area. Weatherproof snap action covers shall be installed on all receptacles located outdoors and in wet indoor areas. In general, receptacles for outdoor and plant indoor wet areas shall be standard 125 volt, 20 amp, 2-pole with ground, NEMA 5-20R type. Selected receptacles in finished and industrial areas shall have GFCI protection in accordance with the NEC. In areas with hazardous atmospheres, convenience outlets shall be suitable for the NEC class, division, and group requirements.

Operation of the Lighting System is dependent upon the visual requirements of the station operating personnel. The general lighting for interior process areas shall be manually switched on and off at panelboard circuit breakers. The lighting for smaller enclosed areas within the buildings shall be manually switched on and off at local light switches near personnel entrance doors. The OFF position of the toggle switch shall be in the downward position. The lighting for continuously occupied control rooms shall be controlled from dimmer switches. The exterior process area lighting shall be controlled through common contactors that automatically operate between sunset and sunrise via photoelectric controllers. The lighting contactors shall have a hand-off-auto (HOA) switch for daytime maintenance override. Luminaires with integral photocells shall be provided for roadway luminaires and luminaires at exterior personnel entrances only. Separate photo-electrically controlled electrically held lighting contactors with a HOA switch shall be provided for exterior lighting in different areas of the plant.

Luminaires shall be installed at a minimum height of 7 feet 0 inches above the floor to provide an unobstructed way of exit travel from any point in the buildings. Luminaires shall be designed and installed with consideration for maintenance and access. Luminaires shall be installed in locations where maintenance shall not be blocked by structural steel, piping, raceway, grating, etc.

Lighting cable powered from 277 volt ac and all branch circuits installed outdoors shall be XHHW-2 . All 120 volt ac branch circuits installed indoors in heated spaces shall be THHN cable. Pre-assembled and prewired cable assemblies shall be used only in finished environments.

Lighting and receptacle branch circuit voltage drop shall not exceed 3%. This shall include the voltage drop from the last outlet in the branch circuit to the lighting panelboard. In addition, 120 volt branch circuits longer than 75 feet shall use 10 AWG and 277 volt branch circuits longer than 200 feet shall use 10 AWG conductors.
General access interior structure lighting for permanent structures required during construction shall be provided using the permanent luminaires connected to the construction power grid, where practical. Any additional lighting required for construction operation shall be provided by the construction contractor.

The Lighting System shall comply with the regulatory requirements of Occupational Safety and Health Administration (OSHA) and applicable building codes.

Lighting shall be designed in accordance with the Illuminating Engineering Society of North America (IESNA) to provide the illumination levels recommended by the following standards and organizations:

- American National Standards Institute (ANSI)/IESNA RP-7, Industrial Lighting.
- ANSI/IESNA RP-8, Roadway Lighting.
- OSHA.

- National Fire Protection Association (NFPA), National Electric Code (NFPA 70).
- NFPA, Life Safety Code (NFPA 101).
- Local Building Code (latest adopted version).

The following criteria shall also be considered in the lighting system design:

- Illumination calculations shall be based upon the mean lumen output of the respective lamps (lamp lumen depreciation [LLD]).
- Illumination calculations shall be based upon a luminaire dirt depreciation (LDD) factor.
- Interior illumination calculations shall be based upon a room surface dirt depreciation (RSDD) factor.
- Illumination calculations shall be based upon the luminaire ballast factors of the light fixtures utilized in the design.
- The illumination calculations shall be determined at a 30 inch workplane height above the floor.

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — Buildings and Enclosures
- System Code — BSA
- File Number — 41.0804.3.B205

1.2 Function

The function of the Buildings and Enclosures System will be to provide support, enclosure, and access to the systems contained within each structure's boundaries.

1.3 Description

The various structures associated with the Buildings and Enclosures will generally consist of the following six components:

- Foundation--provides support and carries the loads to the subsurface.
- Structural frame--provides support for the contained systems and stability for the entire structure.
- Architectural--provides isolation of systems, enclosure, and protection from natural phenomena, where required, through walls, partitions, ceilings, and roofs.
- Access--provides means of ingress and egress and allow for access to the contained systems and equipment through doors, stairs, floors, cranes, and hoists.
- Space Conditioning -- provides the required heating, ventilating and air conditioning for the buildings.
- Drains and Plumbing--provides plumbing, floor and equipment drains and floor trenches and sumps for the enclosed equipment and facilities.

The buildings and structures will be designed to accommodate the function and arrangement of the systems they enclose. Building arrangements will take into consideration maintenance and operating access requirements as well as the equipment itself. Suitable design features will be provided to prevent or contain oil or chemical spills where appropriate. All occupied buildings will be designed to meet NFPA 100 Life

Safety egress requirements. Since no new or refurbished administrative areas are included within the scope of the Phase II Unit 2 modifications, the new structures will not require design in accordance with the Americans with Disability Act Accessibility Guidelines (ADAAG) requirements.

HVAC systems will be designed to maintain indoor conditions suitable for the equipment and operations enclosed under the design ambient conditions for the Project site in the Project Design Memorandum. Ventilation, heating, and cooling equipment will be located to ensure relatively uniform temperature distribution throughout the space. Air conditioning for control and electrical equipment will be designed to meet appropriate filtration levels and noise criteria.

Fire protection systems meeting appropriate NFPA and building code requirements will be provided for each building where required. Since none of the new buildings or structures intended for the Phase II Unit 2 modifications is expected to be manned on a continuous basis, and since existing facilities remain in the immediate area, no plumbing or toilets are intended for these structures.

1.3.1 Unit 2 SCR Support Structure

A 100%-capacity Unit 2 selective catalytic reduction module will be installed in the location noted on the arrangement drawings. The module will be elevated and will require a substantial support structure. The structure will be of braced frame structural steel construction mounted on deep foundations. In addition to the SCR module, the structure will house and support the new FD fan, air preheater, and air heater, plus associated ammonia injection equipment, planned for Unit 2.

The support structure will be enclosed with un-insulated metal wall panel to provide a windbreak and weather protection to the fan and air heater. HVAC is expected to include ventilation only unless the enclosed equipment requires heating or additional cooling. The structure will be served by an integral stairwell for personnel access and will support the necessary platforming and jib crane required for servicing the catalyst in the SCR.

Both the Unit 1 and Unit 2 SCR support structures were, for purposes of the estimate, considered as separate and independent structures. Due to the adjacent locations of these structures, consideration should be given at time of detailed design to incorporating both into a single structure for greater stability and potential cost savings.

1.3.2 Unit 2 PJFF Structure

The Unit 2 pulse jet fabric filter need not be installed at an elevation higher than grade. Accordingly, no separate superstructure beyond that supplied as part of the PJFF itself is required. A concrete foundation supported on auger-cast piles or drilled piers will be provided for the PJFF similar to any other piece of furnished “equipment” such as the ID fans. The area beneath the PJFF bag housing will be enclosed with un-insulated metal wall panel to provide a windbreak and weather protection to the area around the ash hoppers.

1.3.3. Unit 1/Unit 2 Common AQCS Electrical Building

A common AQCS Electrical Building will house additional electrical and control equipment serving the new PJFF at both Unit 1 and Unit 2 and the ID fan at Unit 2. The Common Electrical Building is described in more detail in the Unit 1 Buildings and Enclosures System Description, File 168908.41.0804.3.B105.

1.3.4 Unit 1/Unit 2 Common Fly Ash Handling Building

A Fly Ash Handling Building will house a common Unit 1/Unit 2 dry fly ash handling system serving both Units 1 and 2. The Common Fly Ash Handling Building is described in more detail in the Unit 1 Buildings and Enclosures System Description, File 168908.41.0804.3.B105.

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — Fly Ash
- System Code — ASB
- File Number — 41.0804.3.B206

1.2 Function

At time of this report, installation is underway under separate contract of an onsite dry landfill for fly ash intended to serve all three units at Brown. It is assumed for purposes of this report that the new ash landfill will be completed and that landfilling of fly ash is in operation at the time Unit 2 AQCS modifications are made.

The Fly Ash System will pneumatically remove fly ash from the pulse jet fabric filter (PJFF) hoppers and transfer it to a new dry ash storage and loadout silo located in the general area of the landfill southwest of Unit 3. In addition, the ash handling system will transfer powdered activated carbon (PAC) and sorbent which is injected upstream of the PJFF and collected in the PJFF hoppers. The collected fly ash byproducts will be conveyed to the fly ash silo(s) for temporary storage. The stored ash will subsequently be conditioned and loaded into trucks for deposition in the landfill. The process is shown on drawing 168908-B2ASB-M2022: Unit 2 PFD - Fly Ash Handling.

1.3 Process Description

The Fly Ash System includes the following major equipment and components:

- Fly ash feed valves
- Fly ash filter separators
- Fly ash pressure transfer blowers and conveying equipment
- Common fly ash storage and loadout silos

The Fly Ash System will be essentially an entirely new dry system from the pickup points at the Unit 2 AQCS addition to the new common storage silo. Each collection point in the common Fly Ash System will be tied into a positive pressure conveying system, including filter separators, a collection and transfer tank, pressure pots, and 2 x 50% pressure transfer blowers, located adjacent to the PJFF. The new transfer system

will be sized to transfer all collected fly ash from the 100% capacity PJFF and any additional pickup points required within the ductwork upstream of the PJFFs. The Unit 2 System capacity and operating margin will be determined during detailed design.

Each PJFF hopper or ductwork pickup point will be equipped with a manual hopper isolation valve and new automatic feed valves. The automatic feed valves will isolate the hopper being emptied and provide a controlled flow of fly ash to the conveyor line. The conveying system will sequentially remove ash from the collection hoppers and transfer it to the filter separators and transfer tank. The transfer blowers will then provide the motive force to forward the ash to the common storage silos serving the landfill. Blowers and ancillary equipment for the Common Fly Ash System will be housed in the Unit 1/Unit 2 Common Fly Ash Handling Building.

System Description

1.1 System Identification

- Unit Designation Unit 2
- System Name Induced Draft
- System Code CCE
- File Number 41.0804.3.B207

1.2 Function

The Induced Draft System, in conjunction with the steam generator forced draft fan, provides the static pressure required to induce the flow of combustion gases from the steam generator furnace through the gas path to the stack. The system includes the capability of controlling the flue gas flow rate to maintain furnace draft over the specified load range.

1.3 Process Description

The Induced Draft System will consist of the following major components.

- One new 100 percent capacity, centrifugal induced draft (ID) fan using a single-speed motor and inlet vanes as the primary means of flow control.
- New, direct-drive induction motor designed for the full ID fan capacity.
- New coupling to transmit the rotational energy from the new motors to the new fan.
- New ID fan lubricating oil unit.
- New ID fan inlet vanes and actuator.
- New ID fan discharge damper and damper drive.
- New economizer bypass ductwork, expansion joints, and modulating dampers.
- New economizer backpressure dampers
- Associated new and existing ductwork and expansion joints upstream and downstream of the ID fan.

- Associated new and existing piping, valves, instruments, controls, and accessories.

The ID fan will induce flow of the combustion gases through the steam generator, new selective catalytic reduction (SCR) system, new regenerative air heater, and new pulse jet fabric filter (PJFF). The new ID fan will also provide sufficient pressure to exhaust the combustion gases through the wet flue gas desulfurization (WFGD) scrubber and the existing stack common to all Brown units. The ID fan would also be used during the steam generator and associated equipment and ductwork purging cycle prior to firing fuel in the furnace or after the steam generator is shut down. The existing bypass ductwork to the old Unit 3 stack could be used in these startup and shutdown instances.

The new centrifugal ID fan will be designed for direct connection to a new motor and will use inlet vanes as the primary means of exhaust gas flow control over the unit operating load range. The inlet vanes will be used to control the flow of exhaust gases depending on the desired capacity from the plant control system. The system will control the ID fan to maintain the furnace pressure at a predetermined value. During a severe transient, such as a loss of fuel, the system will be capable of responding to the commands from the Distributed Control System (DCS) in such a manner as to avoid any damage from a negative pressure transient in the steam generator and other draft system components.

In conjunction with the forced draft and primary air fans, combustion flue gas will flow from the PJFF outlet to the inlet duct of the ID fan. The 100 percent capacity ID fan will discharge into ductwork exhausting combustion flue gas to the existing common WFGD scrubber and stack to the atmosphere. Unit 2 could also operate with the common WFGD scrubber offline where the new ID fan would exhaust flue gas to the existing Unit 3 bypass stack. However, Unit 1 and Unit 2 cannot simultaneously bypass to the Unit 3 bypass stack while each is at full load.

The economizer bypass ductwork and dampers would bypass flue gas around the economizer in the boiler to increase the overall temperature of the flue gas entering the new SCR system. The bypass ducts would exit the boiler back pass above the economizer and inject the higher temperature flue gas into the SCR system inlet duct. The proper reaction temperatures entering the SCR system would be maintained by the modulating dampers in the economizer bypass ducts. Should the flue gas pressure drop across the economizer decrease to a point that does not allow a suitable amount of flue gas to bypass the economizer, backpressure dampers would be modulated to correct this.

Expansion joints will be provided in the new ductwork where required to accommodate movements due to thermal expansion and contraction. This will prevent detrimental stresses in the ductwork, deformation, or failure of structures or equipment due to thermal expansion. Inlet and outlet isolation dampers and a forced lubrication oil unit are provided with the ID fan. The ID fan sound level is attenuated by the use of insulation and lagging of the ID fan casing.

The new and existing ductwork will continue to provide a flow path from the outlet of the steam generator to the new SCR system, the new air heater, the new PJFF, then to the new ID fan. The flow path exiting the ID fan will enter the existing common WFGD scrubber and stack.

System Description

1.1 System Identification

• Unit Designation	Unit 2
• System Name	Pulse Jet Fabric Filter
• System Code	CCB
• File Number	41.0804.3.B208

1.2 Function

The Particulate Removal System will collect particulate matter from the boiler flue gas stream on filter bags. Particulate matter will also be collected from the powder activated carbon (PAC) and sorbent injection systems in ductwork upstream of the pulse jet fabric filter. The collected particulate will be stored in hoppers until removed by the Fly Ash Handling System.

1.3 Process Description

The Particulate Removal System will include the following major equipment and components:

- Pulse Jet Fabric Filter (PJFF) casing with inlet and outlet transition ducts and expansion joints.
- Fabric filter compartment inlet, outlet dampers, and casing bypass dampers along with seal air system.
- Fabric filters bags and cages.
- Air pulse cleaning system, including headers, valves, and controls.
- Compressors, air driers, and air receivers with 100 percent spare capacity
- Hoppers, including heaters, level detectors, and ports for hopper fluidizing system.
- Permanent and mobile pre-coating system
- Insulation and lagging of fabric filter housing.
- Walk-in or Top door plenum to allow access to the tube sheet for inspection, and maintenance.
- Weather enclosed penthouse with lighting and ventilation.
- Electric hoist on the exterior penthouse level to lift boxes of bags and cages to the penthouse level for maintenance purposes.
- Access provisions required for maintenance, including hoists.
- Associated piping, valves, instruments, controls, and accessories.

The Particulate Removal System consists of compartmentalized PJFF located between the sorbent injection lances and the inlet of the ID fan. The number of compartments is determined by economic compartment sizing, total flue gas flow rate, air-to-cloth ratio, and cleaning system design. The PJFF will be designed with a spare compartment.

Under normal operation, flue gas enters the fabric filter inlet plenum and is distributed to the individual compartments through inlet dampers at each fabric filter compartment. Flue gas will pass upwards through the filter bags where the particulates within the gas stream will collect on the outside of the filter bags and the clean gas exits each fabric filter compartment through an outlet damper into fabric filter outlet plenum. To prevent collapse of the bag, a metal cage is installed on the inside of the filter bags. Filter bags and cages are suspended from a tube sheet at the top of the compartment. Each individual compartment will be provided with inlet and outlet isolation dampers for access or maintenance.

The collected particulate will be cleaned from the filter bags by suddenly inflating the filter bags with a pulse of compressed air over several rows of filter bags, causing the dust on the outside to separate from the bags and drop into hoppers below. The pulsing system will have optimum flow geometry and will be designed with no mechanically actuated parts or acoustic systems that are required to operate for the pulse air cleaning process. The cleaning frequency will be regulated by the control system based on overall fabric filter pressure drop. Online or isolated mode of cleaning of fabric filter will also be regulated by the control system. The fabric filter will be pulse-cleaned utilizing clean, dry, oil free, compressed air supplied by pulse jet air compressors and associated air receivers and dryers.

The dust collected in the fabric filter discharge hoppers will be fluidized and removed by the Fly Ash Handling System. The flue gas from the outlet plenum of the fabric filter will flow through the ID fan and then to the Wet Flue Gas Desulfurization System.

The PJFF shall be designed to achieve particulate matter emissions of 0.01 lb/MBtu. The fabric filter shall be designed to allow for continuous, reliable operation of the boiler at the maximum flue gas flow rate and grain loading with one fabric filter compartment removed from service for maintenance with the fabric filter net cloth velocity not exceeding 4.0 ft/s.

System Description

1.1 System Identification

• Unit Designation	Unit 2
• System Name	Neural Network
• System Code	SGM
• File Number	41.0804.3.B209

1.2 Function

Neural networks utilize a DCS based computer system that obtains plant data such as load, firing rate, burner position, air flow, CO emissions, etc. The computer system analyzes the impact of various combustion parameters on CO emissions. The system then provides feedback to the control system to improve operation for lower CO emissions.

In addition to burner performance these monitoring systems also allow continuous indication of pulverizer, classifier and fuel delivery system performance to provide early indication of impending component failures or maintenance requirements. This system is also used to improve heat rate and often provides operational cost savings along with CO control.

1.3 Process Description

The Neural Network System uses real-time operational data extracted from the plant DCS to “learn” solutions from plant operational experience to achieve reductions in the emissions produced, while possibly improving the heat rate of the plant.

Neural network computing differs from traditional computing in that engineering, statistical, and first-law principles have been replaced by complex, time-varying, nonlinear relationships. Neural networks do not presume that a relationship is known between process inputs and outputs, but rather determines the relationships by analyzing datasets of input and output.

Neural network equipment will be minimal, consisting of a few computer servers that can be located in the same room as the DCS master equipment

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — AQCS Compressed Air
- System Code — CAB
- File Number — 41.0804.3.B210

1.2 Function

The Air Quality Control System (AQCS) Compressed Air Systems will provide the clean, dry, oil free compressed air at an adequate pressure and adequate capacity for the pulse jet fabric filter (PJFF), actuators, controls, instrumentation, and other air users in the AQCS addition.

1.3 Process Description

The AQCS Compressed Air System includes the following major equipment and components:

- Two full capacity air compressors.
- Two full capacity air filter/dryers.
- One air receiver.
- Distribution pipe, valve, and fittings
- Controls and instruments

Two full capacity air compressors will be provided to supply air to the air receiver. During normal operation, only one of the compressors will be in service at a time. Air from the compressors is routed to the air filter/dryers that will dry control air to a dew point of -40° F or lower before entering the air receiver. Air will be supplied from the receiver to the PJFF and other users upon demand.

Cross-ties with the existing station and control air systems will be installed. These will allow air from either existing system to be used to back-up the AQCS compressed air system. It will also allow AQCS compressed air to be used to back-up the existing systems. The equipment comprising the AQCS Compressed Air System is intended to be located in a room within the Unit1/Unit 2 Common Fly Ash Transfer Building.

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — AQCS Service Water
- System Code — WSC
- File Number — 41.0804.3.B211

1.2 Function

The Air Quality Control System (AQCS) Service Water System will extend the existing service water systems for washdown, makeup, and seal water for equipment in the AQCS areas.

1.3 Process Description

The AQCS Service Water System will consist of the following major equipment and components:

- Washdown stations
- Distribution piping, valves, and fittings
- Controls and instruments

The source of service water will be from a branch connection from the existing service water distribution piping. Existing service water quality will be sufficient for the AQCS systems.

Service water distribution piping will supply seal and makeup water to washdown stations servicing all AQCS additions.

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — Powder Activated Carbon Injection
- System Code — CCH
- File Number — 41.0804.3.B212

1.2 Function

The function of the Powder Activated Carbon (PAC) Injection system is to remove mercury from the flue gas by injecting PAC into the flue gas ductwork between the air heater outlet and the pulse jet fabric filter inlet.

1.3 Process Description

The PAC Injection System will be common between Unit 1 and Unit 2 and will consist of the following equipment and components:

- Two (2) PAC storage silos with structural skirted enclosure with all necessary appurtenances.
- Two blower/feeder skid assemblies for each silo.
- Rotary valve and motors.
- Feed hoppers.
- Screw feeder and motors.
- Eductors.
- PAC distribution manifolds with isolation valves to each lance.
- Custom injection lances with flex hose connections.
- Associated piping, valves, instruments, and accessories.
- Controls and instrumentation.

The PAC Injection System will receive bulk PAC by truck. The PAC will be unloaded pneumatically into one of the storage silos through a stationary positive pressure dilute phase conveying system. The trucks will be equipped with their own pneumatic unloading system or by a secondary blower located at the silos.

The PAC will be fed from the silo by a rotary valve into a volumetric feeder hopper where it will be temporarily stored. The PAC will then be conveyed by the feeder screw into the drop tube. The variable speed motor for the screw feeder allows for adjustment of the PAC feed rate. The PAC will be fed through the drop tube directly into the eductor inlet, located below the feeder discharge.

The passing of motive air through the eductor nozzle will produce a vacuum in the eductor inlet, which will help draw the PAC and air into the mixing zone directly downstream of the mouth. The PAC will be transported through the piping system and is distributed to an array of injection lances to evenly distribute the carbon into the existing flue gas stream to maintain Hg emissions below 1 lb/TBtu based on the flue gas flow rate, temperature and upstream Hg concentration.

The injection lances are placed in the ductwork stream before the pulse jet fabric filter (PJFF). The number of injection lances will vary based on the width of the receiving duct and the required rate of injection. Each lance will contain valves and instrumentation for verifying flow out of each lance. A marshalling cabinet will allow plant operators to access data collected from the injection lances, flue gas analyzers and other instruments on the injection system. A long residence time for the flue gas, moving through straight sections of ductwork from the injection ports to the downstream filtering equipment, is essential to remove Hg. A retention time less than two seconds is unfavorable for a PAC injection system’s ability to remove Hg. The PJFF removes the activated carbon particles along with the adsorbed mercury.

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — Ammonia Supply
- System Code — CGE
- File Number — 41.0804.3.B213

1.2 Function

The Ammonia Supply System shall include the following major components:

- Two 34,000-gallon anhydrous ammonia storage tanks common for all Unit 1, 2, and 3, with adequate storage capacity to require refilling no more than one time per 11 days based on ammonia consumption of all three units.
- Two ammonia truck unloading skids common for all Unit 1, 2, and 3.
- Two full-capacity ammonia pumps common for all Unit 1, 2, and 3.
- One Unit 2 ammonia injection skid, the skid consists of two full capacity mass flow meters and ammonia flow control valve trains.
- Two full capacity ammonia dilution air blowers for Unit 2 SCR reactor.
- Two full capacity air pre-heaters for Unit 2 SCR reactor.

1.3 Process Description

The Ammonia Supply System provides a means of transferring anhydrous ammonia to the selective catalytic reduction (SCR) system

The anhydrous ammonia storage tanks, ammonia truck unloading skids, and Unit 3 ammonia pumps are currently being designed as a part of the Unit 3 SCR system. Liquid anhydrous ammonia from the common anhydrous ammonia storage tanks will be directed to Units 1, 2, and 3 ammonia injection skids by the common ammonia pumps.

Unit 2 ammonia injection system will consist of one ammonia injection skid and an ammonia dilution air system. The ammonia injection skid will consist of two 100% mass flow meters and ammonia flow control valve trains, pipe, valves, and instrumentations. The ammonia dilution air system will consist of two 100% ammonia dilution air blowers and two 100% air pre-heaters to provide hot dilution air. Air pre-heaters will be steam heater type. Steam will be provided from the existing plant auxiliary steam supply header.

Upon demand, ammonia flow rate will be controlled by the flow controllers and mixed with the hot dilution air stream to dilute the ammonia to a concentration of 5% by volume before introduced into Unit 2 SCR flue gas streams. Air flow rate will be measured by air flow meters located upstream of the air/ammonia mixing devices.

System Description

1.1 System Identification

- Unit Designation Unit 2
- System Name Selective Catalytic Reduction
- System Code CCF
- File Number 41.0804.3.B214

1.2 Function

The function of the NO_x Reduction system is to remove NO_x from the flue gas. The NO_x Reduction System uses the injection of ammonia (NH_3) into the flue gas and a Selective Catalytic Reduction (SCR) system to produce molecular nitrogen (N_2) and water vapor. These reactions take place in the SCR reactor in the presence of a catalyst with known cycle life under appropriate temperature conditions, pressure conditions and fuel characteristics.

1.3 Process Description

The Selective Catalytic Reduction System will include the following major equipment and components:

- SCR reactor.
- Catalyst.
- NO_x analyzers.
- Diluent (O_2 or CO_2) analyzers.
- Sonic horns and/or soot blowers
- Large Particle Ash (LPA) Screen
- Ammonia injection control valves
- Delta Wing Static Mixers and Guide Vanes
- Ductwork, dampers, and expansion joints.

The hot flue gas leaving the economizer section of the boiler will pass through a large particle ash (LPA) screen before proceeding to the ammonia injection site and to the SCR reactor. The LPA screen will be used to remove any ash particles that are larger than the pitch of the catalyst. The objective of the LPA screen is to avoid potential operating problems due to catalyst plugging. The primary ammonia mixers are located in the vertical section of the inlet duct to mix the incoming anhydrous ammonia into the flue gas. There are two 100% anhydrous ammonia injection control valves per reactor that flash the sub-cooled anhydrous ammonia and inject vaporized ammonia directly into a dilution air stream. An anhydrous ammonia storage area is currently being designed for the site as part of the Unit 3 SCR installation. It is assumed that this system will supply ammonia to the injection skid via two 100% anhydrous ammonia feed pumps. This ammonia-air vapor is introduced behind the Delta Wing static mixers where it is mixed with the flue gas to ensure uniform distribution of the NO_x and NH_3. The ammonia reacts with the NO_x in the presence of the catalyst to remove NO_x from the flue gas. The quantity of ammonia can be adjusted as it reacts with the NO_x in the presence of the catalyst to remove NO_x from the flue gas. The inlet duct continues onward to the reactor inlet. The elbow at the reactor inlet is fitted with small mixing plates, called homogenizers, which provide increased uniformity of ash distribution across the entire catalyst surface. The final turn downward into the catalyst utilizes a large array of turning vanes to guide the gas downward to the topmost layer of catalyst and minimize dust collection in the reactor cap

The guide vanes in the reactor inlet elbow are used to align the flue gas and ash particles to within the specified flow requirements of design standards required for high removal efficiency SCR systems. The mixing devices including Delta Wings static mixers, and guide vanes are necessary to ensure an optimal flow to the catalyst. The removable door sections on each catalyst layer are used to load and unload catalyst from the reactor. These door sections are seal welded in place to prevent leakage of flue gas or infiltration of air into the reactor. The temperature measurement connections at each catalyst layer and at the SCR inlet and outlet are used to monitor the temperature of the catalyst and reactor steel structure during start-up and operation. The sonic horn catalyst cleaning system on the reactor provides the required cleaning of the catalyst during normal operation. Inlet and outlet flue gas pressure transmitters are provided across the SCR reactor to continually measure and record SCR pressure loss. NOx measurement systems installed in each of the SCR inlet and outlet ducts are used to control ammonia injection to each reactor.

The flue gas leaves the reactor inlet turning vanes and enters the first layer of catalyst in a uniform manner. The flue gas is homogeneously distributed over the reactor cross-sectional area and passes through the catalyst face. This insures minimal erosion by ash impact on the catalyst. The flow continues through the second layer in the same manner. The flue gas exits the reactor and enters the air heater inlet duct. Turning vanes and plates are used, as required, ensuring acceptable distributions of ash, temperature and flow to the air heater.

The potential NO_x reduction is sensitive to the temperature of reaction and time available for the NO_x reducing reaction to occur. The catalyst is of vanadium/titanium dioxide based material. Sealing material is installed between catalyst blocks to prevent untreated flue gas leakage.

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — Sorbent Injection
- System Code — CCH
- File Number — 41.0804.3.B215

1.2 Function

The function of the Sorbent Injection System is to remove SO_3 from the flue gas by injecting sorbent into the flue gas ductwork between the air heater outlet and the pulse jet fabric filter (PJFF) inlet.

1.3 Process Description

The Sorbent Injection System will be common between Unit 1 and Unit 2 and will consist of the following equipment and components:

- Two (2) sorbent storage silos with structural skirted enclosure with all necessary appurtenances.
- Two blower/feeder skid assemblies for each silo.
- Rotary valve and motors.
- Feed hoppers.
- Screw feeder and motors.
- Eductors.
- Sorbent distribution manifolds with isolation valves to each lance.
- Custom injection lances with flex hose connections.
- Associated piping, valves, instruments, and accessories.
- Controls and instrumentation.

The Sorbent Injection System will receive bulk sorbent by truck. The sorbent will be unloaded pneumatically into one of the storage silos through a stationary positive pressure dilute phase conveying system. The trucks should be equipped with their own pneumatic unloading system.

The sorbent will be fed from the silo by a rotary valve into a volumetric feeder hopper where it will be temporarily stored. The sorbent will then be conveyed by the feeder screw into the drop tube. The sorbent will be fed through the drop tube directly into the eductor inlet, located below the feeder discharge.

The passing of motive air through the eductor nozzle will produce a vacuum in the eductor inlet, which will help draw the sorbent and air into the mixing zone directly downstream of the mouth. The sorbent will be transported through the piping system and is distributed to an array of injection lances and into the boiler exhaust gas stream to maintain H_2SO_4 emissions below 5 ppmvd @ 3% O_2 based on the flue gas flow rate, temperature and upstream H_2SO_4 concentration.

The number of injection lances will vary based on the width of the receiving duct and the required rate of injection. Each lance will contain valves and instrumentation for verifying flow out of each lance. A marshalling cabinet will allow plant operators to access data collected from the injection lances, flue gas analyzers and other instruments on the injection system. A long residence time for the flue gas, moving through straight sections of ductwork from the injection ports to the downstream filtering equipment, is essential to remove H_2SO_4. A retention time less than two seconds is unfavorable for a sorbent injection system's ability to remove H_2SO_4.

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — Air Preheat
- System Code — SGC
- File Number — 41.0804.3.B216

1.2 Function

The Air Preheat system provides preheating of the combustion air by using hot water from the Deaerator in combination with the preheat coil. The Air Preheat system is capable of supplying the necessary energy to preheat the combustion air over the specified load range to minimize flue gas acid gas condensation at the air heater gas outlet.

1.3 Process Description

The Air Preheat System will consist of the following major components.

- Two new 100% nominal capacity preheat coil pumps.
- One new 100% preheat coil.
- Associated new valves, instruments, controls, and accessories.

The new Air Preheat system will draw hot water from the Deaerator using the preheat coil pumps. The hot water will then return to the Deaerator for reheating. The hot water will be used in the preheat coil to preheat the incoming combustion air minimizing flue gas acid gas condensation at the air heater gas outlet. The new preheat coil will interface with the outlet of the new Forced Draft (FD) fan combustion air ductwork and the inlet ductwork of the new air heater. The preheat coil inlet will be downstream of the FD fan outlet damper and the outlet will be at the air heater air inlet. The new hot water preheat coil pumps will be located in the same place as the existing preheat coil pumps in the boiler building. Replacement of the new preheat coil pumps in the existing preheat coil pumps location will be confirmed during detailed design.

System Description

1.1 System Identification

- Unit Designation — Unit 2
- System Name — Combustion Air
- System Code — CCE
- File Number — 41.0804.3.B217

1.2 Function

The Combustion Air System, in conjunction with the induced draft fan, provides the static pressure required to force the flow of combustion air from the atmosphere through the combustion air path to the furnace. The system includes the capability of controlling the combustion air flow rate to maintain desired boiler outlet oxygen concentration over the specified load range.

1.3 Process Description

The Combustion Air System will consist of the following major components.

- One new 100 percent capacity, centrifugal forced draft (FD) fan using a two-speed motor and inlet vanes as the primary means of flow control.
- Direct-drive induction motor to drive the FD fan to its full capacity. One of the existing Unit 2 two-speed ID fan motors will be used for this service.
- New coupling to transmit the rotational energy from the motor to the new fan.
- New FD fan lubricating oil unit.
- New FD fan inlet vanes and actuator.
- New FD fan discharge damper and damper drive.
- New FD fan inlet silencer
- Associated new and existing ductwork and expansion joints upstream of the existing air heater air outlet ductwork.
- Associated new piping, valves, instruments, controls, and accessories.

The new FD fan will provide sufficient pressure to force the combustion air from the atmosphere through the new air preheat coil, new air heater, and to the steam generator. A portion of the combustion air will be diverted to the primary air system as well downstream of the new air heater. The FD fan would also be used during the steam generator and associated equipment and ductwork purging cycle prior to firing fuel in the furnace or after the steam generator is shut down.

The new centrifugal FD fan will use inlet vanes as the primary means of combustion air flow control over the unit operating load range. The existing Unit 2 ID fan motors proposed can be used for gross flow control. The inlet vanes will be used to precisely control the flow of combustion air depending on the desired capacity from the plant control system. The system will control the FD fan to a predetermined boiler outlet oxygen concentration. During a severe transient, such as a loss of fuel, the system will remain capable of responding to the commands from the Distributed Control System (DCS) in such a manner as to avoid any damage from a positive pressure transient in the steam generator and other draft system components.

In conjunction with the induced draft fan, combustion air will flow from the atmosphere and silencer to the inlet of the FD fan. The 100 percent capacity FD fan will discharge into new ductwork forcing combustion air through the new air preheat coil and new regenerative air heater to the primary air system and steam generator.

Expansion joints will be provided in the new ductwork where required to accommodate movements due to thermal expansion and contraction. This will prevent detrimental stresses in the ductwork, deformation, or failure of structures or equipment due to thermal expansion. Inlet and outlet isolation dampers and a forced lubrication oil unit are provided with the FD fan. The FD fan sound level is attenuated by the use of a silencer in the FD fan inlet duct and insulation and lagging of the FD fan casing.

The new and existing ductwork will continue to provide a flow path from the atmosphere and inlet silencer of the FD fan to the new FD fan, new air preheat coil, new regenerative air heater, then to the existing primary air system and steam generator.

System Description

1.1 System Identification

• Unit Designation	Unit 2
• System Name	Air Heater
• System Code	CCE
• File Number	41.0804.3.B218

1.2 Function

The Air Heater System provides the heat transfer required to increase the temperature of the incoming combustion air utilizing energy from the flue gas stream. An increase in boiler efficiency and the ability to drying fuel are the results. The system also includes the capability of maintaining the cleanliness of the system through multimedia sootblowers.

1.3 Process Description

The Combustion Air System will consist of the following major components.

- One new 100 percent capacity, bisector ljungstrom vertical shaft regenerative air heater.
- Integral duplex sealing system minimizing leakage
- New, induction motor and gear train to drive the air heater rotor.
- New drive system lubricating oil unit.
- New multimedia sootblowers.
- Associated new piping, valves, instruments, controls, and accessories.

The new air heater will provide sufficient heat transfer maximizing boiler efficiency and allowing for the drying of fuel while minimizing the flue gas outlet temperature's approach to the acid gas dew point. Heat transfer is accomplished through a rotating mass that continuously rotates in and out of the flue gas and combustion air streams. Rotational speed is typically around one revolution per minute. The rotating mass increases in temperature as it passes into the flue gas stream. Then as the mass rotates into the combustion air stream the mass releases the energy gained in the flue gas stream to the combustion air stream thereby increasing the combustion air temperature.

Typically the rotating mass is separated into equally spaced sectors which can be likened to sectors of a pie. Increasing the number of sectors aids in the reduction of leakage along with a duplex sealing system and other measures that are available. Placed in each of these sectors are the baskets that permit combustion air and flue gas to pass through in a turbulent fashion allowing the capture and release of energy.

The rotating mass is also separated vertically. For a selective catalytic reduction (SCR) system application, such as with this air heater, there are typically two sections, a hot section and a cold section. With only two sections the effectiveness of basket cleaning devices is maximized since there is only one open gap in the middle of the air heater for the cleaning media lose a significant amount of energy. The cleaning devices, or sootblowers, for SCR system applications are recommended to be multimedia capable where steam or compress air would be one media and high pressure water would be the other. Also aiding in cleaning ability is an enamel coating on all air heater baskets minimizing the ability of particulate and compounds in the flue gas stream to attach to the baskets. Altogether, these measures discussed here allow the Air Heater System to maintain cleanliness and maximize heat transfer while allow the corresponding unit to remain online.

System Description

1.1 System Identification

• Unit Designation	Unit 3
• System Name	AQCS Power Supply
• System Codes	APB--AC Power Supply (120/208 Volts)
	APC--AC Power Supply (480 Volts)
	APD--AC Power Supply (4160 Volts)
	APF--AC Power Supply (13,200 Volts)
	APH--DC Power Supply
	API--Uninterruptible Power Supply
• File Number	41.0804.03.B301

1.2 Function

The function of the Auxiliary Power Supply System shall be to distribute electrical power to various pieces of equipment, devices, and cabinets, and to provide overcurrent and fault protection.

1.3 Process Description

1.3.1 AC Power Supply (120/208V) (APB)

Power shall be provided to 120V single-phase and 208V three-phase loads by ac panelboards rated 120/208V, three-phase, four-wire. The panelboards shall also provide branch circuit protection and a means of disconnect for the branch circuit loads through manually operated thermal magnetic circuit breakers. Power shall be provided to the panelboards by low voltage transformers, with 480V three-phase primary (APC) and 120/208V secondary with directly grounded neutral. The system shall be designed to provide 100 percent of the required continuous loads with 20 percent spare kVA.

1.3.2 AC Power Supply (480V) (APC)

Power shall be provided to 480V three-phase loads by the following major power system components, in general:

- 13,200V to 480V dry type secondary unit substation (SUS) transformers with high resistance grounded wye secondary grounding.
- 480V, 3-phase, 3-wire, metal enclosed double-ended SUS switchgear.
- 480V, 3-phase, 3-wire, motor control centers (MCCs).
- 480V, 3-phase, 3-wire, panelboards.
- 480V to 480Y/277V and 120/208V dry type transformers for lighting and receptacle loads.
- 480 Y/277V and 120/208V, 3-phase, 4-wire panelboards for lighting and receptacle loads.

The 480V secondary of the SUS transformers shall be connected high resistance grounded wye. All SUS transformers shall be indoor, dry type transformers furnished with AN or ANAF cooling rating and a 150 ^{o}C temperature rise.

The AC Power Supply (480 V) System will be designed to feed the facility's low voltage loads. Each SUS transformer and associated low voltage switchgear line-up will be sized to serve its maximum coincidental operation load. All SUS, MCCs and panelboards will be initially designed with a minimum of 20 percent spare circuit breakers.

1.3.3 AC Power Supply (4160V) (APD)

The 4160V systems shall consist of the following major components:

- Two (2), two-winding delta primary, resistance grounded wye 4160V Transformer. The high voltage rating shall be 13.2 kV and the low voltage rating 4160V to serve the Unit 3 switchgear buses A & B.
- One neutral grounding resistor on each secondary winding of each auxiliary transformer.

The 4160V system shall also consist of the following major components:

- Two (2) 4160V metal-clad, single-ended switchgear with a main breaker on each bus connecting it to the 4160V Transformer. The 4160V switchgear shall be arc resistant and of two-high construction. The switchgear shall be located within the AQC Electrical Building

- 4160V medium voltage circuit breakers and contactors.

1.3.4 Existing AC Power Supply (13,200V) (APF)

The existing FGD 13,200V system consists of the following major components:

- One two-winding delta primary, delta secondary Main Auxiliary Transformer (UAT-3C). The high voltage rating shall be 25kV and the low voltage rating 13.2 kV to serve the Unit 3, 13.2 kV switchgear buses A & B.

The existing 13,200V system also consists of the following major components:

- Two (2) 13.2 kV metal-clad, single-ended switchgear with a main breaker on each bus connecting it to the Main Auxiliary Transformer UAT-3C and a secondary main breaker connecting the switchgear bus to the Unit 1 Generator terminals through a triggered current limiter.
- 13,200V medium voltage circuit breakers.

The existing 13,200V system:

- The existing 13.8 kV FGD metal-clad, switchgear OAPO1E-A-SWGR contains a spare 1200A feeder breaker. This breaker will be used to supply primary power to the new Unit 3 AQC 480V SUS XFMR A and AQC 4160V Switchgear XFMR A. During detailed design the extent of the modification will need to be accessed. It is likely that the current transformers may have to be replaced as well as the feeder protection.
- The existing 13.8 kV FGD metal-clad, switchgear OAPO1E-B-SWGR contains an equipped space that will accept a new 13.2 kV, 1200A feeder breaker. The equipped space in section B5 should be utilized as the protective device is designed for transformer feeder protection. The current transformers may also require replacement. The extent of modifications will be determined during detailed design. This new breaker will be used to supply primary power to the new Unit 3 AQC 480V SUS XFMR B and AQC 4160V Switchgear XFMR B.
- 15 kV cable will be used to make the connection from the feeder breakers to the primary side of the transformers. It is expected that this cable will be routed through newly installed tray and conduit.

1.3.5 DC Power Supply (APH)

The DC Power Supply System will consist of 125VDC lead acid station batteries, two (2) full-capacity redundant solid-state chargers per battery and a Main distribution panel.

The DC Power Supply System will consist of a station battery system located in a dedicated battery room. The system will utilize flooded type batteries with trays under the batteries. These batteries will provide DC power to the plant DCS, critical FGD System loads, and control power for the auxiliary electrical system equipment. The battery will be connected to a main distribution panel and continuously charged by two fully redundant battery chargers.

Under normal conditions, the battery chargers supply dc power to the dc loads. The battery chargers receive 480VAC power from the motor control centers. The chargers will continuously float-charge the battery while supplying power to the dc loads. Under abnormal or emergency conditions when 480VAC power is not available, the battery supplies dc power to the dc loads. Recharging of discharged batteries occurs whenever 480VAC power becomes available. The rate of charge is dependent upon the characteristics of the battery, battery chargers, and the connected dc load during charging. Each station battery charger shall be capable of charging the fully discharged battery within 8 hours with battery load present.

The battery will be located in a dedicated battery room that is a space conditioned area so that suitable temperatures can be maintained, thus helping to ensure long battery life. Battery temperature for sizing calculations shall be 77^{o} F. The battery shall be sized in accordance with IEEE 485. An exhaust fan(s) shall be furnished for limiting the concentration of hydrogen gas in each battery room. The equalizing voltage shall be used to determine the hydrogen gas emission for fan sizing. Climate control and exhaust fans shall be provided that are suitable for the environment.

1.3.6 Uninterruptible Power Supply (API)

A UPS shall be provided in the AQC Electrical Building for Unit 3. The UPS shall provide reliable power to the control system equipment, other equipment needing a regulated power supply, and other critical equipment needing a reliable power supply. . The UPS system shall be able to handle full load capacity for four (4) hours.

One (1) 120V AC Main UPS Distribution Panel shall be mounted with the chargers and UPS inverter. The panels shall be mounted within the AQS Electrical Building.

A120-208V AC distribution panel for the instrumentation shall be located in the AQC Electrical Building. This distribution panel shall be fed from a 480V:120-208V isolation transformer. The isolation/regulating transformer will regulate the output voltage and provide isolation and noise attenuation based on normal AC input. The voltage regulation shall be + - 1% with -10% to +20% input variation.

Each transformer will be fed from an automatic transfer switch (ATS) which will be fed from each of the 480V MCCs in the building. The ATS shall consist of a double throw power transfer switch mechanism and microprocessor controller of the same manufacturer to provide automatic operation. The ATS shall be switched automatically via voltage sensing and have the capacity to be transferred manually both locally and remotely. The distribution panels shall include circuit breakers in series with fast acting fuses for branch circuit protection.

Each UPS and isolation/regulating transformer shall include 20% spare capacity and distribution panelboards shall have 20% spare branch breakers/fuses for future use by the Purchaser.

1.4 Reference Drawings

- Conceptual Overall One Line – Unit 3: 168908-B3DE-E1003
- Existing FGD 13.2 kV SWGR One Line – BRO-E-00100-001 and 002

System Description

1.1 System Identification

• Unit Designation	Unit 3
• System Name	Communication
• System Code	CMA
• File Number	41.0804.3.B302

1.2 Function

The function of the Communication System shall be to provide station personnel with a reliable and convenient means of plant paging and party line communications, and to provide raceway and other provisions for telephone/LAN wiring and equipment.

1.3 Process Description

The Communication System shall include microprocessor-based page/party equipment, raceway, and page/party communication cable as manufactured by GAI-Tronics Corporation. The new microprocessor-based system shall be fully adaptable to the existing system installed at Brown Unit 3 and shall provide self-diagnostic monitoring of the new system for system integrity. The page/party equipment shall provide two-way voice communication on each party line and shall utilize a page line for voice transmission over a plant-wide speaker system. While a conversation is taking place on a party line, other conversations may be held on other party lines or the page line. Each page/party handset station shall have five party lines and one page line. Page/party handset stations and speakers shall be strategically located throughout the plant site. The power supply for the page/party equipment shall be 120 volts ac, from the normal AC System.

The new system shall interface with the existing Brown Unit 3 system.

Raceway and space provisions for telephone/LAN equipment shall be provided. Base equipment shall be located in the common control room and peripheral equipment shall be strategically located.

System Description

1.1 System Identification

- Unit Designation Unit 3
- System Name Control and Monitoring
- System Code COA
- File Number 41.0804.3.B303

1.2 Function

The existing Foxboro I/A Series Distributed Control System (DCS) will be expanded to incorporate control and monitoring of the new AQCS equipment. The resulting DCS shall provide a means to control in manual and automatic the AQCS equipment individually, as well as in coordination with other plant systems. The DCS shall be central to all plant operations and control the various systems and subsystems, including those required for the new AQCS equipment. The existing DCS will be the central location in the plant for alarm management, historical data archiving, report generation, and data trending. The primary operator interface to the DCS shall be the existing Unit 3 workstations located in the Unit 3 Brown Control Room. The existing unit protection system will be retained in the existing Unit 3 DCS to protect critical plant equipment, including critical draft system interlocks.

New local operator stations are included in the conceptual design for the AQCS areas.

- The new AQCS DCS shall consist of the extending existing Unit 3 and FGD mesh network, and the addition of new redundant controllers to control the new AQCS common unit equipment. The AQCS DCS equipment shall communicate by means of redundant network data highways.

The AQCS DCS equipment shall include the following major components:

- AQC Network Cabinet/Fiber Optic Patch Panel.
- Redundant Controllers.
- DCS system cabinets and input/output (I/O) cabinets.

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1.3 Process Description

The AQCS DCS control processors shall contain the control logic for the AQCS equipment. Analog control loop logic and discrete logic shall be implemented in the redundant control processors. The Unit 3 Main Control Room DCS operator interface equipment shall be used as the means to control and monitor plant AQCS processes and process equipment. The DCS configuration will provide interface to all AQCS processes and equipment from either the Unit 3 designated operator workstations.

The AQCS DCS equipment shall interface with the existing DCS to allow retrieval of historic plant data, trend process parameters, and to develop specialized displays of plant information. The operator graphics shall be developed based on the AQCS systems to be controlled, and displayed in a hierarchical format.

The configuration of the AQCS DCS equipment shall take into account redundancy wherever the failure or loss of a component could cause plant upset or loss of generation capacity. Total control processor loading for all required control parameters and communication functions shall be limited to no more than 80 percent loading on each redundant pair. . Each input/output cabinet shall contain 20 percent installed spare modules to allow for future expansion.

DCS processor and I/O cabinets shall be located in space-conditioned rooms in the following locations to allow control and instrument cabling to be managed within buildings, minimizing the amount of cable installed between buildings:

- Unit 3 AQCS Electrical Building.

Control processors, power supplies, input/output cards, and other associated hardware shall be a common form factor to provide flexibility of mounting individual control system devices on common rack or carrier. Process controllers, input/output modules, mounting racks or carriers, communication hardware, power supplies, ventilation fans, and other required accessories shall be housed in industrial enclosures with NEMA rating appropriate for the mounting location of the cabinet.

System Description

1.1 System Identification

- Unit Designation — Unit 3
- System Name — Lighting
- System Code — LTA
- File Number — 41.0804.3.B304

1.2 Function

The function of the Lighting System is to provide station personnel with illumination for station operation under normal conditions, egress under emergency conditions, and emergency operational lighting to perform tasks during a power outage of the normal source. The permanent lighting may be used for construction lighting in areas where early installation is practical. Additional construction lighting shall be provided using temporary luminaires and construction power distribution grid. The system also provides 120 volt convenience outlets for portable lamps and tools.

1.3 Process Description

Luminaires for areas with finished acoustical ceilings, if any, shall be fluorescent static troffers. The lighting system for continuously occupied control rooms shall utilize the same type static troffer, except with a dimming ballast and 1/2 inch square louvered low iridescent parabolic diffuser for glare control. Fluorescent lamps shall be energy effiicent 3000K, T8 and not exceed four feet and shall be low mercury content. Ballasts shall be energy efficient electronic type with less than 10 percent harmonic content.

Low bay, wall and stanchion mount luminaires shall be used in outdoor areas and unfinished, hazardous and non-hazardous, enclosed areas of the station. Metal halide luminaires shall be used in the industrial and high bay areas of the plant. Metal halide luminaires shall comply with the Energy Independence and Security Act of 2007, and therefore, all metal halide ballasts and lamps 400 watts and under shall be pulse start metal halide type. Except for high bay areas, pulse start metal halide luminaires shall be enclosed and gasketed with threaded glass refractors. Luminaires located in hazardous areas shall be Underwriters Laboratories (UL), or other North American third party testing lab, listed for the National Electrical Code (NEC) classification. High bay luminaires shall be enclosed and have aluminum or glass reflectors. Luminaires in wet locations or in wash down areas shall be in National Electrical Manufacturers Association (NEMA) 4 enclosures. Approximately 25 percent of the non-hazardous industrial area metal halide luminaires shall be provided with a quartz auxiliary lamp option to provide immediate illumination upon starting and restrike conditions.

Emergency lighting shall be provided for interior building egress paths, interior stairways, selected areas around electrical equipment, and local control rooms. The emergency lighting luminaires for the plant areas shall be powered from individual battery pack units with halogen lamps. Emergency lighting shall provide 90 minutes of operation per the NFPA Life Safety Code 101. Emergency operational lighting for control room area lighting shall be powered by connecting selected fluorescent luminaires to the plant UPS system.

Exit light luminaires shall use light emitting diode (LED) lamps for most areas, with compact fluorescent lamps used in hazardous rated areas, and shall be located in the egress pathways and ground level exit doors of enclosed buildings. The exit luminaires shall be powered from normal ac power and integral batteries for emergency service.

Roadway luminaires shall be pulse start metal halide, cutoff cobra head type mounted on aluminum or galvanized steel poles with helix steel or concrete anchor foundations.

Power used to supply fluorescent and pulse start metal halide luminaires shall be 277 volt ac, except for the possible use of 120 volt ac power for some small remote buildings where 277 volt ac power is not readily available or economically feasible. Luminaires shall be powered from the panelboards, with alternate luminaires or rows of luminaires fed from alternate panelboard circuit breakers. Power used to supply convenience receptacles shall be 120 volts ac. Power used to supply roadway and area lighting shall be 480 or 277 volts ac.

Lighting is not required for roof top PRVs. However, one 120 volt ac ground fault current interrupter receptacle shall be installed on the roof and suitable for access to all the PRV's. A photoelectric controlled light fixture shall be installed near any roof top access doors.

Convenience receptacles shall be grounded duplex type and located throughout the station. The convenience receptacles shall be a minumum of 15 inches above the floor in office areas and 36 inches above the floor in industrial areas. The convenience outlets shall be spaced, at the same elevation, to provide access to any point in the industrial areas with a 100 foot extension cord. Convenience outlets for use without extension cords shall be located in finished areas such as offices, control room, and laboratory. Each outlet shall have the grounding pole located at the top of the device. Each office shall have a minimum of two receptacles on opposite walls. No more than eight receptacles shall be connected to a branch circuit breaker. Receptacles shall be circuited to alternating circuits within an area. Weatherproof snap action covers shall be installed on all receptacles located outdoors and in wet indoor areas. In general, receptacles for outdoor and plant indoor wet areas shall be standard 125 volt, 20 amp, 2-pole with ground, NEMA 5-20R type. Selected receptacles in finished and industrial areas shall have GFCI protection in accordance with the NEC. In areas with hazardous atmospheres, convenience outlets shall be suitable for the NEC class, division, and group requirements.

Operation of the Lighting System is dependent upon the visual requirements of the station operating personnel. The general lighting for interior process areas shall be manually switched on and off at panelboard circuit breakers. The lighting for smaller enclosed areas within the buildings shall be manually switched on and off at local light switches near personnel entrance doors. The OFF position of the toggle switch shall be in the downward position. The lighting for continuously occupied control rooms shall be controlled from dimmer switches. The exterior process area lighting shall be controlled through common contactors that automatically operate between sunset and sunrise via photoelectric controllers. The lighting contactors shall have a hand-off-auto (HOA) switch for daytime maintenance override. Luminaires with integral photocells shall be provided for roadway luminaires and luminaires at exterior personnel entrances only. Separate photo-electrically controlled electrically held lighting contactors with a HOA switch shall be provided for exterior lighting in different areas of the plant.

Luminaires shall be installed at a minimum height of 7 feet 0 inches above the floor to provide an unobstructed way of exit travel from any point in the buildings. Luminaires shall be designed and installed with consideration for maintenance and access. Luminaires shall be installed in locations where maintenance shall not be blocked by structural steel, piping, raceway, grating, etc.

Lighting cable powered from 277 volt ac and all branch circuits installed outdoors shall be XHHW-2 . All 120 volt ac branch circuits installed indoors in heated spaces shall be THHN cable. Pre-assembled and prewired cable assemblies shall be used only in finished environments.

Lighting and receptacle branch circuit voltage drop shall not exceed 3%. This shall include the voltage drop from the last outlet in the branch circuit to the lighting panelboard. In addition, 120 volt branch circuits longer than 75 feet shall use 10 AWG and 277 volt branch circuits longer than 200 feet shall use 10 AWG conductors.
General access interior structure lighting for permanent structures required during construction shall be provided using the permanent luminaires connected to the construction power grid, where practical. Any additional lighting required for construction operation shall be provided by the construction contractor.

The Lighting System shall comply with the regulatory requirements of Occupational Safety and Health Administration (OSHA) and applicable building codes.

Lighting shall be designed in accordance with the Illuminating Engineering Society of North America (IESNA) to provide the illumination levels recommended by the following standards and organizations:

- American National Standards Institute (ANSI)/IESNA RP-7, Industrial Lighting.
- ANSI/IESNA RP-8, Roadway Lighting.
- OSHA.

- National Fire Protection Association (NFPA), National Electric Code (NFPA 70).
- NFPA, Life Safety Code (NFPA 101).
- Local Building Code (latest adopted version).

The following criteria shall also be considered in the lighting system design:

- Illumination calculations shall be based upon the mean lumen output of the respective lamps (lamp lumen depreciation [LLD]).
- Illumination calculations shall be based upon a luminaire dirt depreciation (LDD) factor.
- Interior illumination calculations shall be based upon a room surface dirt depreciation (RSDD) factor.
- Illumination calculations shall be based upon the luminaire ballast factors of the light fixtures utilized in the design.
- The illumination calculations shall be determined at a 30 inch workplane height above the floor.

System Description

1.1 System Identification

- Unit Designation: Unit 3
- System Name: Buildings and Enclosures
- System Code: BSA
- File Number: 41.0804.3.B305

1.2 Function

The function of the Buildings and Enclosures System will be to provide support, enclosure, and access to the systems contained within each structure's boundaries.

1.3 Description

The various structures associated with the Buildings and Enclosures will generally consist of the following six components:

- Foundation--provides support and carries the loads to the subsurface.
- Structural frame--provides support for the contained systems and stability for the entire structure.
- Architectural--provides isolation of systems, enclosure, and protection from natural phenomena, where required, through walls, partitions, ceilings, and roofs.
- Access--provides means of ingress and egress and allow for access to the contained systems and equipment through doors, stairs, floors, cranes, and hoists.
- Space Conditioning -- provides the required heating, ventilating and air conditioning for the buildings.
- Drains and Plumbing--provides plumbing, floor and equipment drains and floor trenches and sumps for the enclosed equipment and facilities.

The buildings and structures will be designed to accommodate the function and arrangement of the systems they enclose. Building arrangements will take into consideration maintenance and operating access requirements as well as the equipment itself. Suitable design features will be provided to prevent or contain oil or chemical spills where appropriate. All occupied buildings will be designed to meet NFPA 100 Life

Safety egress requirements. Since no new or refurbished administrative areas are included within the scope of the Phase II Unit 2 modifications, the new structures will not require design in accordance with the Americans with Disability Act Accessibility Guidelines (ADAAG) requirements.

HVAC systems will be designed to maintain indoor conditions suitable for the equipment and operations enclosed under the design ambient conditions for the Project site in the Project Design Memorandum. Ventilation, heating, and cooling equipment will be located to ensure relatively uniform temperature distribution throughout the space. Air conditioning for control and electrical equipment will be designed to meet appropriate filtration levels and noise criteria.

Fire protection systems meeting appropriate NFPA and building code requirements will be provided for each building where required. Since none of the new buildings or structures intended for the Phase II Unit 2 modifications is expected to be manned on a continuous basis, and since existing facilities remain in the immediate area, no plumbing or toilets are intended for these structures.

1.3.1 Unit 3 PJFF Structure

The Unit 3 pulse jet fabric filter need not be installed at an elevation higher than grade. Accordingly, no separate superstructure beyond that supplied as part of the PJFF itself is required. A concrete foundation supported on auger-cast piles or drilled piers will be provided for the PJFF similar to any other piece of furnished “equipment”. The area beneath the PJFF bag housing will be enclosed with un-insulated metal wall panel to provide a windbreak and weather protection to the area around the ash hoppers.

1.3.3. Unit 3 AQCS Electrical Building

A Unit 3 AQCS Electrical Building will house additional electrical and control equipment serving the new PJFF at Unit 3. The Electrical Building is intended as a single story pre-engineered metal building mounted to a small foundation with a floating interior slab. For purposes of the estimate, drilled piers were assumed under the columns of the building with a floating slab making up the interior floor. The superstructure will consist of steel framing enclosed with insulated metal panel walls and roof. The interior will be of unfinished construction and doors will be located and sized to access equipment for maintenance as well as provide personnel access. HVAC will be as required for the equipment enclosed, but will at minimum include heating and ventilation. The battery room and DCS equipment room within the building are expected to be air conditioned to provide the environment required for the equipment. The building is intended as a “dry” enclosure and floor drains will be minimized.

1.3.4 Unit 3 Fly Ash Handling Building

A Unit 3 Fly Ash Handling Building will house a dry fly ash handling system serving Unit 3. This equipment, along with the air compressors and receivers required to perform the pulse jet cleaning of the PJFF bags, will be housed in a building adjacent to the PJFF. The Fly Ash Handling Building is intended as a single story pre-engineered metal building on a concrete foundation. Similar to the Electrical Building, the concrete foundation is assumed supported on drilled piers for purposes of the estimate and will contain equipment pads for mounting of equipment. The superstructure will consist of steel framing enclosed with insulated metal panel walls and roof. The interior will be of unfinished construction. Personnel and overhead doors will be located and sized to access equipment for maintenance as well as provide personnel access. HVAC will include heating and ventilation, except as otherwise required by specific equipment.

System Description

1.1 System Identification

- Unit Designation — Unit 3
- System Name — Fly Ash
- System Code — ASB
- File Number — 41.0804.3.B306

1.2 Function

At time of this report, installation is underway under separate contract of an onsite dry landfill for fly ash intended to serve all three units at Brown. It is assumed for purposes of this report that the new ash landfill will be completed and that landfilling of fly ash is in operation at the time Unit 3 AQCS modifications are made.

The Fly Ash System will pneumatically remove fly ash from the pulse jet fabric filter (PJFF) hoppers and transfer it to a new dry ash storage and loadout silo(s) located across the road southwest of the Unit 3 PJFF. In addition, the ash handling system will transfer powdered activated carbon (PAC) and sorbent which is injected upstream of the PJFF and collected in the PJFF hoppers. The collected fly ash byproducts will be conveyed to the fly ash silos for temporary storage. The stored ash will subsequently be conditioned and loaded into trucks for deposition in the landfill. The process is shown on drawing 168908-B3ASB-M2022: Unit 3 PFD - Fly Ash Handling.

1.3 Process Description

The Fly Ash System includes the following major equipment and components:

- Fly ash feed valves
- Fly ash filter separators
- Fly ash pressure transfer blowers and conveying equipment
- Common fly ash storage and loadout silos

The Fly Ash System will be essentially an entirely new dry system from the pickup points at the Unit 3 AQCS addition to the new common storage silo. Each collection point in the common Fly Ash System will be tied into a positive pressure conveying system, including filter separators, a collection and transfer tank, pressure pots, and 2 x 50% pressure transfer blowers, located adjacent to the PJFF. The new transfer system

will be sized to transfer all collected fly ash from the 100% capacity PJFF and any additional pickup points required within the ductwork upstream of the PJFFs. The Unit 3 System capacity and operating margin will be determined during detailed design.

Each PJFF hopper or ductwork pickup point will be equipped with a manual hopper isolation valve and new automatic feed valves. The automatic feed valves will isolate the hopper being emptied and provide a controlled flow of fly ash to the conveyor line. The conveying system will sequentially remove ash from the collection hoppers and transfer it to the filter separators and transfer tank. The transfer blowers will then provide the motive force to forward the ash to the common storage silos serving the landfill. Blowers and ancillary equipment for the Common Fly Ash System will be housed in the Unit 3 Fly Ash Handling Building.

System Description

1.1 System Identification

- Unit Designation: Unit 3
- System Name: Induced Draft
- System Code: CCE
- File Number: 41.0804.3.B307

1.2 Function

The Induced Draft System, in conjunction with the steam generator forced draft fan, provides the static pressure required to induce the flow of combustion gases from the steam generator furnace through the gas path to the stack. The system includes the capability of controlling the flue gas flow rate to maintain furnace draft over the specified load range.

1.3 Process Description

The Induced Draft System will consist of the following major components.

- Two existing 50 percent nominal capacity, centrifugal induced draft (ID) fans using two-speed motors and inlet vanes as the primary means of flow control.
- Existing, direct-drive two-speed induction motors designed for full ID fan capacity.
- Existing couplings to transmit the rotational energy from the motors to the fans.
- Existing ID fan lubricating oil units.
- Existing ID fan inlet vanes and actuators.
- Existing ID fan discharge dampers and damper drives.
- Associated new and existing ductwork and expansion joints upstream and downstream of the ID fans.
- Associated new and existing piping, valves, instruments, controls, and accessories.

The existing ID fan will induce flow of the combustion gases through the steam generator, selective catalytic reduction (SCR) system, regenerative air heaters, and new pulse jet fabric filter (PJFF). The ID fans will also provide sufficient pressure to exhaust the combustion gases through the wet flue gas desulfurization (WFGD) scrubber and the existing stack common to all Brown units. The ID fans would also be used during the steam generator and associated equipment and ductwork purging cycle prior to firing fuel in the furnace or after the steam generator is shut down.

A portion of the existing induced draft system between the ESP system outlet and the ID fan inlet contains the current NFPA 85 vent that is required due to the common WFGD system arrangement. This portion of the existing induced draft system would remain in operation to allow natural venting of flue gases through the old Unit 3 stack in the event of a plant trip and loss of ID fans and other situations where venting through the common WFGD system is not possible.

The existing centrifugal ID fans will continue to use inlet vanes as the primary means of exhaust gas flow control over the unit operating load range. The inlet vanes will be used to control the flow of exhaust gases depending on the desired capacity from the plant control system. The system will control the ID fans to maintain the furnace pressure at a predetermined value. During a severe transient, such as a loss of fuel, the system will remain capable of responding to the commands from the Distributed Control System (DCS) in such a manner as to avoid any damage from a negative pressure transient in the steam generator and other draft system components.

In conjunction with the forced draft and primary air fans, combustion flue gas will flow from the PJFF outlet to the existing inlet duct of the ID fans. The two 50 percent capacity ID fans will discharge into existing ductwork exhausting combustion flue gas to the existing common WFGD scrubber and stack to the atmosphere.

Expansion joints will be provided in the new ductwork where required to accommodate movements due to thermal expansion and contraction. This will prevent detrimental stresses in the ductwork, deformation, or failure of structures or equipment due to thermal expansion. Inlet and outlet isolation dampers and forced lubrication oil units are provided with the ID fans. The ID fan sound level is attenuated by the use of insulation and lagging of the ID fan casings.

The new and existing ductwork will continue to provide a flow path from the outlet of the steam generator to the new SCR system, the new air heater, the new PJFF, then to the existing ID fan. The flow path exiting the ID fan will enter the existing common WFGD scrubber and stack.

System Description

1.1 System Identification

- Unit Designation — Unit 3
- System Name — Pulse Jet Fabric Filter
- System Code — CCB
- File Number — 41.0804.3.B308

1.2 Function

The Particulate Removal System will collect particulate matter from the boiler flue gas stream on filter bags. Particulate matter will also be collected from the powder activated carbon (PAC) and sorbent injection systems in ductwork upstream of the pulse jet fabric filter. The collected particulate will be stored in hoppers until removed by the Fly Ash Handling System.

1.3 Process Description

The Particulate Removal System will include the following major equipment and components:

- Pulse Jet Fabric Filter (PJFF) casing with inlet and outlet transition ducts and expansion joints.
- Fabric filter compartment inlet, outlet dampers, and casing bypass dampers along with seal air system.
- Fabric filters bags and cages.
- Air pulse cleaning system, including headers, valves, and controls.
- Compressors, air driers, and air receivers with 100 percent spare capacity
- Hoppers, including heaters, level detectors, and ports for hopper fluidizing system.
- Permanent and mobile pre-coating system
- Insulation and lagging of fabric filter housing.
- Walk-in or Top door plenum to allow access to the tube sheet for inspection, and maintenance.
- Weather enclosed penthouse with lighting and ventilation.
- Electric hoist on the exterior penthouse level to lift boxes of bags and cages to the penthouse level for maintenance purposes.
- Access provisions required for maintenance, including hoists.
- Associated piping, valves, instruments, controls, and accessories.

The Particulate Removal System consists of compartmentalized PJFF located between the sorbent injection lances and the inlet of the ID fans. The number of compartments is determined by economic compartment sizing, total flue gas flow rate, air-to-cloth ratio, and cleaning system design. The PJFF will be designed with a spare compartment.

Under normal operation, flue gas enters the fabric filter inlet plenum and is distributed to the individual compartments through inlet dampers at each fabric filter compartment. Flue gas will pass upwards through the filter bags where the particulates within the gas stream will collect on the outside of the filter bags and the clean gas exits each fabric filter compartment through an outlet damper into fabric filter outlet plenum. To prevent collapse of the bag, a metal cage is installed on the inside of the filter bags. Filter bags and cages are suspended from a tube sheet at the top of the compartment. Each individual compartment will be provided with inlet and outlet isolation dampers for access or maintenance.

The collected particulate will be cleaned from the filter bags by suddenly inflating the filter bags with a pulse of compressed air over several rows of filter bags, causing the dust on the outside to separate from the bags and drop into hoppers below. The pulsing system will have optimum flow geometry and will be designed with no mechanically actuated parts or acoustic systems that are required to operate for the pulse air cleaning process. The cleaning frequency will be regulated by the control system based on overall fabric filter pressure drop. Online or isolated mode of cleaning of fabric filter will also be regulated by the control system. The fabric filter will be pulse-cleaned utilizing clean, dry, oil free, compressed air supplied by pulse jet air compressors and associated air receivers and dryers.

The dust collected in the fabric filter discharge hoppers will be fluidized and removed by the Fly Ash Handling System. The flue gas from the outlet plenum of the fabric filter will flow through the ID fans and then to the Wet Flue Gas Desulfurization System.

The PJFF shall be designed to achieve particulate matter emissions of 0.01 lb/MBtu. The fabric filter shall be designed to allow for continuous, reliable operation of the boiler at the maximum flue gas flow rate and grain loading with one fabric filter compartment removed from service for maintenance with the fabric filter net cloth velocity not exceeding 4.0 ft/s.

System Description

1.1 System Identification

- Unit Designation Unit 3
- System Name Neural Network
- System Code SGM
- File Number 41.0804.3.B309

1.2 Function

Neural networks utilize a DCS based computer system that obtains plant data such as load, firing rate, burner position, air flow, CO emissions, etc. The computer system analyzes the impact of various combustion parameters on CO emissions. The system then provides feedback to the control system to improve operation for lower CO emissions.

In addition to burner performance these monitoring systems also allow continuous indication of pulverizer, classifier and fuel delivery system performance to provide early indication of impending component failures or maintenance requirements. This system is also used to improve heat rate and often provides operational cost savings along with CO control.

1.3 Process Description

The Neural Network System uses real-time operational data extracted from the plant DCS to “learn” solutions from plant operational experience to achieve reductions in the emissions produced, while possibly improving the heat rate of the plant.

Neural network computing differs from traditional computing in that engineering, statistical, and first-law principles have been replaced by complex, time-varying, nonlinear relationships. Neural networks do not presume that a relationship is known between process inputs and outputs, but rather determines the relationships by analyzing datasets of input and output.

Neural network equipment will be minimal, consisting of a few computer servers that can be located in the same room as the DCS master equipment

System Description

1.1 System Identification

• Unit Designation	Unit 3
• System Name	AQCS Compressed Air
• System Code	CAB
• File Number	41.0804.3.B310

1.2 Function

The Air Quality Control System (AQCS) Compressed Air System will provide the clean, dry, oil free compressed air at an adequate pressure and adequate capacity for the pulse jet fabric filter (PJFF), actuators, controls, instrumentation, and other air users in the AQCS addition.

1.3 Process Description

The AQCS Compressed Air System includes the following major equipment and components:

- Two full capacity air compressors.
- Two full capacity air filter/dryers.
- One air receiver.
- Distribution pipe, valve, and fittings
- Controls and instruments

Two full capacity air compressors will be provided to supply air to the air receiver. During normal operation, only one of the compressors will be in service at a time. Air from the compressors is routed to the air filter/dryers that will dry control air to a dew point of -40° F or lower before entering the air receiver. Air will be supplied from the receiver to the PJFF and other users upon demand.

Cross-ties with the existing station and control air systems will be installed. These will allow air from either existing system to be used to back-up the AQCS compressed air system. It will also allow AQCS compressed air to be used to back-up the existing systems. The equipment comprising the AQCS Compressed Air System is intended to be located in the Unit 3 Fly Ash Transfer Building.

System Description

1.1 System Identification

- Unit Designation — Unit 3
- System Name — AQCS Service Water
- System Code — WSC
- File Number — 41.0804.3.B311

1.2 Function

The Air Quality Control System (AQCS) Service Water System will extend the existing service water systems for washdown, makeup, and seal water for equipment in the AQCS areas.

1.3 Process Description

The AQCS Service Water System will consist of the following major equipment and components:

- Washdown stations
- Distribution piping, valves, and fittings
- Controls and instruments

The source of service water will be from a branch connection from the existing service water distribution piping. Existing service water quality will be sufficient for the AQCS systems.

Service water distribution piping will supply seal and makeup water to washdown stations servicing all AQCS additions.

System Description

1.1 System Identification

- Unit Designation — Unit 3
- System Name — Powder Activated Carbon Injection
- System Code — CCH
- File Number — 41.0804.3.B312

1.2 Function

The function of the Powder Activated Carbon (PAC) Injection system is to remove mercury from the flue gas by injecting PAC into the flue gas ductwork between the air heater outlet and the pulse jet fabric filter inlet.

1.3 Process Description

The PAC Injection System will consist of the following equipment and components:

- Two (2) PAC storage silos with structural skirted enclosure with all necessary appurtenances.
- Three blower/feeder skid assemblies.
- Rotary valve and motors.
- Feed hoppers.
- Screw feeder and motors.
- Eductors.
- PAC distribution manifolds with isolation valves to each lance.
- Custom injection lances with flex hose connections.
- Associated piping, valves, instruments, and accessories.
- Controls and instrumentation.

The PAC Injection System will receive bulk PAC by truck. The PAC will be unloaded pneumatically into one of the storage silos through a stationary positive pressure dilute phase conveying system. The trucks will be equipped with their own pneumatic unloading system or by a secondary blower located at the silos.

The PAC will be fed from the silo by a rotary valve into a volumetric feeder hopper where it will be temporarily stored. The PAC will then be conveyed by the feeder screw into the drop tube. The variable speed motor for the screw feeder allows for adjustment of the PAC feed rate. The PAC will be fed through the drop tube directly into the eductor inlet, located below the feeder discharge.

The passing of motive air through the eductor nozzle will produce a vacuum in the eductor inlet, which will help draw the PAC and air into the mixing zone directly downstream of the mouth. The PAC will be transported through the piping system and is distributed to an array of injection lances to evenly distribute the carbon into the existing flue gas stream to maintain Hg emissions below 1 lb/TBtu based on the flue gas flow rate, temperature and upstream Hg concentration.

The injection lances are placed in the ductwork stream before the pulse jet fabric filter (PJFF). The number of injection lances will vary based on the width of the receiving duct and the required rate of injection. Each lance will contain valves and instrumentation for verifying flow out of each lance. A marshalling cabinet will allow plant operators to access data collected from the injection lances, flue gas analyzers and other instruments on the injection system. A long residence time for the flue gas, moving through straight sections of ductwork from the injection ports to the downstream filtering equipment, is essential to remove Hg. A retention time less than two seconds is unfavorable for a PAC injection system's ability to remove Hg. The PJFF removes the activated carbon particles along with the adsorbed mercury.