T.E.S. FILER CITY STATION

MAINTENANCE MANAGEMENT PLAN
FOR
BOILERS #1 & #2, SCRUBBERS, LIME SLURRY,
BAGHOUSES AND CEM EQUIPMENT

Revised
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1.0 General Information

T.E.S. Filer City Station is a 60 MW plant that burns coal, tire derived fuel, wood bark waste and natural gas. The plant is also permitted to burn petroleum coke and construction demolition waste, but these fuels are not routinely utilized. Pursuant to an Administrative Consent Order with the US EPA, if the facility accepts any deliveries of petroleum coke, then ambient monitoring for particulate matter with a mean diameter of less than 10 microns (PM_{10}) must be conducted consistent with Appendix 3 of the Renewable Operating Permit (ROP).

The intent of this plan is to list the responsibilities of various personnel and provide procedures to be used by the employees to correct problems.

2.0 Responsibilities

2.1 Plant Manager

The Plant Manager is responsible for the compliance with all permit limits and conditions of ROP and with the content of this Maintenance Management Plan.

2.2 Operations Superintendent

The Operations Superintendent will control the daily operations of the plant in assuring that operators are following the procedures outlined in the ROP and the Maintenance Management Plan. This role also assures that the plant operators are properly trained and experienced in the handling of plant upsets.

2.3 Maintenance Supervisor

The Maintenance Supervisor will control the daily Maintenance and Instrument, Control & Electrician operations. This role ensures that maintenance will be performed in a timely manner and that appropriate spare parts are available at the plant per the manufacturer's recommendations and plant operating experience.

2.4 Environmental Coordinator

The Environmental Coordinator is a person, agent or contractor that is designated by the Plant Manager to have responsibility for reporting emission levels and plant operating data as required by the ROP. The Environmental Coordinator also notifies the Michigan Department of Environment, Great Lakes and Energy (EGLE) of any abnormal conditions, malfunctions or control equipment that results in an excess emission and suggests changes to the Maintenance Management Plan as necessary to ensure that the emission levels required by the ROP are achieved.

3.0 Definitions:

The following relevant definitions are from Part 1 of the EGLE Air Pollution Control Rules:

"Malfunction" means any sudden, infrequent and not reasonably preventable failure of a source, process, process equipment, or air pollution control equipment to operate in a normal or usual manner. Failures that are caused in part by poor maintenance or careless operation are not malfunctions.

"Responsible official" means the individual who is responsible for the purposes of signing and certifying the truth, accuracy, and completeness of permit applications, monitoring and other reports, and compliance certifications.

"Shutdown" means the cessation of operation of a source for any purpose.

"Start-up" means the setting in operation of a process or process equipment for any purpose.

Note that certain emission limits, including the Renewable Operating Permit (ROP) carbon monoxide (CO) lb/mmBTU emission limit and the sulfur dioxide (SO_2) lb/mmBTU emission limit under the Mercury and Air Toxics Standard (MATS), exclude periods of startup and shutdown. For purposes of these associated emissions data exclusions, startup and shutdown are more explicitly defined as follows:

"Shut-down" is defined as that period of time from the lowering of the boiler steam pressure to below 1,200 PSIG until the point at which the combustion process has stopped.

"Start-up" is defined as the period of time from when the combustion process starts until the boiler pressure reaches 1,200 PSIG.

4.0 EQUIPMENT

4.1 Boiler

Description

T.E.S. Filer City Station consists of two Foster Wheeler Boilers which utilize coal as the main fuel and additional fuels consisting of wood, tire derived fuel (TDF) and natural gas. The natural gas is used for purposes of startup, shutdown and at other times to support good combustion. While the boilers are allowed to fire petroleum coke and construction/demolition waste, these fuels are not routinely utilized. Each boiler is rated at 311,000 lbs/hr steam, and together they can generate a combined 60MW gross output and extraction steam of 50,000 lbs/hr.

Critical Criteria

Proper control and efficient operation of the boiler ensures that complete combustion will be achieved and emissions minimized. In order for the overall plant emissions to be in compliance with the ROP, the boiler will be operated to maintain the following critical criteria:

A. Particulate
1. The particulate emission rate from each of the boilers shall not exceed 0.03 lb/mm/BTU heat input.
2. The particulate emission rate from each boiler shall not exceed 11.5 lb/hr.
3. Visible emissions from each of the boilers shall not exceed a 6-minute average of 10% opacity.

B. Sulfur Dioxide, (SO_2)
1. The sulfur dioxide (SO_2) emission rate from each of the boilers shall not exceed 0.5 lb/mm/BTU heat input, based on a 30-day rolling average.
2. The SO_2 emission rate from each of the boilers shall not exceed 0.7 lb/mmBTU heat input, based on a 24-hour daily average.
3. The combined SO_2 emission rate from the boilers shall not exceed 6.45 tons per day.
4. The combined SO_2 emission rate from the boilers shall not exceed 1,681.9 tons based on a 12 month rolling period as determined at the end of each calendar month.
5. When firing solid fuels only, the SO_2 emission rate from each of the boilers shall not be in excess of 10% or 30% of the potential SO_2 emission rate, based on a 30-day rolling average emission rate, depending upon the actual outlet SO_2 emission rate. There are other applicable percentages based upon the proportion of solid and gaseous fuels, but the plant follows the 90% reduction requirement as a conservative measure (other required removal percentages are lower). Note that there are also percent reduction requirements for natural gas firing only, but the plant does not anticipate only firing natural gas during a 30-day rolling time period and those requirements are not discussed further.
6. The sulfur dioxide (SO_2) emission rate from each of the boilers shall not exceed 0.200 lb/mm/BTU heat input, based on a 30-day rolling average, excluding periods of startup and shutdown.

C. Nitrogen Oxides, (NO_x)
   1. The nitrogen oxides, as nitrogen dioxide (NO_2) emission rate from each of the boilers shall not exceed a maximum of 0.60 lb/mmBTU heat input, based on a 30-day rolling average, with the actual limit dependent upon the fraction of heat input supplied by solid fuels and gaseous fuels. If only natural gas is fired during a given 30 day rolling period, the NO_x emission rate shall not exceed 0.20 lb/mmBTU.
   2. The combined NO_x emission rate from the boilers shall not exceed 2,018 tons based on a 12 month rolling period as determined at the end of each calendar month.

D. Carbon Monoxide, (CO)
   1. The carbon monoxide (CO) emission rate from each of the boilers shall not exceed 0.3 lb/mmBTU heat input, based on a 24 hour rolling time period determined each operation hour, excluding periods of start-up and shutdown.
   2. The carbon monoxide (CO) emission rate from each of the boilers shall not exceed 115.2 lbs/hr, based on a 24 hour rolling time period determined each operating hour.
   3. The combined CO emission rate from the boilers shall not exceed 1,009.2 tons based on a 12 month rolling period as determined at the end of each calendar month.

E. Total non-methane hydrocarbons (NMHC)
   1. The total non-methane hydrocarbon emission rate, measured as carbon, from each of the boilers shall not exceed 4.6 pounds per hour.

Inspections

A. Daily inspections will be performed on the boilers to ensure that the equipment is operating properly and to observe changes that may indicate potential malfunction.

B. Normal operation and operating parameters will be continuously observed in the control room.

C. Annual inspections will be performed on the boilers to ensure that the equipment is in proper operating condition.
   1. Stokers will be inspected visually for wear on all moving and stationary parts. Repairs are made based on inspection.
   2. Super heater, water-wall and generating tubes will be inspected ultrasonically.
   3. Tubular air heater, economizer, dust collector and all related ductwork from boiler to stack will be inspected visually and ultrasonically.

Operation

A. Start-up
   1. When firing the boiler, special attention must be taken to minimize the environmental impact caused by emissions in the flue gas.
   2. Place the baghouse in service. (TESFM387 step 19)

3. Start the boiler Induced Draft (ID) fan. (TESFM387 step 20)
4. Start the Natural Gas Warm Up Gun FD fan and the boiler Forced Draft Fan (TESFM387 step 23). Open the boiler FD damper until air flow is above 30% and begin a boiler purge.
5. Start the Overfire Fire Air (OFA) fan.
6. Place the Natural Gas Warm Up Gun in service (TESFM387 step 27).
7. The boiler should be fired as per manufacturer's recommended start-up rate (100 degrees per hour drum metal temp.
8. An atomizer should be installed and started up at approximately 150 deg. F scrubber inlet temperature. The baghouse temperature requirements drop to 145 deg. F when an atomizer is placed into operation.
9. Start the coal feeders and rotors (TESFM387 step 31).
10. When steam conditions allow, stop the burner warm up gun.
11. Experience has demonstrated that "Banking" the boilers has the potential to produce elevated excess CO emissions. The practice of "Banking" the boilers shall only be performed on rare occasions when return to service is imminent and the "Banking" duration is expected to be less than 1 hour.

B. Normal Shutdown
1. During a boiler-controlled shutdown both SO_2 removal and baghouse operation must be maintained until the boiler flue gas cools to 145 deg F.
2. At that time the coal should be run off the boiler grates and the boiler fans can be shut down to avoid excess opacity emissions.

C. Emergency Shutdown
1. During an emergency boiler shutdown due to either a water or steam tube rupture, it will be necessary to bypass the baghouse immediately to prevent wetting and caking of the filter bags.
2. The coal fire should be extinguished and run off the grate as soon as possible to help reduce stack opacity emissions.

Maintenance

Repairs will be performed based upon inspection and/or as a preventive measure. Record keeping is maintained within the computerized maintenance management system.

A. Preventive
1. Overfire air fan bearings – oil changes every 6 months.
2. Overfire air fan flow, pressure and temperature transmitters – calibration every 6 months.
3. Forced draft fan bearings – oil changes every 6 months.
4. Forced draft fan flow transmitters – calibration every 6 months.
5. Stoker grate bar combustion air passages – clean passages every 6 months.
6. During each boiler outage, TES shall perform a grate bar pin inspection provided that (1) an appropriate period of time has elapsed since the last pin inspection, and (2) that the outage duration will provide adequate time for a grate bar pin inspection.

7. Past experience has shown that a problem exhibited in one boiler may often occur in the other boiler as well. During outages of appropriate duration, TES shall take appropriate action to inspect and repair potential damage in one boiler that has already manifested itself in the other boiler.
8. Special care shall be taken in the event that new vendors are used by TES to perform critical maintenance activities on major boiler equipment components.

   Note: The above preventive maintenance procedures can only be performed when the associated boiler is shut down. Boiler shut downs generally occur at 6 month intervals but they may be extended to up to one year. Some of the preventive maintenance activities discussed above may also be performed on forced outages as well as planned outages.

B. Inspection Related Repairs
   1. The boilers are inspected one or two times a year to ensure that the boiler skin, ducts and their associated expansion joints and the tubular air heaters are free of holes which would leak air into the boiler.

Spare Parts

Spare parts will be purchased and stored in inventory based on the manufacturer's recommendations and plant operating experience (see tab #4).

Malfunction Abatement Measures

In the event that a malfunction should occur to the boiler(s) equipment that affects the controls of the plant emissions and causes the plant to exceed the permitted levels, a specific action will be taken to bring the plant back into compliance. This action will be either one or more of the following steps:

1. Continue to run with the failed equipment as long as the plant emissions are in compliance. This may or may not require the boiler(s) to run at a reduced load.
2. Correct the malfunctioning equipment by taking the equipment out of service for repairs. This may or may not require the boiler(s) to run at a reduced load.
3. Correct the malfunctioning equipment by shutting down the boiler(s) and repairing the equipment.

4.2 Spray Dryer Absorber System Operation

Theory of Operation

The spray absorption process utilizes an aqueous slurry of slaked lime to chemically capture sulfur dioxide present in flue gases via the formation of calcium sulfites and sulfates, which are ultimately reduced to dry particulates and removed from the gas stream along with the fly ash by a fabric filter. The primary element in the process is a spray dryer which contacts the flue gas stream with a fine spray of sorbent slurry droplets in a manner which promotes chemical absorption of sulfur dioxide by the droplets and results in a drying of the spent sorbent to a particulate suspended in the desulfurized gas stream. The other major elements in the process are the sorbent slurry generating system and the fabric filter used to remove the suspended solids from the absorber discharge gas stream.

Spray Absorber

A. The spray absorber consists of a low-pressure drop gas dispenser, belt-driven atomizer, and absorbing chamber. The spray absorber is a solid drying device widely used in food processing, dye and chemical and mineral processing industries. The spray absorber must be carefully optimized so that the sorbent slurry is atomized, contacted with the flue gas, and dried in a manner that promotes maximum capture of SO_2, minimum sorbent consumption, and low-energy use, while maintaining stable and reliable plant operation. The absorber is intended for continuous service with automatic controls.

B. The absorber uses a centrifugal atomizer design to generate a uniform spray of fine (50-80 micron) droplets over a wide range of feed rates. The slurry is introduced to a central cavity in a high speed rotating disk called the atomizer wheel and is induced by inertial forces to flow outward through radial passages in the wheel and then breaks off to form a spherical droplet whose size is chiefly governed by the viscosity and surface tension of the liquid and the atomizer wheel tip speed. As the droplets move away from the wheel and disperse into the gas stream, exiting the gas disperser vanes, they form an umbrella shaped spray pattern that is symmetric about the chamber axis, and serves as the zone of inertial contact between the sorbent and flue gas.

C. Because of the abrasive character of the slurry atomized in the spray absorption process, a wheel design is used which features silicon carbide inserts in the slurry passages, which may be repositioned as local wear spots appear. A monorail and hoist is provided for maneuvering the atomizer.

D. The absorber gas disperser is designed for high SO_2 removal without high-pressure drop or fly ash abrasion problems. A top entry vaned scroll type gas disperser discharges an annular vortex flow of flue gas down into the chamber on all sides of the atomizer wheel. The gas disperser has two vertically separated gas passages, discharging in an annular pattern around the atomizer. The gas disperser is equipped with vanes to obtain optimum mixing of the spray and the flue gas.

E. The absorber chamber is sized in relation to the gas flow volume to assure that the slurry droplets will have adequate residence time in the chamber for the various stages of reaction with SO_2 and drying to occur. The chamber size also affects the degree of dropout in the absorber, which is maximized to reduce the particulate loading going to the fabric filter. The absorber is designed as an axial entry cyclone to achieve up to 50 percent dust dropout in the chamber. The hopper is not intended for solids storage and must be evacuated continuously.

Lime Slurry Generation

A. Lime handling storage and slaking equipment are contained in an independent plant. Similar plants are widely used in water treatment, process pH control and mineral processing.

B. Calcium oxide, CaO, a white caustic solid (also known as lime, burnt lime, quick lime or caustic lime) is the reactant used in the spray absorption process. The hydration of lime to form calcium hydroxide, also known as hydrated lime or slaked lime, in the presence of excess water by an exothermic reaction is called slaking. The following is the specific chemical reaction:

CaO (s) + H2O (1) = Ca (OH) 2 (s) + 27,500 BTU/lb-mole

When high calcium, soft burned pebble lime is slaked with clean water at a water/lime ratio of 2 to 1, the lime pebbles rapidly disintegrate in an explosive chain slaking reaction, producing a slurry of extremely fine (0.5-4 micron) slaked lime particles suspended in water which is ideal for use in the spray absorption process. The primary element of the slurry generator is the lime slaker, which performs the function of metering the flow of lime and water into a paste slaker to generate the slaked lime slurry, which is then diluted with more water and processed to remove inert impurities called grits. Grits generally consist of uncalcined limestone called "core", fragments of kiln brick, and impurities, which were present in the limestone from which the lime was calcined, mainly silica, alumina and ferric oxide. It is important to remove the grits from the lime slurry because they are highly abrasive and prone to settle out in the slurry piping. Slaking under non-optimum conditions, using hard burned or dolomitic lime, with too high a water/lime ratio, or with poor quality slaking water containing excessive dissolved solids will result in a less reactive slaked lime slurry, characterized by larger and less porous slaked lime particles, which will produce unsatisfactory results when used in the spray absorption process.

C. The lime used is high calcium (90 to 95 percent available CaO) soft burned pebble lime. This lime is slaked at a water/lime ratio of 2 to 1 using water of near potable quality (less than 500 mg/1 sulfates, less than 1000 mg/1 total dissolved solids). The slaking reaction produces a temperature rise of at least 40 degrees Celsius (72 deg. Fahrenheit) above the incoming water temperature within four minutes.

Two-Loop Control

A. In order to operate the spray absorption process in an optimum manner, two (2) key parameters must be controlled; the spray absorber outlet SO_2 concentration and the absorber outlet gas temperature. The former must be controlled in order to remain within the required emission standard without wasting sorbent via excessive removal and the latter must be controlled in order to remain within the required emission standard without wasting sorbent via excessive removal, and the latter must be controlled to a level as close as practical to the water dew point for maximum performance, while maintaining a suitable safety margin against moisture carryover or condensation in the fabric filter, fan and stack.

B. To achieve such optimum spray absorber operation over a wide range of boiler operating conditions, the General Electric Environmental Services Inc. (GEESI) system incorporates a novel two loop control concept for regulating the quantity and concentration of sorbent slurry flow feeding into the spray absorber atomizer in such a manner that the two (2) key parameters are independently maintained at optimum values.

C. The lime slurry is prepared and stored at a reagent concentration substantially higher than would normally be required to achieve the required absorber SO_2 removal level. Thus, for an optimum outlet temperature to be reached, the lime slurry has to be diluted prior to injection to the process.

D. The first of the two (2) automatic loops regulates the flow of concentrated lime slurry to the absorbers, based on the SO_2 concentration signal transmitted to a flow controller, which controls the slurry flow to the process.

E. The second automatic loop regulates the flow of recycle slurry which is mixed with the concentrated lime slurry at the atomizers, based on a signal from the absorber outlet gas temperature thermocouples.

F. Since the lime slurry must always be diluted to some extent to obtain the desired outlet temperature, the outlet temperature may be raised by reducing the recycle slurry and lowered by increasing the recycle slurry, either of which is readily accomplished by modulating the recycle slurry control valve for the absorber.

G. By following this procedure, the spray absorbers operate at the optimum design point, so no condensation occurs in the system. If the system temperature drops below the predetermined safety margin due to failure of the temperature controller or if the I.D. fan or rotary atomizer fails, a PLC output automatically closes the recycle slurry and lime slurry valves to prevent any further decrease in temperature.

H. The separate automatic control of outlet temperature and SO_2 concentration makes possible rapid and highly efficient control of the spray absorption process and also provides an important safety feature such that the recycle slurry flow will automatically increase to maintain absorber outlet temperature in the event of interruption of slurry flow. The fabric filter is also protected from sudden low temperature extremes, such as might be caused by a boiler flameout, or by automatic shutoff features in the slurry control valves which are triggered by a signal from the absorber outlet low temperature thermocouple.

Recycle Slurry/Absorber Outlet Temperature Loop

A. The desired absorber outlet temperature is selected and inputted to a controller for the absorber. The outlet temperature at the absorber is measured by a thermocouple located in the stub duct between the absorber and the absorber/baghouse manifold. The absorber outlet temperature is maintained by modulating the recycle slurry flow to the absorber.

Lime Slurry SO_2 Removal Control Loop

A. SO_2 removal may be controlled by one (1) of two (2) modes determined by the automatic or manual mode selector key on the lime slurry feed controller on the Air Quality Control Panel (AQCP).
   1. Fixed Slurry Flow – The position of the lime slurry control valve is selected from 0 to 100 percent open. This option is used during startup, shutdown, SO_2 monitor malfunction, and maintenance checkout. The outlet SO_2 signal from an absorber on fixed slurry flow is not included in the automatic lime slurry flow balancing.
   2. SO_2 – The desired stack outlet SO_2 (ppmv) is selected, input to a controller, and compared to the actual concentration determined by the flue gas analyzer. The position at the lime slurry control valve on automatic setting is modulated to maintain the desired removal.

Absorber Quench System – Control Concept

A. This system is used to maintain the absorber outlet (baghouse inlet) temperature in the range of 250 degrees Fahrenheit to 275 degrees Fahrenheit. This system utilizes plant water and is atomized into the absorber vessel using a set of three (3) two fluid nozzles. The two fluids (water and air) are automatically introduced into the absorber whenever the absorber outlet temperature reaches 265 degrees Fahrenheit. The programmable logic controller is used. This program must not be modified without GEESI project Manager approval.

B. This system is provided with a keyed switch, which enables the selection of "OFF" and "AUTOMATIC". The switch should only be turned to the "OFF" position when the boiler is not operating.

C. The baghouse is bypassed if the Quench System Malfunction alarm occurs and the absorber outlet temperature reaches 275 degrees Fahrenheit.

D. This system maintains the following critical alarms:
   1. Quench System Permissives Disabled
      a. Water supply pressure below LOW level or,
      b. Air supply pressure below LOW level or,
      c. System control switch is in OFF position
   2. Quench System Malfunction
      a. Absorber outlet temperature is above 175 degrees Fahrenheit and the quench system permissive disabled alarm is active.

E. The sequence of operation for the quenching system control is as follows:
   1. If the Quench System Permissives Disabled alarm is <u>not</u> active, the programmable logic controller (PLC) will release the control valve isolation override when the flue gas temperature reaches 175 degrees Fahrenheit.

2. The control valve is released to control the absorber outlet temperature when it reaches 265 degrees Fahrenheit. When the temperature controls are released, the system will atomize water and control the outlet temperature at 250 degrees Fahrenheit.
3. If load is reduced, or the atomizer liquid flows are established, the PLC output will eventually reduce the absorber outlet temperature to 175 degrees Fahrenheit. When this occurs, the quench system resets and will not atomize water until 265 degrees Fahrenheit is reached again.

Fabric Filter Description

A. The collector is a GEESI Model 2.4-14.0(6)-14.15-2.4P modular pulse jet type fabric filter. A walk in plenum for weather protection during bag replacement is provided.

B. The collector is intended for continuous service with automatic controls and consists of eight compartments, each containing 210 filter bags, 6 inches in diameter and 14 feet long.

C. Below each compartment is a single hopper used to collect fly ash. The hoppers are furnished with one door for maintenance and inspection.

D. Separating the compartment from the walk in plenum is a metal plate known as the tube sheet. This plate has a hole for mounting the bag and cage assembly. The upper open end of the bag is attached to this tube sheet and hangs downward.

E. Dust laden gas enters the fabric filter through the inlet manifold, which distributes the gas to the eight compartments through the upper sections of the hoppers. As the gas stream enters the hopper, there is a drop in the gas velocity and a portion of the entrained dust falls into the hopper. The remaining ash in the gas stream is carried upward and deposits on the outside of the bags. The clean, filtered gas passes through the bags and into the outlet manifold.

F. Each compartment is equipped with walk in plenum at the bag hanging level.

G. Each compartment has a pneumatic operated inlet butterfly damper, and one outlet poppet damper which has a pneumatic operator. In normal operation, the inlet and outlet dampers are open and allowing filtering. When a compartment is being cleaned, the outlet damper is closed. Each row of bags has an air header for injection of high pressure, instantaneous pulse air. Each row of bags receives a pulse of air to clean the bags which breaks up the filter cake and allows it to drop into the hopper.

H. The bypass system is used in the event of certain emergencies to divert the gas stream around the fabric filter compartments and directly to the induced draft fans. The system makes use of a poppet damper to interconnect the inlet and outlet manifold.

Operation Procedures

Following is a description of how the DFGD and Particulate Collection Systems are to be brought on and off line. Many of the functions are automatic and should be used accordingly. Several pieces of equipment have manual operation capability which should be used only during maintenance activities.

Even though some equipment has manual operation capability, interlocks still exist to prevent equipment damage.

References to switch positions, adjusting set-points, etc., are described as though hardware devices are used.

Pulse Jet Fabric Filter Precoat Instruction

Pre-coat Requirement

To facilitate proper operation of the particulate control equipment, GE requires that new filter bags be precoated prior to initial operation. The precoat will help to provide greater protection of the new filter bags during the initial startup should boiler upsets and/or acid condensation occur causing irreversible bag damage in the form of bag failures, high opacities and/or low bag/filter cake permeability. Precoating of second generation or replacement bags is normally not required; however, GE Environmental Systems should be consulted prior to any commissioning of the replacement bags.

Material Specification

A. The precoat material shall be dry fly ash obtained from a pulverized coal fired boiler, burning coal with a maximum sulfur content of 1%, sodium levels of less than 1%, moisture content less than 10%, and having a mass mean particle size distribution of greater than 8 microns with no more than 2% less than 1 micron.
B. An optional precoat material to the prescribed flyash is a 90% available limestone material, with a minimum of 80% passing 325 mesh or preferably a commercially available material used primarily for precoat called Nutralite.

Samples

A. Samples from any selected source of precoat material shall be obtained and submitted to GE Environmental Systems for analysis and approval prior to use. Samples should be sent to: GE Environmental Systems
200 North Seventh Street
Lebanon, PA 17042
Attention: Mr. T. Lugar
Mgr., Particulate Technology

B. Samples should be packaged in leak proof/moisture proof containers and be properly protected for shipment via mail. Samples should be clearly labeled as to the source and marked as part of the Filer City project.
C. Samples should preferably be collected from a fabric filter system. The compartment should be cleaned, and then isolated. The ash sample should be pulled from the hopper at this time to collect a more typical ash.

Quantity

A. The precoat protection is established by having the new filter bags coated with approximately 3.0 pounds of material per 10 square feet of cloth. Therefore, the fabric filter will require approximately 5.5 tons of precoat material.

Equipment Condition

A. Boiler Condition

Prior to applying the precoat material, the boiler should be checked out and demonstrated as being capable operating on coal. This is to ensure a minimum amount of time between the completion of precoat and admitting particulate laden flue gas into the compartments. The boiler should be pre-fired on natural gas only to bring it to as high a temperature as possible with the fabric filter on bypass, if needed, prior to actually precoating the bags. This will provide as hot a source of clean air as possible to facilitate precoating the filter bags. Use of the I.D. fans will be required for this procedure.

B. Baghouse Condition

Bags must be completely installed in all compartments to be precoated. All construction must be complete, including controls, hopper heaters, leak tests and insulation (casing and ductwork). The hopper heaters must be turned on at least 48 hours prior to initiation of the precoat process. The internal compartment should reach a minimum temperature of 140 degrees Fahrenheit prior to the introduction of the precoat material with the preheated air stream from the boiler. The pulsing system must remain off (disabled) during this process.

C. Environmental Conditions

The application of the precoat material must occur on a relatively low humidity day, with relative humidity of less than 50% to avoid moisture gain of the precoat.

Detailed Precoat Procedures

A. All fabric filter dampers, differential pressure instruments, temperature gauges and recorders, hopper heaters, fly ash evacuation system, etc. must be completely checked out and ball valves and door openings closed prior to proceeding with precoating.

B. The bypass damper on the fabric filter will be manually opened in order for a free flow path and to establish a known ACFM when starting the I.D. fans. When using the fans for this procedure, the fabric filter casing will be under a slight negative pressure which will more easily allow precoating through the inlet test ports.

C. After establishing the inlet fabric filter flow at approximately 19,800 ACFM per compartment to be precoated, individual compartments can manually be opened up (both inlet and outlet valves) and the bypass damper manually closed. A minimum of two compartments are to be precoated at any one time, since this represents a practical number to ensure high enough fabric filter inlet flow rates to minimize ductwork dropout of precoat material.

D. The best procedure is to start with the first two compartments (as gas flow enters the fabric filter) and end with the two compartments located closest to the I.D. fan.

E. Record the clean bag tube sheet pressure drops of all on line compartments prior to the introduction of the precoat material. The pressure drops across each of the compartments being precoated will be monitored during this process via local compartment Magnahelic gauges. When any compartment reaches a nominal 0.75-inch increase in pressure drop over its "clean bag pressure reading", that compartment will be isolated and another compartment opened. If no compartments remain to be precoated, then the airflow via the I.D. fan is to be terminated unless the system is to be immediately placed into service.

F. The hopper heaters will remain on with all hoppers emptied of dropout material from precoating.

G. The unit should be started up immediately after precoating has been completed, if at all possible. The time period between completion of precoat and start up of the baghouses <u>must</u> <u>not</u> exceed a 168-hour period. If the unit is not to be put into operation immediately after precoating, the inlet and outlet dampers must be closed. Also no personnel entries should be made into any compartment during this period, since this would cause precoat to be shaken from the bags.

H. Once the baghouse unit is put into operation, no personnel entry should be made into any of the compartments until after a bag seasoning period is completed (approximately 90 days) unless an emergency situation exists.

   Note: If Neutralite is used for precoat materials, special procedures are required to properly coat the filter bags. GEESI is to be notified if this material is used.

<u>Cold Startup Operating Instructions for DFGD</u>
This procedure is to be used to start the DFGD system following boiler outages which were longer than 48 hours and when starting with new bags.

A. Check the following:
   1. Fabric filter control air pressure low
   2. Lime Storage silo low-low alarm
   3. Absorber hopper level high alarm
   4. Fabric filter compartment hopper level high alarm
   5. Atomizer lube oil system malfunction alarm
   6. Lime and recycle system malfunction alarm

B. If any of the above alarm points are active, the alarm must be resolved prior to proceeding.

C. Make sure the atomizer is in the storage rack and that the atomizer holds cover is closed.

D. Check that all equipment is ready.

E. Start heat tracing for lime slurry and recycle slurry piping.

F. Start the ash removal equipment.

G. Start lime preparation as outlined by the manufacturer.

H. Start lime slurry pumping system by performing the following:
   1. Check to see that both slurry pumps suction valves are fully closed. Open both discharge valves, then both flush valves for thirty seconds. This is done to insure no solids are settled in the pumps. Close both flush valves. Close discharge valve on standby pump; leave discharge valve OPEN on pump to be started.

   2. Manually open the pump suction valve on the pump to be started.

   3. Turn pump control switch on the slaker control panel to AUTO.

   4. Check that the back pressure control valve is at 25 psig (on the back pressure control valve).

   5. Start the boiler (refer to the appropriate MMP section).

   6. Start the emission monitoring system.

   7. Lift atomizer into the absorber and connect power cable, instrument cables, lube oil hoses, dilution water hose, and lime slurry hose.

   8. Turn atomizer lubrication switch to START.

   9. After the lubrication system has been on for five (5) minutes, turn the atomizer switch to START.

WARNING

THE ATOMIZER CANNOT REMAIN IN THE ABSORBER IN HOT FLUE GAS FOR MORE THAN 15 MINUTES UNLESS THE ATOMIZER IS ROTATING.

   10. Insure that the lime slurry control valve is in MANUAL with zero output on the lime slurry feed controller.

   11. Select the modulate position of the isolation/modulate lime slurry and recycle slurry valve switches on the AQCP panel.

PROCEED ONLY AFTER THE FABRIC FILTER OUTLET TEMPERATURE HAS BEEN 250 DEGREES FAHRENHEIT OR MORE.

12. Turn all fabric filter compartment switches to AUTO.

CHECK THAT ALL COMPARTMENT INLET DAMPERS ARE FULLY OPEN

CAUTION

CHECK THAT THE BOILER GAS FLOW IS A MINIMUM OF 64,700 ACFM BEFORE CONTINUING. FAILURE TO ADHERE TO THIS CAUTION WILL RESULT IN THE PRODUCTION OF WET ASH. PROCEED ONLY AFTER THE ABSORBER OUTLET TEMPERATURE IS ABOVE 250 DEGREES FAHRENHEIT.

13. Simultaneously perform the following steps:
    a. Introduce solid fuel to the boiler. Begin to reduce supplemental start-up fuel.
    b. Check that the baghouse bypass permissive satisfied light is illuminated. If it is, select the bypass function switch to START. This is a momentary command.

    Note: The compartments should sequence on line by opening the outlet dampers automatically. When six compartments are acknowledged to be in the filtering mode (inlet and outlet dampers are fully open), the bypass damper will automatically close.

14. Do not manually initiate a cleaning cycle. Allow the automatic differential initiation to occur.

15. Gradually, manually open the lime slurry control valve to maintain an absorber outlet temperature of 200 degrees Fahrenheit.

16. Adjust the lime slurry valve controller automatic set point to desired ppm and switch to AUTO.

17. Allow absorber outlet temperature to stabilize.

18. Adjust Recycle Slurry Control Valve controller set point to 10 degrees Fahrenheit below temperature stabilized and place controller in AUTO. Then gradually reduce controller set point to 155 degrees Fahrenheit.

19. Turn all hopper heaters to AUTO.

THE SYSTEM SHOULD NOW MAINTAIN ITSELF IN STEADY STATE OPERATION.

Steady State Operation

A. The Dry Flue Gas Desulfurization System is designed to be self-sustaining when operating in a steady state mode (64,700 to 150,400 ACFM).

B. If the System inlet volume goes down below 64,700 ACFM, the operator, as a minimum, stops slurry flow to the absorber. This is done as follows:

1. Set the manual output of the recycle slurry controller to zero, adjust the automatic set point to full-scale temperature and turn the recycle slurry controller to MANUAL and the control switch to ISOLATE.

2. **IF THIS CONDITION IS GOING TO EXIST FOR MORE THAN TWO HOURS, SHUT THE SYSTEM DOWN AS DESCRIBED IN EITHER "LONG TERM SHUTDOWN" OR "SHORT TERM SHURDOWN" INSTRUCTIONS.**

3. The absorber gas distribution equipment is designed for controlling flows above 64,700 ACFM; internal inspections must be made to determine if wall buildup is occurring during low load operation.

4. If the boiler has been operating at a reduced load for a long period of time (e.g., overnight at a low load demand) the fabric filter should have a cleaning cycle manually initiated 30 minutes prior to ramping up in load. Depress the fabric filter cleaning – push to clear pushbutton.

5. On occasion, it will be necessary to switch lime slurry pumps during the steady state operation. This is done as follows:

   a. Turn pump to OFF. The operating pump will stop; then proceed through a manual pump flush sequence as follows:
      - Close the pump suction and discharge valves.
      - Open the pump suction drain and flush valves.
      - After 30 seconds, close the discharge flush and suction drain valves.

   b. Turn standby pump to AUTO.

Short Term Shutdown

This procedure is to be followed when a boiler outage is expected to be for a period less than 24 hours.

WHEN THE INLET GAS FLOW IS REDUCED TO 64,700 ACFM OR LESS, PROCEED WITH THE FOLLOWING:

A. Set the manual output of the recycle/temperature controller to zero, adjust the automatic set point to full-scale temperature and turn the recycle controller to MANUAL and the AQCS Panel Recycle Slurry Feed Valve Switch to ISOLATE.

B. Set the manual output of the lime slurry feed controller to zero, adjust the automatic set point to full scale, and turn the controller to MANUAL and the AQCS Panel Lime Slurry Feed Valve Switch to ISOLATE.

C. Begin to slowly reduce solid fuel feed. This should occur over a period of approximately 30 minutes.

D. Turn the atomizer switch to STOP.

E. Check that the atomizer lubrication system function switch is in the REMOTE position and after the atomizer has coasted to a stop, turn the lubrication system switch to OFF.

F. Lock out the atomizer power source at the MCC. Disconnect recycle slurry hose, lime slurry hose, lubrication supply and return hoses, atomizer power quick disconnect plug and atomizer and motor instrument disconnect plugs. Lift atomizer from the absorber. After the absorber clears the atomizer hole covers, close the hole cover.

G. Place the atomizer in its storage rack and plug in the space heater.

H. Remove atomizer wheel and liquid distributor, clean and replace.

WARNING

THE ATOMIZER CANNOT REMAIN IN THE ABSORBER IN HOT FLUE GAS FOR MORE THAN 15 MINUTES UNLESS THE ATOMIZER IS ROTATING.

I. Turn all hopper heater switches to ON.

J. The fabric filter should remain on line for a period following final burning of the fuel for a sufficient time to purge flue gas from the gas flues and fabric filter compartments. As the residual heat of the boiler and flue system reduces, the fabric filter inlet temperature decreases and the low inlet (240 degrees Fahrenheit) temperature alarm activates, turn the fabric filter bypass damper switch to MANUAL BYPASS.

K. Keep the ash removal system operating until the hoppers are completely empty, and then turn it off.

<u>Long Term Shutdown for DFGD</u>

This procedure is to be followed when a boiler outage is expected to be for a period of 24 hours or more.

CAUTION: INLET GAS FLOW MUST BE MAINTAINED ABOVE 64,700 ACFM.

A. Turn the recycle feed valve switch to ISOLATE, turn the recycle/temperature controller to MANUAL and change the set point to full scale (zero output).

B. Turn the lime slurry feed valve to ISOLATE, turn the lime slurry feed controller to MANUAL and adjust the output to the bottom end of the scale (zero output).

C. Turn the lime slurry pump OFF.

D. Close the suction valve of the lime slurry pump that was in operation.

E. Open the adjacent pump discharge valve. At this time, both discharge valves will open.

F. Open both lime slurry flush valves.

G. After 3 minutes, gradually open the lime slurry control valve while watching absorber outlet temperature. Allow the temperature to drop 40 degrees Fahrenheit. Note the percent output on the Controller. Set manual output to zero, then return to the above noted controller output. This is done to flex the valve. Repeat this several times and leave valve closed.

H. Close both lime slurry flush valves one minute after completing.

I. Begin to slowly reduce solids fuel feed. This should occur over a period of approximately 30 minutes.

J. Turn the atomizer switch to STOP.

K. Check that the atomizer lubrication system function switch is in the REMOTE position and after the atomizer has coasted to a stop, turn the lubrication system switch to OFF.

L. Lock out the atomizer power source. Disconnect process water hose, lime slurry hose, lubrication supply and return hoses, atomizer power quick disconnect plug and atomizer and motor instrument disconnect plugs. Lift atomizer from the absorber. After the atomizer clears the absorber, close the hole cover.

M. Place the atomizer in its storage rack and plug in the space heater.

N. Remove atomizer wheel and distributor, clean and replace wheel.

WARNING
THE ATOMIZER CANNOT REMAIN IN THE ABSORBER IN HOT FLUE GAS FOR MORE THAN 15 MINUTES UNLESS THE ATOMIZER IS ROTATING.

O. Turn all hopper heater switches to ON.

P. If the boiler is going to be off for more than 48 hours, shut down slaker system, including draining the slaker and slurry tank.

Q. Turn all compartment cleaning mode switches to OFF LINE.

R. Keep the ash removal system operating until the hoppers are completely empty, and then turn it off.

S. Stop the emission monitoring equipment.

<u>Atomizer Removal</u>

Periodically the operating atomizer needs to be cleaned and inspected. This procedure can be used to remove the operating atomizer.

A. Set the manual output of the recycle/temperature controller to zero, adjust the automatic set point to full-scale temperature and select the MANUAL control mode on the controller.

B. Set the recycle feed valve switch to the ISOLATE position.

C. Adjust the lime slurry feed controller manual output to zero and automatic set point to full scale.

D. Insure that the atomizer function switch is in the REMOTE position, and then turn the atomizer switch to STOP.

E. Check that the atomizer lubrication system function switch is in the REMOTE position and after the atomizer has coasted to a stop, turn the lubrication system switch to OFF.

F. Lock out the atomizer power source at the MCC. Disconnect recycle slurry hose, lime slurry hose, lubrication supply and return hoses, atomizer power quick disconnect plug and atomizer and motor instrument disconnect plugs. Lift atomizer from the absorber. After the absorber clears the atomizer hole cover, close the hole cover.

G. Place the atomizer in its storage rack and plug in the space heater.

H. Remove atomizer wheel, clean and replace.

Installation of Atomizer

A. Unplug space heater.

B. Lift atomizer from rack storage, remove atomizer hole cover and install atomizer.

C. Connect lubrication supply and return hoses.

D. Turn atomizer lubrication switch to ON.

E. Connect recycle slurry hose, lime slurry hose, atomizer power quick connect plug and atomizer and motor instrument plug, then unlock and CLOSE the atomizer power breaker at the MCC.

F. After the lubrication system has been on for five (5) minutes, turn the atomizer switch to START.

WARNING

THE ATOMIZER CANNOT REMAIN IN THE ABSORBER IN HOT GLUE GAS FOR MORE THAN 15 MINUTES UNLESS THE ATOMIZER IS ROTATING.

G. Gradually, manually open the Lime Slurry Control Valve via the Lime Slurry Feed Controller to maintain an outlet temperature of 200 degrees Fahrenheit.

H. Adjust the Lime Slurry Feed Controller automatic set point to desired PPM, and switch to AUTO.

I. Allow absorber outlet temperature to stabilize.

J. Adjust Recycle/Temperature Controller set point to 10 degrees Fahrenheit below temperature stabilized and place controller in AUTO. Then gradually reduce controller set point to 155 degrees Fahrenheit.

Startup Operating Instruction for Fabric Filter

The fabric filter is controlled for automatic operation by the use of Air quality Control System (AQCS) Panel furnished by GEESI. The permissive conditions which must exist before the fabric filter can be put on line are as follows:

A. Hopper heaters are ON 48 hours prior to startup.

B. Fabric filter bypass damper OPEN.

C. Compressed air pressure at above 80 psig.

D. Inlet temperature below high set point of 275 degrees Fahrenheit.

E. Inlet temperature above low set point of 240 degrees Fahrenheit when the fabric filter is ON and spray absorber is OFF.

F. Fabric filter BYPASS FUNCTION in AUTO position.

G. A minimum of six (6) compartment cleaning mode switches in AUTO position and their corresponding six (6) inlet dampers opened.

H. Control power exists to the system programmable logic controller.

I. Ash handling system OPERATING.

J. High ash level detectors ON.

Startup Procedure

When the above permissives are met, the fabric filter can be placed into service. This is accomplished by the following procedure:

A. Ensure that the baghouse has been manually put into service before introducing solid fuel.

B. Place all compartment cleaning mode switches in the AUTO position.

C. After the fabric filter inlet temperature has reached a required minimum operating temperature of 240 degrees Fahrenheit, sequence the compartments on line by selecting the START position of the Bypass Function Switch, automatically opening the compartment outlet dampers. When a minimum of six (6) compartments are acknowledged to be in the filtering mode (inlet and outlet dampers open), the bypass damper will automatically close.

D. The automatic cleaning system will be activated to allow the cleaning of the filter bags should the appropriate pressure drop (5.5 inches w.c.), timer override and/or operator initiated cleaning signal be received.

E. The fabric filter is now in its normal operating mode. During startup, the boiler operator must avoid any ramping (quick load changes) of the boiler to allow the fabric filter to be started up as smooth as possible to avoid damage to the filter bags in the first compartments brought on line.

F. As there is a short time delay between the AQCS panel receiving its signal to open up the appropriate compartments and the time that the compartments are actually placed in full filtration mode, any ramping of the boiler load and/or air flow could cause the fabric filter to initiate an automatic bypass caused by a high pressure drop signal thereby allowing uncontrolled emissions to escape into the atmosphere.

G. A high fabric filter pressure drop will be alarmed at 8.0 inches w.c., prior to bypassing at 8.5 inches w.c., to allow the operator ample time to make any appropriate changes as required to reduce the pressure drops below the actual bypass set points.
Note: To meet emission requirements there is a 250 switch that is used to override the temperature limits. This allows the fabric filter to be placed into service when flue gas temperatures are out of range. Putting the 250 switch into override can also be used to prevent an auto bypass function on the fabric filter system.

System Bypass

Bypass Conditions
The fabric filter will automatically bypass for any of the following conditions:

- High inlet temperature.
- Low inlet temperature. Spray absorber OFF.
- Low-low inlet temperature. Spray absorber ON.
- High fabric filter pressure drop.
- More than six (6) compartments off line.
- The fabric filter can also be put into the bypass mode manually by the operator from the main control panel. (See bypass function switch.)

Bypass Sequence
When a bypass takes place, the following sequence occurs:

- Bypass poppet OPENS fully.
- All outlet poppets CLOSE after the interlock permissive signal indicates the bypass damper is OPEN.
- Automatic fabric filter cleaning sequence is TERMINATED.
- The cleaning of individual compartments can be conducted manually, one compartment at a time during bypass by the operator from the AQCS panel.

<u>Warm Restart</u>

Once a bypass condition has been cleared and all required permissives are met, the unit can be placed back in service by the operator from the main control panel in the following sequence:

- Set all compartment cleaning modes switches in the AUTO mode.
- Select the START position on the bypass function switch.

- This switch will spring return to the AUTO position. This will OPEN the outlet poppets, and when confirmed open, the bypass damper will CLOSE.

Compartment Cleaning Mode

A. During NORMAL operation of the fabric filter, all systems will be in the automatic mode. Cleaning will be OFF LINE and will be normally initiated by either a flange-to-flange pressure drop signal or timer initiated signal after eight (8) hours of continuous filtration.

B. The AQCS will automatically switch to an ON LINE (outlet dampers remain open) cleaning mode when one-compartment mode switches are in the OFF LINE position. This switch can be locked in off line position with the key removed by the operator. All automatic cleaning modes can still initiate cleaning under normal operation.

C. Manual compartment cleaning can be accomplished when a compartment is OFF LINE via the compartment cleaning mode switches. However, only one compartment can be cleaned at any one time. If a total of two (2) compartments are off line at any one time, manual cleaning of a third compartment is prohibited since the AQCS will detect three compartments off line which is an automatic BYPASS condition.

Shutdown Procedures

Shutdown of the fabric filter is controlled from the Air Quality Control System (AQCS) panel. These detailed procedures are as follows:

Long Term (Cold) Shutdown

The following procedure shall be utilized when the fabric filter is expected to be off line for more than 48 hours.

A. Approximately 20 minutes after coal firing in the boiler has stopped (to allow sufficient time for purging the fabric filter of acid laden flue gas with hot clean air), manually initiate a bypass of the fabric filter system by turning the bypass function switch to BYPASS position.

B. Immediately upon bypass, the unit is to have each compartment manually cleaned at least twice to remove as much ash off the bags as possible.

C. The ash system is to remain in operation until all hoppers are completely empty.

D. Upon the completion of ash removal from the hoppers, the hopper heater controls can be switched off at the MCC until 48 hours prior to the next startup, but it is highly recommended that they remain on to minimize the chances of condensation from occurring on the filter cake.

E. The unit is to remain sealed to ambient conditions except for necessary maintenance. Any unnecessary entries into the compartments can cause long-term bag damage.

Hot Shutdown

The following procedure shall be utilized when the unit is expected to remain off line 48 hours or less:

A. Follow the LONG TERM SHUTDOWN procedure up to the shutdown of the ash removal system.

B. Upon shutdown of the ash removal system, the hopper heaters are to remain ON with the temperature set for 210 degrees Fahrenheit.

C. The unit is to remain SEALED with only emergency maintenance requiring main entry to the compartments allowed.

WARNING

ON ANY MAN ENTRY INTO THE COMPARTMENTS AND/OR UNIT HOPPERS, STRICT ADHERENCE TO SAFETY IS NECESSARY. INJURY OR DEATH CAN RESULT FROM NEGLIGENCE.

Fabric Filter Compartment Isolation

A. Operator isolates compartment from the AQCS control panel by turning the compartment cleaning mode selector switch to OFF LINE.

WARNING

BEFORE ANY ENTRANCE TO A COMPARTMENT IS ALLOWED, THE COMPARTMENT CLEANING MODE MUST BE LOCKED IN THE OFF POSITON. ALL MECHANICAL STOPS AND PADLOCKS, IF SUPPLIED, MUST BE UTILIZED ON ISOLATION DAMPERS.

B. The isolated compartment is to be cleaned at least twice by selecting the MANUAL position of the compartment cleaning mode switch before any entrance is made.

C. Should an extended outage be anticipated for the compartment, the hopper shall be emptied, and the hopper heaters switched OFF.

D. For short outages of one (1) hour or less, the hopper heaters should remain ON.

Ventilation of Compartments

To ventilate the compartments, two (2) methods can be used. These are as follows:

A. Primary Method – Open the hopper access door and clean air plenum access door. Allow natural ventilation to cool the compartment. To speed up the process, a ventilation fan can be placed at the upper access door to draw flow through the compartment.

B. Alternate Method – Open the clean air plenum access door and crack open the butterfly inlet damper. (These dampers are pneumatically closed by operation of the OFF LINE switch.) This will induce flow in through the access door and into the inlet manifold.

WARNING

FULL CAUTION NEEDS TO BE EXERCISED WHEN OPENING ANY ACCESS DOORS. REVIEW ACCESS DOOR SAFETY RULES BEFORE ATTEMPTING TO ENTER THE FABRIC FILTER COLLECTION SYSTEM.

Compartment Restart

To place an isolated compartment back on line, the following procedure must be followed:

A. Follow all safety procedures to ensure that all personnel are out of the compartment.

B. Close the access doors and check that the doors are properly latched.

C. Turn ON hopper heaters, if OFF.

D. Manually remove any padlocks and stops if supplied on the inlet damper.

E. The operator unlocks the compartment cleaning mode switch and places it in the AUTO position. This will automatically open the inlet and outlet damper and place the compartment back on line.

4.3 FLUE GAS DRY SCRUBBERS

Description

The Flue Gas Dry Scrubber controls the SO_2 emissions as required by the ROP. This system includes atomizers, slurry and recycle control valves, pumps, etc. The slurry is pumped to the atomizer, which contacts the flue gas stream with a fine spray of sorbent slurry droplets in a manner which promotes chemical absorption of sulfur dioxide by the droplets.

Critical Criteria

The system will be operated in a manner that will control the plant's SO_2 emissions in compliance with the ROP.

Inspections

A. Daily visual inspections of the scrubbers will be performed by the operations department. This is accomplished by routine rounds made during each shift. Work orders will be generated when concerns arise.
B. Weekly preventive maintenance will be performed on the scrubber atomizer wheels. Atomizers will be maintained according to the manufacturers recommended guidelines.
C. Scrubber vessels will be inspected annually during routine outages. Vessels will be inspected visually and ultrasonic thickness testing will be performed to determine vessel condition. Repairs will be performed based on these inspections.

Component Operating Descriptions

Flue Gas Dry Scrubbers - Atomizer Assembly

A. Components – Atomizer Body
    1. Location – Center of gas distributor cone.
    2. Quantity – One.
    3. Description – Steel body with insulated jacket, stainless steel external jacket and base plate. Flat belt drive. Stainless steel spindle supported by two preloaded ball bearings and designed for operating at high speed. Two stainless steel feed pipes with quick disconnect couplings. 400 mm diameter stainless steel wheel with replaceable silicon carbide inserts. An internal distributor is used to evenly introduce the slurry into the rotating wheel. An oil collection sump is located below the lower bearing. Instrumentation is provided for monitoring bearing temperature and vibration on both bearings.
    4. Normal Control Mode – Manual by switch (see motor).
    5. Fault Control Mode – High-high bearing vibration or high-high bearing temperature will automatically trip atomizer motor.

B. Atomizer Motor
    1. Location – Bolted to special base frame mounted on top of atomizer base plate.
    2. Quantity – One.
    3. Description – Self ventilated, vertical, 150 HP, 460 VAC, 3 phase, 60 Hz power. Anti-friction type bearings, grease lubricated. Space heater for condensation protection of starter windings. Insulation is Class F. Instrumentation is installed for measuring the winding temperatures.

4. Function – Drive atomizer.
5. Normal Control Mode – Manual by switch, on AQCS Panel automatically tripped by atomizer instrumentation to prevent mechanical damage. Interlocked to prevent operation without atomizer lubrication system functioning.
6. Fault Control Mode – High-high bearing vibration, high-high bearing temperature on atomizer, loss of atomizer speeds will trip the motor.

C. Lubrication System
1. Location – Air distribution cone upper level.
2. Quantity – One.
3. Description – Skid mounted, volumetric, once-through oil lubrication, powered by air driven supply pump and air driven return pump. Oil supply and return reservoirs. Control for supply pressure, air pressure, and reservoir level. Connected to atomizer by quick-disconnect couplings.
4. Function – Lubricate atomizer spindle bearings.
5. Normal Control Mode – local/remote manual switch.
6. Fault Control Mode – Malfunction will trip atomizer motor.

Function
Mix the recycle slurry and lime slurry and atomize the slurry to approximately 40 microns. Introduce the atomized slurry into the absorber chamber to mix with the flue gas.

Means of Control
Manual via AQCS Panel or local atomizer panel switch. Automatic shutdown by atomizer instrumentation to prevent mechanical damage.

Internal Fault Modes
Mechanical failure of atomizer, electrical or mechanical failure of motor.

Countermeasures – Remove and repair.
Consequences – No sulfur dioxide removal until system is repaired. Exposure to hot gas stream which may damage the atomizer bearing assemblies.
Lubrication System Failure – Automatically trips the atomizer.
Countermeasure – None.
Consequences – Faults automatically show on AQCS annunciator.

D. Gas Inlet Flow Control
1. Louver Damper
   - Location – Gas distributor lower section.
   - Description – Louver damper with air operated actuators.
   - Function - Direct flue gas into appropriate cone section to maintain minimum gas velocity.
   - Normal Control Mode – Open/closed based on gas flow signal. Set point to open lower louver (increasing flow) 90,000 ACFM, set point to close lower louver (decreasing flow) 85,000 ACFM.
   - Fault Control Mode – Close on loss of signal.

2. Function
   Introduce flue gas into the absorber chamber concurrent with the slurry spray and maintain gas-to-liquid contact for volumes in excess of 64,700 ACFM.

3. Means of Control
   Open/closed operation based on flue gas volume.

4. Internal Fault Modes
   Fails closed on loss of signal, power or air.

Lime Slurry Generator

1. Truck Loading System
   - Location – Side of silo.
   - Quantity – One.
   - Description – Fill pipe, 4” diameter, with inlet cap and discharge target box. Unloading control panel with cap limit switch. Silo ventilation filter with discharge fan.
2. Function – Provide attachment to pneumatic truck for conveying pebble lime to silo. Remove dust from conveying air.
3. Normal Control Mode – Connection of the feed pipe from the truck to the lime fill pipe actuates the silo vent fan.

Slaker

1. Location – Second level of lime slurry preparation building (on tank).
2. Description – Wallace and Tierman Series A-758 welded steel construction, replaceable steel inner liner and inspection cover. Lime rate and emergency dilution controls.
3. Function – Mix metered quantities of water and lime together to form a calcium hydroxide slurry with a minimum possible particle size and prescribed fluid density.
4. Normal Control Mode – Automatic on-off in response to slurry tank level. Feed rate of water is adjustable manually by operator. The slaker system control is entirely automatic (with manual overrides) and ensures a constant availability of slurry. The slaker system also utilizes a “cascade” interlock control concept which prevents the starting of any dynamic component (mixer, pump, screw conveyor, vibrator) unless the downstream component is operating satisfactorily.

5. Operation of the slaker system is initiated by the slurry transfer tank low level and is stopped by the high level. Operations so controlled are:

   - Silo discharge vibrator
   - Lime feeder
   - Slaker mixer
   - Slaking water valve
   - Dilution water valve
   - Vibrating screen

- Vapor remover
- All slaker emergency functions

6. Fault Control Mode – Mechanical failure of the slaker mixer will trip the slaker agitator low-speed switch, stopping the lime feeder.

Grit Removal (see Volume 3)
1. Location – Second level of lime slurry preparation building (on tank).
2. Description – Circular grit removal screen with dilution jets and overflow spout. Vibrating screen with replacement steel screen. Conveyor to disposal.
3. Function – Separate grits from slurry and transfer grits to storage.
4. Normal Control Mode – Automatic.
5. Fault Control Mode – None.

Slurry Storage and Transfer (see Volume 3)
1. Location – Bottom level of lime slurry preparation building.
2. Description – Slurry tank with one turbine agitator and level control. Two slurry pumps with manual water flushing. Valves and piping.
3. Function – Store slurry from slaker/grit removal overflow and from absorber return. Agitate slurry to prevent settling of solids. Feed slurry to absorber.
4. Normal Control Mode – Agitator and pumps manually operated. Manual flush.
5. Fault Control Mode – A lime slurry tank low-low level trips lime slurry pump to prevent pump cavitations. A lime slurry tank high level stops the lime feeder and slaker water to prevent tank overflow.

Slurry Feed Control Components
Lime Slurry Control Valve
1. Location – Inside absorber penthouse.
2. Description – 1” ceramic ball valve, positioner. Air to open.
3. Function – Control flow of lime slurry to atomizer.
4. Normal Control Mode – Automatic by system, or manual by operator.
5. Fault Control Mode – Fail-safe closed.

Recycle Slurry Control Valve
1. Location – Inside absorber penthouse.
2. Description – 1” ceramic ball valve, positioner. Air to open.
3. Function – Control flow of process water to atomizer.
4. Normal Control Mode – Automatic by system or manual by operator.
5. Fault Control Mode – Fail-safe closed.

Slurry Back Pressure Regulator Valves
1. Description – Pinch valve, 3” with air pressure regulator.
2. Function – Regulate slurry pressure into slurry control valve at constant value to avoid valve seeking.
3. Normal Control Mode – Automatic.
4. Fault Control Mode – Fail open.

Slurry Pump Suction Valves

1. Location – Upstream of lime slurry pump.
2. Quantity – One each pump; two total.
3. Description – 3” straight through diaphragm valve. Manually operated.
4. Function – Pump isolation.
5. Normal Control Mode – Manually opened by operator on pump start and closed on pump stop.

Slurry Pump Discharge Valve

1. Location – Downstream of lime slurry pump.
2. Quantity – One each pump; two total.
3. Description – 3” straight-through diaphragm valve. Manually operated.
4. Function – Pump isolation.
5. Normal Control Mode – Manually opened by operator on pump start and closed on pump stop.
6. Function - Control the slurry flow rate to the atomizer to achieve optimum SO_2 removal. Stop flows to avoid formation of wet powder in absorber.

Lime Slurry / SO_2 Removal

The degree of SO_2 reduction achieved in the spray dryer absorber and fabric filter is directly related to the rate of lime feed to the atomizer. The lime slurry feed rate to the atomizer is regulated by a control valve which is modulated by a signal from an analog control system utilizing the signal from the SO_2 analyzer, located in the stack. An analog control system will automatically control the SO_2 concentration leaving the system at a level set on the slurry feed controller on the AQCS Panel.

Recycle Slurry / Absorber Outlet Temperature

The desired absorber outlet temperature is normally selected to be 155 degrees Fahrenheit. The absorber outlet temperature is maintained at this temperature by modulating the recycle slurry valve.

Internal Fault Modes

Mechanical Failure

Countermeasure – Control valves are provided with manual isolation valves upstream.
Consequences – Failure to recycle slurry valve may indirectly cause slurry trip via absorber outlet low temperature. A failed slurry valve may cause high SO_2 alarm. Failure of isolation valve will not affect normal system operation.

Loss of Control Air or Control Power

Countermeasure – Fail-safe.
Consequences – Valves fail closed and stop slurry flow and recycle slurry flow to atomizer.

The separate automatic control of outlet temperature and SO_2 concentration makes possible rapid and highly efficient control of the spray absorption process.

Hopper Heaters
Hopper heaters are modular (blanket) design. The bottom one-third of the hopper will be heated. Heating will be sufficient to maintain internal skin temperature above 160 degrees Fahrenheit. Hopper heaters are controlled automatically by thermostats.

Operation
Start-up

A. When starting up the flue gas scrubbers, special attention must be taken to minimize the environmental impact caused by SO_2 emissions in the flue gas. This includes starting up on natural gas only such that an atomizer is started up before coal is introduced to the boiler.
B. When the flue gas temperature leaving the scrubber vessel reaches approx. 145 deg. F. an atomizer should be installed and started up.

Note: When firing solid fuel only, the baghouse temperature requirements drop to 145 deg. F when an atomizer is placed into operation. Once the atomizer is started when firing solid fuel only, the baghouse can then be placed into operation. When starting up on natural gas only, the atomizer should be installed and started up before the introduction of coal.

C. Lime slurry should be admitted to the scrubber as soon as practical, (slowly at first) so as not to decrease the flue gas temperature below 145 deg. F. where the baghouse will bypass. SO_2 emissions control (90% removal of all SO_2 admitted to the scrubber from the boiler) should begin at the earliest stages of start-up.
D. As the boiler load increases, it will become necessary to add recycle water spray to the vessel along with the lime slurry to control scrubber outlet temperature. Maintain160 – 165 deg. F at the scrubber outlet.

Normal Shutdown

A. During a boiler controlled shutdown, SO_2 removal operation must be maintained until the boiler flue gas cools to 145 deg F.
B. At that time the coal should be run off the boiler grates and the boiler fans can be shut down to avoid excess SO_2 emissions.
C. Reduce the recycle and lime slurry flows to zero.
D. Stop the atomizer and remove the atomizer from the scrubber vessel for cleaning.

Emergency Shutdown

A. Should the scrubber have to be shut down due to an emergency, compliance with all SO_2 emissions limits is still required and Data Acquisition and Handling System (DAHS) Reports should be routinely consulted to understand if compliance with any SO_2 emissions limits is in jeopardy.
B. Should the scrubber not be able to be placed back into service and/or the SO_2 emissions limits are in imminent danger of being exceeded, then the boiler must be removed from operation and the coal removed from the grate.

The Effects of Boiler on Flue Gas Dry Scrubbers

The essential operating characteristic of the spray absorber is to maintain an absorber outlet temperature above 160 degrees Fahrenheit. Boiler changes which have an immediate effect on the absorber must be recognized by the control system and appropriate action taken. Longer-term changes can be counteracted by operator actions.

Boiler Tube Leak

A. Absorber Response: 10 to 60 seconds.
B. Severity:
    1. In the event that a massive boiler tube leak occurs, the majority of the water, steam, and muddy dust in the boiler gas stream will be intercepted by the economizer during boiler tube leak.

    2. The absorber will perform like a cyclone collector. Inertial forces will centrifuge the larger and denser mud particles and agglomerated ash toward the vessel wall and into the absorber hopper. It is unlikely that any wet particles over 50 microns would pass through the absorber.

    3. Possible wet deposits may be formed in the absorber in the event of boiler tube pinhole leaks or superheater tube.
C. Predictability: None.
D. Countermeasures: Massive rupture may initiate boiler main fuel trip, causing reduction in flue gas temperature. <u>Operator should immediately trip absorber</u> (slurry valves will close). If the operator does not intervene, the flue gas temperature will eventually drop below the low absorber outlet temperature set point, thereby automatically tripping absorber.

Boiler Trip

A Absorber Response: Immediate.
B. Severity: Partial saturation of gas and powder in absorber.
C. Predictability: None
D. Countermeasures: Operator should immediately trip absorber (slurry valves will close). If operator does not intervene, the flue gas temperature will eventually drop below the low absorber outlet temperature set point, thereby automatically tripping absorber.

Load Reduction

A. Absorber Response: Immediate repositioning of inlet louver dampers in response to flow change.
B. Severity: None for gradual reduction. Rapid reduction may form wet powder in absorber.
C. Predictability: Operator initiated for manual boiler load control. Fair to poor for automatic load control.
D. Countermeasures: Adjust rate of boiler load reduction to be compatible with absorber control lag time. Rapid load reduction may reduce absorber outlet

temperature below the low set point and automatically stop slurry flow to the atomizer.

Steam Soot Blowers

A. Absorber Response: 15 – 60 seconds.
B. Severity: Operation of soot blowers at lower loads will increase dew point which will cause wet powder to form in the absorber.
C. Predictability: Operator initiated.
D. Countermeasures: Restrict soot blower operation.

Wet Fuel

A. Absorber Response: 1 – 24 hours, depending on fuel storage capacity.
B. Severity: Wet fuel may increase the gas dew point up to 10 degrees Fahrenheit.
C. Predictability: Fair, depending on coordination between boiler operator and fuel handling. Time of occurrence and effect of flue gas dewpoint cannot be accurately predicted.
D. Countermeasures: Increase absorber outlet temperature control point by 10 degrees Fahrenheit when wet fuel is burned. (Actual value may be adjusted after sufficient operating experience is gained).

Air Heater Failure

A. Absorber Response: 1 – 15 minutes.
B. Severity: Absorber inlet temperature will rise dramatically. The absorber controls will tend to react by increasing flow of recycle slurry.
C. Predictability: None.
D. Countermeasures: Operator will stop all slurry flow to absorber. If temperature to the fabric filter exceeds 275 degrees Fahrenheit, control system will automatically place the fabric filter in the emergency bypass mode, which, in turn, will automatically stop slurry flow.

Induced Draft Fan Trip

A. Absorber Response: Immediate.
B. Severity: Complete saturation of gas and powder in the absorber.
C. Predictability: None.
D. Countermeasures: The boiler main fuel trip should occur which will automatically stop slurry flow to the atomizer.

System Power Failure

A. Absorber Failure: Immediate.
B. Severity: If a power failure was to occur and slurry valves remained open, temperature control would be lost and the gas and powder in the absorber could become saturated.
C. Predictability: None.
D. Countermeasure: The recycle slurry and lime slurry are designed to fail closed on loss of a control signal. Loss of control signal will cause lime slurry pump to trip.

Also, the control system fails to isolate mode on power failure preventing premature injection of liquids to the system.

Maintenance
Repairs will be performed based upon inspection and/or as a preventive measure. Record keeping is maintained within the computerized maintenance management system.

A. Preventive
   1. Atomizers - cleaned weekly with a clean spare available at all times
   2. Atomizer motors - greased every 6 months
   3. Atomizers are rebuilt – after 60,000 hours
   4. Quench spray nozzles - cleaned every 6 months
   5. Scrubber instrumentation (flows, temperatures, etc.) – calibrated every 6 months
   6. Scrubber vessel integrity - measure wall thickness annually
   7. Lime and recycle slurry pumps (4) – change oil every 6 months.

B. Inspection Related Repairs
   1. Diaphragm valves are rebuilt as needed.
   2. Atomizer electrical plugs are inspected and repaired as needed.

Troubleshooting
Corrective Action: Flue Gas Dry Scrubbers
This section describes the possible causes of serious absorber fault conditions, means of detection and corrective action to be taken to recover from the fault condition.

High Differential Pressure

A. Possible Causes
   1. Blockage of outlet duct by high dust level in hopper or accumulated buildup.
   2. Blockage of gas distributor wing inserts.
   3. Wing inserts in fully closed or partially closed position.
   4. Inlet dampers closed or partially closed.

B. Means of Detection
   1. Normal operating range for differential pressure is 4 to 6” W.C.
   2. Normal operating range for the absorber inlet temperature is 310 deg. F and the outlet temperature is 164 deg. F.
   3. Normal operating range for the lime slurry flows is 10 to 20 gallons per minute.
   4. Normal operating range for the recycle flows is 10 to 20 gallons per minute.
   5. Hopper high-level alarm.
   6. High absorber pressure drop.

C. Remedial Action
   1. Check the level of ash in the hopper. Remove ash if required.
   2. Check wing inserts actuator, which should not have moved from setting during original commissioning. Readjust to proper position.

3. Bring absorber and boiler off line and remove dust buildup on internal gas distributor parts, including vanes, wing inserts, and inlet dampers.

Low SO_2 Removal

B. Possible Causes
   1. Failure of lime slurry control loop.
   2. Operating of absorber at too high an exit temperature.
   3. Plugged lime slurry pipe valve failed.
   4. Improper slaking.
   5. SO_2 monitor failure.
   6. Atomizer malfunction.
   7. Too much dilution of lime slurry.

C. Means of Detection
   1. SO_2 indication recorder or alarm (by others).
   2. Absorber outlet temperature indicator.
   3. Atomizer low-speed alarm.
   4. Check lime slurry density.

D. Remedial Action
   1. Recalibrate SO_2 monitor.
   2. Measure absorber exit gas water dew point.
   3. Switch lime slurry feed control switch to manual. Gradually open the lime slurry control valve.
      a. If lime slurry flow does not increase and there is no reduction in SO_2 emissions, valve has failed or valve control has failed or lime slurry line has plugged. Repair actuator or controller or unplug line.
      b. If lime slurry flow increases, but absorber exit sulfur dioxide does not decrease substantially, lime slurry is of poor quality or is too dilute. Adjust slaker operation or change lime source.
      c. If lime slurry flow increases and absorber exit sulfur dioxide decreases substantially, sulfur dioxide control loop failed. Repair controls.
   4. Repair Atomizer.

High Absorber Outlet Temperature

A. Possible Causes
   1. High boiler outlet temperature due to unusual combustion conditions, excessive slag-up or low feed water flow.
   2. Fire in ductwork.
   3. Failure of recycle/temperature control loop and/or quench system loop.
   4. Rapid change in boiler operation.

B. Means of Detection
   1. Absorber outlet temperature thermocouples as indicated on AQCS panel or alarm.

C. Remedial Action
   1. To avoid potential condensation, slurry valves will trip automatically (absorber trip).
   2. Increase absorber outlet temperature controller set point.
   3. Repair or replace thermocouples as required.
   4. Repair absorber outlet temperature controls.
   5. Observe readings of lime slurry flow and recycle slurry flow rates. If lime slurry flow is unusually high or if recycle slurry flow is at or near zero, proceed with remedial action listed in Low SO_2 Removal.
   6. Switch recycle temperature controller to manual mode. Gradually open control valve.
      a. If recycle slurry flow rate does not respond, valve has failed or valve control has failed. Repair valve, actuator, controller or plugged pipe.
      b. If recycle slurry flow increases and absorber exit temperature decreases substantially, temperature control loop failed. Repair controls.

Wet Ash or Plugged Hopper

A. Possible Causes
   1. Saturation due to low absorber outlet temperature.
   2. Failure of atomizer.
   3. Failure of absorber hopper heaters.
   4. High flue gas moisture content due to wet fuel or boiler tube leak.

B. Means of Detection
   1. Absorber hopper level indicator and alarm.
   2. Absorber outlet temperature thermocouples as indicated on AQCS or alarm.
   3. Atomizer low-speed alarm.

C. Remedial Action
   1. If caused by low absorber outlet temperature, slurry water valves will trip automatically.
   2. Shut off slurry flow and atomizer.
   3. Repair atomizer.
   4. Rod out hopper to dislodge and remove all ash from hopper.
   5. Repair absorber hopper heaters.
   6. Repair boiler.

Spare Parts

Spare parts will be purchased and stored in inventory based on the manufacturer's recommendations and plant operating experience (see tab #4).

Malfunction Abatement Measures

In the event that a malfunction should occur to the flue gas dry scrubber that affects the plant emissions and causes the plant to exceed the permitted levels, specific action will be taken to bring the plant back into compliance. This action will be one or more of the following steps:

1. Continue to run with the failed equipment as long as the plant emissions are in compliance. This may or may not require the boiler(s) to run at a reduced load.
2. Correct the malfunctioned equipment by taking the equipment out of service for repairs. This may or may not require the boiler(s) to run at a reduced load.
3. Correct the malfunctioned equipment by shutting down the boiler(s) and repairing the equipment.

4.4 LIME SLURRY PREPARATION

Description

The lime preparation system serves two atomizers. The lime preparation system is provided with all the equipment for receiving, storing, feeding, slaking (pebble quicklime) and pumping the lime to the atomizers.

Critical Criteria

The lime slurry system is critical to the operation of the atomizers in the Flue Gas Dry Scrubbers.

Inspections

Daily inspections will be performed on the lime slurry preparation system to insure proper operation of the system. The slaker grits screen is changed based upon these inspections.

The plant generally experiences two planned outages each year. Outages usually occur in April and September or October. During the planned outages the lime slaker receives a thorough inspection, which includes power washing the internals.

Operation

A. The lime slurry preparation system is generally operated automatically and it is controlled by a locally mounted PLC (programmable logic controller). The system starts up when the slurry storage tank level falls to 12.5 feet. The system shuts off at 14 feet in the slurry storage tank. In this manner the plant will maintain no less than 25,000 gallons of lime slurry.
B. Prior to boiler start-up, the lime slurry system shall be placed into operation. The slurry storage tank will normally contain at least 10 feet of slurry before the boiler(s) are placed into operation.
C. Operators will make rounds each shift, checking the system for proper operation.
    1. Verify the lake makeup water supply strainer is not plugged.
    2. Verify the secondary water strainer is not plugged (located behind the slaker unit).
    3. Verify the following equipment control switches are in the auto position:
        a. Lime volumetric feed screw.
        b. Slaker paddle shaft.
        c. Slaker supply water booster pump.
        d. Lime silo hopper vibrator
D. Check the slurry (visually) for proper lime/water mixture and slaking.

E. Verify the lime volumetric feed screw housing is not plugged and that lime is flowing freely.
F. Check that the lime silo hopper vibrator cycles on and off at the desired intervals.
G. Verify the slaker water spray nozzles are not plugged.
H. Record the lime storage silo level and report any low levels that may be encountered so that the lime supplier can be notified.
I. Operators will also perform weekly cleaning of the slaker to keep it in optimum operating condition:
   1. Shut down slaker, open the tub hatches and remove the screens.
   2. Scrape excess lime from the paddle shaft in the paste area.
   3. Poke out the weir spray nozzles (3).
   4. Scrape excess lime off the de-lumper portion of the slaker shaft and ensure that the distributor downspout is clear.
   5. Clean out the vapor removal tube and remove the 4” plug and clean out the tube drain line.
   6. Clean out the slaker slurry overflow chamber and ensure that the drain to the slurry tank is clear.
   7. Replace the tub screens.
   8. Start the slaker and check that all three-spray nozzles are not plugged.
   9. Replace the slaker tub covers.

Maintenance
Preventive maintenance is performed on all equipment related to the slaker at scheduled intervals. Repairs are based upon inspections. Record keeping is maintained within the computerized maintenance management system.

A. Preventive
   1. Grease motors monthly
   2. Gearboxes – change oil every 6 months
   3. Grit screen - clean biweekly
   4. Check belt tension on torque valve and grit screw – replace belts if worn
   5. Replace lime volumetric feed screw every 2 years or as needed.
   6. Calibrate the water pressure regulator - annually

B. Inspection
   1. Check operation of water pressure regulators, shutdown solenoid, etc. Repair or replace defective items.

Spare Parts
Spare parts will be purchased and stored in inventory based on the manufacturer’s recommendations and plant operating experience (see tab #4).

Malfunction Abatement Measures
1. Continue to run with the failed equipment as long as the plant emissions are in compliance. This may or may not require the boiler(s) to run at a reduced load.

2. Correct the malfunctioned equipment by taking the equipment out of service for repairs. This may or may not require the boiler(s) to run at a reduced load.
3. Correct the malfunctioned equipment by shutting down the boiler(s) and repairing the equipment.

4.5 BAGHOUSES

Description

The baghouses are made up of fabric filter unit(s) that use Pulse Jet cleaning design to ensure removal of the collected particulates. Each fabric filter unit is composed of eight modules, which can be individually isolated from the gas flow. The unit is designed for full-load operation with one module off-line for cleaning. Each module contains 210 bags, which are 6” in diameter and 14’ total length.

Critical Criteria

The operation of the baghouses will control the final particulate emissions from the plant. The baghouses will be operated in a manner to satisfy the following critical criteria:

A. Particulate
   1. The particulate emission rate from each of the boilers shall not exceed 0.03 lb/mmBTU heat input.
   2. The particulate emission rate from each boiler shall not exceed 11.5 lbs/hr.
   3. Visible emissions from each of the boilers shall not exceed a 6-minute average of 10% opacity.

Inspections

A. Daily visual inspections of both baghouses will be performed by the operations department. This is accomplished by routine rounds made during the shift. Work orders will be generated when concerns arise.
B. Annual inspections will be performed to determine the condition of all baghouse compartments and ducts. Wall thickness readings will be taken, and bags and cages will be inspected. Inlet, outlet and bypass valves will also be inspected
C. Bags and cages will be replaced approximately on a four-year rotating schedule.

Component Operating Description: Baghouses

Fabric Filter Bypass

A. Components – One pneumatically actuated poppet damper located between the fabric filter inlet and outlet plenums.
B. Function – Means of causing the flue gas stream to bypass the fabric filter, as required by various normal and fault modes of the emission control system.
C. Means of Control – Opening of damper initiated by signal from operator or automatic control system.
D. Internal Fault Modes – Mechanical failure of damper.
   1. Countermeasures – High quality damper and actuator.
   2. Consequences – Fabric filter failure to bypass will result in high-pressure drop which may cause boiler flameout. Possible damage to bags due to high or low

temperatures, high pressure drop or undesirable deposits or condensation in the event of failure of the outlet damper in the open position.

E. Loss of control power or control air pressure.
   1. Countermeasures – None.
   2. Consequences – Damper fails open by gravity.

F. Leakage of damper due to poor blade/seat fit.
   1. Countermeasures – Double-blade damper design.
   2. Consequences – Increased outlet grain loading due to leakage of dirty gas across damper into outlet manifold.

Fabric Filter Bypass Damper

A. Location – At outlet end of fabric filter.
B. Quantity – One
C. Description – 63" diameter double plate poppet type with purged chamber to prevent leakage of dirty gas to outlet manifold, pneumatic positioner actuated by control signal.
D. Function – Closed during normal operation. Opened to provide a path for diverting the flue gas stream directly from the inlet plenum to the outlet plenum, bypassing the fabric filtration subsystem.
E. Normal Control Mode – Command to open given manually by operator or bypass control. Once opened, bypass valve "close" command can only be made by the boiler operator by resetting control system.
F. Fault Control Mode – Open during most system fault modes. Will fail open on loss of power or air.

Fabric Filtration

A. Components – Fabric filter compartments and their inlet and outlet manifolds, compartment inlet dampers, tube sheet, filter bags, cages and compartment outlet dampers.
B. Function – Direction and distribution of contaminated flue gas to fabric filter compartments, admission of flow to each compartment, distribution of flow to filter bags where particulates are trapped and admission of cleaned flue gas to outlet manifold, which directs it to the induced draft fan inlet ducts.
C. Means of Control – Fabric filtration is initiated by opening the compartment pneumatic inlet butterfly and compartment pneumatic outlet poppet dampers while the induced draft system is operating and the fabric filter is in bypass mode. The outlet poppet dampers are actuated pneumatically, as commanded by the control system.
D. Internal Fault Modes – Mechanical failure of poppet damper.
   1. Countermeasures – Use of one outlet damper per compartment.
   2. Consequences – If failed closed, reduction in compartment flow will occur, tending to back pressure inlet manifold and increase flow and pressure drop in other compartments. If failed open, bag cleaning and/or compartment maintenance may be prevented until condition is corrected. Also, there may be

some compartment flow when the fabric filter is in bypass (possible bag damage).

E. Loss of individual damper service compressed air pressure or control power.
    1. Countermeasures – Fail-safe design. Outlet dampers will close.
    2. Consequences – Fabric filter bypass mode initiated, with no component damage.
F. Rupture of filter bags, leakage through tube sheet separating "clean side" and "dirty side".
    1. Countermeasures – Periodic inspection.
    2. Consequences – Increased outlet grain loading due to leakage of dirty gas from the inlet to the outlet manifold.
G. Blinding of bags.
    1. Countermeasures – Specification of fabric filter operating procedures designed to avoid situations where blinding might occur, particularly during fabric filter startup and shutdown.
    2. Consequences – Increase of differential pressure following clean down above normal levels. In severe cases, inability to maintain acceptable fabric filter differential pressure.

Compartment Inlet Dampers

A. Location – Lower portion of compartment just above the hopper.
B. Quantity – One per compartment.
C. Description – Butterfly type, vertically mounted damper equipped with pneumatic operator.
D. Function – Open during normal operation in order to admit dirty gas to fabric filtration subsystem for cleaning. Closed for compartment isolation during maintenance.
E. Normal Control Mode – Compartment cleaning mode switch.
F. Fault Control Mode – Close on loss of electrical power.

Compartment Outlet Dampers

A. Location – Roof of fabric filter outlet plenum.
B. Quantity – One per compartment.
C. Description – 37" diameter poppet type, vertically mounted damper with horizontal metal-to-metal seat. Operated by 24" stroke double-acting pneumatic cylinder equipped with directional and flow control solenoid valves actuated by control signal or by manual override. Has mechanical lock for closed position.
D. Function – Open during normal operation and on-line cleaning to admit clean gas from fabric filtration subsystem to outlet manifold. Closed during off-line cleaning, compartment maintenance and when fabric filter is in bypass mode.
E. Normal Control Mode – Control power from 120 VAC system, control signal generated by AQCS.
F. Failure Control Mode – If control electric power fails, solenoid valves will return them to closed position. In event of low compressed air pressure, will close by gravity. Not fail safe in event of internal mechanical failure.

Filter Bags

A. Location – Attached to tube sheet by snap bands. Suspended in compartment by spring and hanger.
B. Quantity – 210 per compartment.
C. Description – 6" diameter x 14 ft. long. Filter material 16 minimum oz./sq. yd. Weight (nominal) acrylic (Draylon T) felt.
D. Function – Remove particulate from gas stream.

Compartment Cleaning

This operation can only take place if the bypass damper is completely closed.

Compartments are cleaned sequentially, starting nearest the boiler and proceeding toward the stack. If any compartments are in the off-line condition, the controller will proceed to the next "on-line" compartment.

A. Sequence – The cleaning operation is performed by opening and closing compartment dampers and sequencing pulse air through each row of bags, one row at a time with high-pressure instantaneous bursts.
   1. Close compartment outlet damper (off-line cleaning only).
   2. After a delay, begin pulsing bag rows (15 rows total).
   3. Upon completion of pulsing, a period of time is permitted for dust to settle to the hopper.
   4. Open compartment outlet damper (off-line cleaning only).
   5. Begin cleaning next compartment.
B. Differential Pressure Cleaning – This method of cleaning is initiated only when a high differential pressure condition exists and is the normal method of operation. If the differential pressure should drop below the initiation point, the fabric filter will be completely cleaned through the last compartment. At this point, the cleaning will stop and wait for a high differential pressure condition before commencing another cleaning cycle. If the high differential condition exists after the last compartment has been cleaned, the cycle will automatically repeat itself.
C. Manual Initiation Cleaning – The cleaning sequence can be initiated from the AQCS by the operator. Upon initiation, the entire fabric filter will clean one time and stop.
D. Time Interval Cleaning – For periods of low loads where dust buildup is low, a timed interval of eight (8) hours will initiate one cleaning cycle if neither differential pressure nor manual initiated cleaning has occurred.

Hopper Heaters

Hopper heaters are modular (blanket design). Each fabric filter hopper will have 4.1 KW heater. The bottom one-fourth of the area of each hopper will be heated. Heating will be sufficient to maintain the internal skin temperature at the gas temperature.

Hopper heaters are controlled automatically by thermostats at each hopper.

Operation

Start-up

A. When firing the boiler, special attention must be taken to minimize the environmental impact caused by emissions in the flue gas.
B. The boiler should be fired with natural gas as the manufacturers recommended startup rates would allow.
C. To avoid having to wait until the baghouse inlet temperature is 250 deg. F., place the baghouse override 250 switch into override and place baghouse in service. An atomizer should be installed and started up at approximately 150 deg. F scrubber inlet temperature. The baghouse temperature requirements drop to 145 deg. F when an atomizer is placed into operation. Now you can put the override 250 switch back normal.

Normal Shutdown

A. During a boiler controlled shutdown, baghouse operation must be maintained until the boiler flue gas cools to 145 deg F.
B. At that time the coal should be run off the boiler grates and the boiler fans can be shut down to avoid excess opacity emissions.

Emergency Shutdown

A. During an emergency boiler shutdown due to either a water or steam tube rupture, it will be necessary to bypass the baghouse immediately to prevent wetting and caking of the filter bags.
B. The coal fire should be extinguished and run off the grate as soon as possible to help reduce stack opacity emissions.

Effects of Boiler Operation on the Fabric Filter

Boiler Tube Leaks Effect Upon Fabric Filter Operation

Continued operation with boiler tube leaks may require manual cleaning of the bags to remove the deposits. If operation still continues, permanent high-pressure drop and permanent bag damage will result.

If a tube leak should occur (especially with the atomizer off line), the following procedures must be followed:

A. If the tube leak is massive (i.e., one which will cause the boiler to be taken off line immediately), perform the following:
    1. Bypass fabric filter immediately, if possible.
    2. Baghouse should remain in bypass mode until boiler fires are out.
    3. After boiler fires are out, fabric filter should be placed back in the filtering mode and initiate cleaning.
    4. The fabric filter should remain in the filtering mode for at least one complete cleaning cycle. When one cleaning cycle is finished, the fabric filter may be bypassed or remain on line until the low temperature bypass set point is reached. Drying out the filter cake after a massive tube leak by purging with hot boiler purge air in the filtering direction is an important part of fabric filter recovery.

B. If the tube leak is small, the boiler will most likely stay on line. In this case, the fabric filter differential pressure will increase due to the increased moisture content which will cause a denser filter cake.
   1. Manual cleaning initiation should continue on a continuous basis.
   2. Baghouse should clean continuously until boiler is shut down and boiler fires are out.
   3. After boiler fires are out, fabric filter should remain in the filtering mode.
   4. The fabric filter should remain in the filtering mode for at least one complete cleaning cycle. When one cleaning cycle is finished, the fabric filter may be bypassed or remain on line until the low temperature bypass set point is reached. Drying out the filter cake by purging with hot boiler purge air in the filtering direction is an important part of fabric filter recovery after operation with a tube leak.

Baghouse Routine Inspection
It is necessary, as with any mechanical equipment, to establish an effective maintenance program for the fabric filter if continuous, efficient operation is to be achieved. The program should be supervised by a plant engineer, maintenance engineer or supervisor.

An accurate log of all inspections and maintenance work should be maintained. A periodic review of the log will disclose whether the equipment is functioning in accordance with the manufacturer's warranty.

WARNING

WHENEVER INSPECTION OR MAINTENANCE IS BEING PERFORMED WITHIN THE SYSTEM COMPARTMENTS OR FLUE DUCTWORK, SAFETY INSTRUCTIONS MUST BE FOLLOWED. PROPER VENTILATION SHOULD BE FOLLOWED PRIOR TO PERSONNEL ENTRY.

Checklist (I = Initial; M = Monthly; A = Annual; W = Weekly)

A. Check bolt tightness on all bolted parts, especially around poppet and louver dampers and expansion joints. The actuators must be mounted securely with all bolts being wrench tight. The shaft jam nut and packing retainer nut must also be wrench tight on the poppets.
B. Inspect each compartment for bag failure.
C. Manually check all dampers to assure that they are operating properly. Actuate the dampers by turning the manual override on the solenoids and check to be sure that the dampers are seated properly in the closed position and also that they are open to approximately the dimensions shown on the drawings. Check the limit switches by operating the damper to be sure they are functioning. All poppet dampers are either fully open or fully closed and must be maintained accordingly. Under no circumstances should the poppets be adjusted for partial flows. Set the damper stroke speeds as follows (actuate to +0/-2 seconds):

Outlet Poppets	Open – 10 seconds
	Close – 10 seconds
Bypass Poppet	Open – 10 seconds
	Close – 10 seconds

D. Manually check the butterfly dampers at each compartment inlet to assure that they are operating properly. Check the damper seating in the closed position and return to the full, open position. Check the limit switches to assure that they are functioning. The bolts for the bearing must be secure.
E. Check the manual and automatic damper controls from control room AQCS by operating the switches, checking the status indication to assure the operation of the equipment in the field.
F. Follow all compressed air piping per the P & ID's. Blow down piping system prior to connection to final devices to remove any debris which may be in the piping.
G. Inspect the compressed air piping. Blow down all drip legs. Calibrate all pressure regulators. Inspect filters, lubricators and valves. Check entire system for leaks. Calibrate the low-pressure switch. Fill the lubricators and set on lowest dosage rate.
H. Check the AQCS Panel by having it run through at least one complete cleaning cycle, confirming that all equipment is activated properly during the cycle. The AQCS Panel indicators should be viewed during this cycle, along with the actual equipment in the field.
I. Check the operation of all alarm points by inducing alarm conditions at the field instrument.
J. Check the operation of all switches located on the AQCS Panel.
K. Check the operation and calibration of all temperature loops by applying a millivolt signal to the thermocouple lead wire at the head of each thermocouple.
L. Check the operation and calibration of all pressure loops by applying a pressure or differential pressure at each transmitter.
M. Check the operation and calibration of all indicators and set the operating alarm points as specified.
N. Check the operation of the fabric filter bypass controls by simulating a bypass. The dampers should close in the proper sequence. Check the operation of the dampers both in the field and at the control panel.
O. Check the preset values of all timers and counters in the programmable logic controller.
P. Check all bags to see if they are torn, worn, blinded, twisted (should be a straight seam), contain any moisture, or are loose on the cage.
Q. Check all expansion joints for holes or worn areas.
R. Check all internal surfaces for cracks, presence of moisture, corrosion, erosion, or build-up of fly ash.
S. Inspect the blowpipe above each row of bags to ensure that it is centered above the row. An adjustment slot is provided at the downstream end of the pipe to adjust the traverse location of the pipe. If the pipe is not aligned, loosen the mounting bolt and nut, center the pipe and retighten the bolt and nut.
T. Check the plant air dryer to ensure proper operation. A dryer malfunction can cause condensation on bags during cleaning and blind bags. Also, air pipes and equipment can freeze up in cold weather.

U. Check all lubricators or pneumatic lines and refill if necessary.
V. Check door and flange gaskets for leaks. A hissing sound indicates air in leakage, thus identifying a problem with the gasket. Replace gasket immediately.
W. Check pressure drop across each compartment using a manometer.

Absorber Routine Inspection

Vessels and Flues

This category encompasses all ductwork, tanks, absorbers, sumps and silos. These items will be checked for appropriate mechanical construction in compliance with erection prints. Every pipeline must be traced to ensure continuity and agreement with flow prints.

Expansion Joints

A. Fabric expansion joints must be properly bolted to flue work and damper frames. Check that these erection bolts do not extend far enough to tear the fabric. Expansion joints must be aligned within tolerance to the ductwork section in which they are installed.
B. Pipeline expansion joints must be aligned within tolerance to the section of piping in which they are installed.

Centrifugal Pumps

A. The suction and discharge pipeline to each pump should be independently supported to prevent strain on the pump casing. The inlet end of the suction line should be installed below the minimum liquid level of the tank or sump, to eliminate cavitations. The base plate must be level in all directions after all anchor bolts are secured.
B. All pumps are supplied fully assembled, but should be checked for proper impeller clearance by manual rotation. Check the alignment of the motor sheave with the pump sheave on slurry pump. Check to assure that the pump shaft is concentric with the inner packing gland housing.
C. Bearing condition must be satisfactory. Check corroded or pitted surfaces, obtaining specified tolerance and providing the proper amount and type of grease lubricant. See the vendor’s manual for alignment and lubrication procedures. Flush the oil reservoir with mineral oil and fill to the specified level on pumps supplied with oil reservoirs.
D. All motor wiring must be rung out to ensure correct connections. The grounding circuitry must be inspected for compliance with electrical drawings to ensure safe operation. Make sure that the pump starter overload heaters are correctly sized for motor trip current. All motor terminals should be meggered to ascertain proper insulation. Space heaters should be operational from the time of initial inspection through motor startup. Use portable heating elements on smaller motors to dry wiring for 48 hours prior to motor startup. No motors should be energized with less than specified resistance to ground. If moisture cannot be readily eliminated with the heaters, apply 110V to the primary pump motor windings (one phase at a time),

with the load unbelted from the motor. (NOTE: 110V to be applied to only those motors rated at 480V or more.)

E. Check for fan inclusion on totally enclosed, fan-cooled motors. Ensure sufficient lubrication of motor bearings as per vendor's manuals.

F. Determine correct motor drive rotation by "bumping" the motor unbelted from the pump. Certain pumps are interlocked to prevent operation under abnormal process conditions or for process control. See the specific starting sequence before "bumping" any pumps. Heat run each slurry pump motor unbelted to the pump for approximately four hours. During this period, monitor no load current and voltage at the MCC. Excessive bearing temperature or vibration should be acknowledged as an indication of abnormality.

G. Before the pump is operated, the impeller eye must be submerged and the suction line filled with water. Never operate a pump with a restricted discharge line. Failure to prime a pump may cause the lantern ring to seize or scoring of the shaft at the packing box. With the motor breakers racked out, install the belts, obtaining correct V-belt tension. Proper tension is obtained by employing the following formula:

$$D_B = 1/64 \times \text{Sheave Span}$$

Where D_B = deflection of belt (measured in inches) when 30 psi force is applied to the belt.

Sheave Span = distance between centerline of sheaves (measured in inches)

H. Note: When new belts are installed, they should be initially tightened 30 percent tighter than the formula indicates. This compensates for initial belt stretching.

I. After coupling of the motor and pump, rotate the shafts by hand to ensure that all moving parts are free of foreign objects and to check for possible binding. "Bump" the motor before starting the pump. Once running, check the packing box and suction line for leaks. Check that the thrust bearing and bearing journals are cool and sufficiently supplied with oil.

J. On slurry pump, retightening of the gland will be required during the first hours of operation. During the first eight hours of operation, monitor the voltage and current (phase balance) of the motor. Check bearing temperature and vibration. Visually check sheave alignment.

K. Observe pump vibration and possible cavitations. Existence of either of these conditions to a significant degree will require immediate correction. Vibration without cavitation implies improper impeller balance or alignment. Cavitation can be prevented by increasing the pump's suction head.

L. Prime the standby pump in the same manner as previously described and continue with checkout procedures for the standby pump.

Agitators

A. Agitator supports must be attached securely and installed for correct agitator location. Ascertain that motor grounding is installed as per the electrical drawings for safe operation. Meggar all motor terminals to ensure proper insulation from ground. If dampness has impaired the insulation, apply 110V across one motor winding at a time to evaporate moisture (note: only on motors rated at 480V or More). Check that overload heaters are properly sized for the agitator motors.

B. Check the gear reducer bearing condition. Make sure the bearings are free of corrosion, pitting and galling. Ascertain that the proper amount and type of grease has been applied to the bearings (see respective vendor manual). Flush the gear case oil reservoir with mineral oil and fill to the specified level with approved oil. Make sure the gearbox pressure equalization breather is undamaged and unobstructed. Where applicable, check the winding cooling fan for obstruction and determine proper fan operation.

C. "Bump" the agitator motor to verify correct rotation as per the nameplate directional arrows. Run the motor and gearbox uncoupled from the impeller for four hours. During this period, monitor no load motor current (phase balance) and voltage, bearing temperature and vibration. Rated motor current and voltage and the maximum allowable bearing temperature are printed on the nameplate.

D. Now the agitator can be coupled to the impeller shaft. The coupling should be aligned so as to maintain shaft run out as specified by the manufacturer. The sleeve bearing must be aligned properly to avoid binding. Grease the bearings and couplings where applicable. The impeller shaft must be installed at the proper angle. The static and dynamic forces exerted on the shaft are accommodated by the agitator support for the design installation angle only. Hand rotate the impeller to ascertain the manufacturer's recommended clearance from baffles or other obstructions.

E. Fill the vessel to the expected normal level above the impeller, in conjunction with vessel leak testing. The agitator should never be operated with fluid drag on the impeller blades. Start up the agitator. Observe the concentricity of the shaft coupling, the sleeve bearings and the stuffing box. Monitor bearing temperature and vibration, motor current (phase balance) and voltage and shaft RPM.

Valves

A. Check each valve for freedom of movement, proper clearance and seating and absence of obstruction. Ascertain the sufficiency of the packing material or Teflon seal around the valve stem. On rubber-lined valves, check that the lining has not been damaged.

B. Ensure that the local and remote (where applicable) position indication corresponds with the actual valve position and that the indicator is unobstructed from full travel.

C. When the pumps are hydrostatically tested, check for leakage around valve flags and valve stems. Solenoid controlled, air operated valves and control valves require supplemental commissioning.

    1. Solenoid-Controlled, Air-Operated Valves (two position) - Ensure that electrical wiring connections to the solenoid and instrument air supply connections to the operator are correctly made up. Energize and de-energize the solenoid several times and determine proper valve operation.
    2. Control Valves – In conjunction with density, level or flow-control loop commissioning, provide the control signal (contact closure on 110V supply,

4-20 MA or 3-15 PSIG) to the control valve and observe the response. Determine correct drive rotation to satisfy the logic of the control loop. Ensure full travel of the valve.

Hoists

A. Be sure that the trolley wheel spacing is correct with respect to the beam on which the wheels travel.
B. All motor wiring must be rung out to ensure correct connections. The grounding circuitry must be inspected for compliance with electrical drawings to ensure safe operation. Make sure that the hoist circuit breaker is properly sized for motor trip current. All motor terminals should be meggered to ascertain proper insulation. The motor should not be energized with less than specified resistance to ground. If moisture cannot be eliminated with a portable, wrap-around heating element, apply 110V to the primary motor windings (one phase at a time) with no load on the hoist hook. Proper direction of rotation must be verified. Using the pushbutton control, push the "UP" button. While the hoist is operating "UP", raise the limit switch lever. This will open the "UP" circuit and shop the hoist. If it does not stop the hoist, the direction of rotation is reversed. Reverse any one of the incoming phases to reverse the rotation of the motor.
C. Once proper rotation has been established, operate the hoist up and down using the pushbutton station. During this period, monitor current and voltage and ascertain that the motor is operating within its nameplate ratings.

Atomizer

A. Atomizer inspection should be performed per the vendor information.

Bag Failure Identification and Repair

A. A properly maintained and operated fabric filter should yield filtering efficiency of 99+%, in which case the outlet gases may have visible hue due to emissions. Do not confuse water vapor condensation with particulate emissions.
B. Opacity readings should be checked daily. A change in the opacity may indicate broken bags. Observe opacity during the cleaning cycle. When a compartment is being cleaned, it does not participate in the particulate removal. If opacity is notably lower during a part of the cleaning cycle, the compartment being cleaned at this time likely has broken bags.
C. Low compartment pressure may also indicate broken bags. If any one compartment has a tube sheet differential pressure which is consistently lower than the other compartments, and the stack opacity is poor, chances are very good that the low reading compartment has broken bags. This can be determined using a manometer and connecting it to the tube sheet pressure taps.
D. Damage to the filter cloth must be located at the earliest possible time and the punctured bag replaced. There are two basic inspection techniques:
    1. First, visual inspection of all bags. The first indication of a bag failure is often an accumulation of dust in the bottom of the failed bag. This is particularly true if the bag failure occurs near the bottom; however, those failures near the top of

the bags are unlikely to provide any tell-tale dust accumulation, and in this case it will be necessary to inspect the full length and circumferences of each bag looking for the failures. Dust patterns, even when they cannot specifically locate the failed bag, can be of assistance in at least locating the general area.
2. A second technique is the use of a tracer powder and ultraviolet light (visolite). In this instance a black-light sensitive powder is fed into the compartment while the system is on line. The compartment is then brought off line and is scanned with an ultraviolet light. The light-sensitive material will glow and immediately identify the location of leaks. It will probably be necessary to search the full area of each bag.

Inspection and Replacement of Filter Bags

A. Shut down the system, as per shutdown procedure.
B. Open the clean-air plenum access door and inspect them for dust deposit, which would indicate the area containing the damaged bag.
C. Locate the damaged bag by inspection with the air of a standard extension light. The light may be suspended inside the bag and dropped until it strikes the bottom of the bag. Any accumulation of dust at the bottom of the bag indicates the dust was released from the inside of the bag by the shock of the falling light and the bag is, in fact, damaged.
D. To remove the filter bag and cage assembly:
    1. Lift the cages out of the bag far enough to clear the bag cuff. Temporarily store the cages in clean air plenum or on access platform.
    2. Pull the bags out by pinching in bag cuff (by firmly applying both thumbs at one point) to a kidney shape and lift the bag out far enough to clear the tube sheet (which is the floor of the walk in plenum).

WARNING: Clean air plenum must be totally free of dust before the unit is put back on line. Any free dust can be aspirated into pulse blowpipe and can cause bag damage during subsequent cleanings.

3. To replace filter bag and cage assembly, reverse the above procedure. Take care not to damage any part of the assembly during this operation.

Troubleshooting

Corrective Action – Baghouses

This section describes the possible causes of serious fabric filter fault conditions, means of detection and corrective action to be taken to recover from the fault condition.

High Differential Pressure

A. Possible Causes
   1. Unusual rate of filter cake buildup due to high grain loading.
   2. Blockage of flow into compartment due to high dust in hoppers. Blockage of ductwork due to dust buildup.
   3. Blinding of bags, probably caused by excessive boiler tube leaks or operation at temperatures close to dew point.
   4. Loss of cleaning function due to cleaning sequence failure.
   5. Failure of compartment outlet dampers in fully or partially closed position.
   6. Plugging of differential pressure sensor lines.
   7. More than one compartment off line.
   8. Boiler load increase. A thicker filter cake is obtained under sustained operation at low load to maintain the same maximum pressure drop across the fabric filter. When load is increased, the pressure drop may exceed the maximum allowable. This can be avoided by initiating a cleaning cycle approximately one hour prior to a load increase.
B. Means of Detection
   1. Normal operating range for differential pressure is 4” to 6” WC.
   2. Baghouse controls by-pass the baghouse at 8 to 9” WC.
   3. Normal temperature operating range for the baghouse is 164 degrees F.
   4. Baghouse controls by-pass the baghouse at 150 deg. F. on low temperature and 270 degrees F. on high temperature.
C. Remedial Action
   1. Manually initiate the cleaning mode.
   2. Purge the differential pressure lines with compressed air.
   3. If the damper position indicators on the AQCS Panel indicate closed inlet or outlet dampers on compartments which should be operating, attempt to open them manually.
   4. Check the level of ash in the hopper. Remove ash if required.
   5. Inspect bags for blinding. (See Maintenance Procedures).
   6. Analyze ash for size and loss on ignition.
   7. Analyze flue gas for change in oxygen or carbon monoxide content. A change in boiler operation or fuel source may cause incomplete combustion, whose products can blind bags.
   8. Check that proper startup procedures are followed.
   9. If the differential pressure does not drop below the alarm point after two complete cleaning cycles, consult GEESI on the cleaning period.

High Fabric Filter Temperature

A. Possible Causes

1. Fire in compartment or ductwork.
2. Thermocouple failure.

B. Means of Detection
   1. Fabric filter outlet temperature indication on AQCS or alarm.

C. Remedial Action
   1. Manually initiate bypass. Enter affected compartment with appropriate fire extinguishing equipment to verify that the fire is out.
   2. Following normal off-line maintenance procedure, inspect compartment to determine extent of equipment damage, if any.
   3. Analyze ash for loss on ignition and flue gas for carbon monoxide content. An increase in either shows incomplete combustion in the boiler. Adjust boiler operation to prevent future fires.

High Opacity

A. Possible Causes
   1. Bag failures.
   2. Over cleaning the bags.
   3. Failure of bypass damper to seat properly.
   4. Leakage across bypass damper.

B. Means of Detection
   1. Normal operating range for differential pressure is 4" to 6" WC.
   2. Baghouse controls by-pass the baghouse at 8 to 9" WC.
   3. Normal temperature operating range for the baghouse is 164 deg. F.
   4. Baghouse controls by-pass the baghouse at 150 deg. F. on low temperature and 270 deg. F. on high temperature.

C. Remedial Action
   1. Check compartment differential pressures. An abnormally low differential pressure may indicate an inadequate filter cake or broken bag.
   2. Identify and replace broken bags (see Maintenance Procedures). If broken bags exist in only one or two compartments, the compartment(s) can be located by monitoring the stack during a cleaning cycle. At the time that a compartment with failed bags is brought off-line, the opacity will be reduced. When it returns on-line, the opacity will increase.
   3. Check for other potential causes of leakage if there are no apparent bag failures. Welds in the wall separating the inlet and outlet manifolds, around the thimbles or in the tube sheets can be a source of leaks.
   4. Adjust bypass damper linkage or damper actuator to seat damper in closed position.

High Fabric Filter Inlet Temperature

A. Possible Causes
   1. High boiler outlet temperature due to unusual combustion conditions, excessive slag-up or low feed water flow.
   2. Boiler air pre-heater failure.

3. Fire in ductwork between absorber and fabric filter.
4. Excessive flue gas reheat.

B. Means of Detection
1. Fabric filter inlet temperature thermocouple, as indicated on AQCS Panel.
2. High inlet temperature alarm.

C. Remedial Action
1. The fabric filter will automatically be put into bypass mode by the control system, if temperature exceeds 275 degrees Fahrenheit.
2. The operator will take appropriate action relating to the boiler, air pre-heater or fire once the cause of the over-temperature condition has been determined.

Low Fabric Filter Outlet Temperature

A. Possible Causes
1. Low absorber outlet temperature.
2. Cracks in ductwork or casing, causing substantial in leakage of outside air.
3. Failure of the fabric filter outlet thermocouple.
4. Failure of inlet, outlet or reverse air dampers to seat properly when a compartment is isolated for maintenance, allowing in leakage of outside air.
5. Access doors left open or not adequately closed.
6. Rupture of expansion joints.
7. Failure of insulation.
8. Substantial in leakage through failed door gaskets.

B. Means of Detection
1. Baghouse outlet temperature thermocouple, as indicated on AQCS Panel.

C. Remedial Action
1. To avoid potential condensation, fabric filter should be put into bypass mode.
2. Increase absorber outlet temperature, if applicable.
3. Repair or replace thermocouples as required.
4. Repair absorber outlet temperature control.
5. Repair poppet dampers for compartment currently off-line to achieve less leakage.
6. Replace door gaskets.
7. Repair or replace expansion joints.
8. Check for hot spots around exterior of casing, hoppers, ducts and reverse air system. Repair or replace insulation.
9. Check for in leakage. (See Maintenance Procedures). Repair cracks.

Spare Parts

Spare parts will be purchased and stored in inventory based on the manufacturer's recommendations and plant operating experience (see tab #4).

Malfunction Abatement Measures

In the event that a malfunction should occur to the baghouse system that affects the plant emissions and causes the plant to exceed the permitted levels, specific action will be taken to bring the plant back into compliance. This action will be one or more of the following steps:

1. Continue to run with the failed equipment as long as the plant emissions are in compliance. This may or may not require the boiler(s) to run at a reduced load.
2. Correct the malfunctioned equipment by taking the equipment out of service for repairs. This may or may not require the boiler(s) to run at a reduced load.
3. Correct the malfunctioned equipment by shutting down the boiler(s) and repairing the equipment.

4.6 Continuous Emissions Monitoring Systems (CEMS)
Description

Continuous emissions monitoring systems (CEMS) are used to provide monitoring and recording of the emissions as required by the ROP or other applicable air quality requirements not yet incorporated into the ROP. Each system is a complete emissions monitoring, data gathering, and reporting system used to provide information for reports submitted to EGLE and EPA. The CEMS monitor the Inlet CO_2 and SO_2 and Stack CO_2, SO_2, NO_X, CO, Flow and Opacity for each of the individual units.

CEMS and opacity monitor data are collected and recorded using a data acquisition and handling system (DAHS). The CEMS is housed in a common environmentally-controlled shelter located at the base of the Units 1 and 2 stacks. Comprehensive descriptions of the CEMS, opacity monitors and DAHS are contained in the vendor O&M manuals, maintained on file at the facility. A detailed description of the individual CEMS, opacity monitors and DAHS (e.g., monitor component serial numbers and date of installation) can be found in the Monitoring Plan. The Monitoring Plan and the system O&M manuals are available for examination by the applicable regulatory agencies.

Out-of-stack dilution probes are mounted in the exhaust gas ducts upstream of the spray dryer absorbers and in the stack flues for each of the boilers. The dilution probes remove a small sample of the boiler effluent, dilute the sample with conditioned air, and then transport the sample through an umbilical to the remote CEMS analyzers. The sample probes are installed in a manner that ensures the collection of a representative effluent sample. The designed dilution ratio for the CEMS is 100:1.

A PLC is used to control the interface between the probes, instrument air supply, calibration gases and analyzers. The PLC controls the proper valve sequencing for automatic sampling and calibration. The sample umbilical connects the probe to the analyzer extraction manifold. A sample-conditioner controller is used to control the interface between the probe, purge air supply, calibration gases and the CEMS analyzers. The sample-conditioning controller contains the pressure regulators, manifolds and solenoids needed to coordinate the distribution of the instrument air, calibration gases and diluted gas samples.

Operation
The CEMS will be operated properly by trained and experienced operators at all times when the boiler(s) are in operation. Specifically, the opacity monitors will be in service whenever the induced draft (ID) fans are in operation, while the gaseous CEMS and Flow CEMS will be in operation whenever fuel is being combusted in the boilers (i.e., when flame is detected in the boiler). The equipment will be operated in accordance with the manufacturer's recommendations and operating procedures.

Critical Criteria

A. Opacity

Each opacity monitor is designed to accurately monitor and record the individual flue gas opacity. Visible emissions from the boilers shall not exceed a six minute average of 10% opacity.

B. NO_X

Each NO_X analyzer is designed to accurately monitor and record the NO_X concentration levels from the boilers. This data is used in conjunction with the diluent gas levels to calculate NO_X lb/mmBtu emissions rates, and is also used in conjunction with the Flow CEMS data to calculate NO_X mass emissions. The NO_X emission rate from the boilers shall not exceed 0.60 pound per million Btu heat input; based on a 30-day rolling average, or 2,018 tons per 12-month rolling time period (for both boilers combined). Note that the NO_x lb/mmBTU emission limit varies based upon the relative heat input fraction from solid and gaseous fuels.

C. CO

Each CO analyzer is designed to accurately monitor and record the CO concentration levels from the boilers. This data is used in conjunction with the diluent gas levels to calculate CO lb/mmBtu emissions rates, and is also used in conjunction with the Flow CEMS data to calculate CO mass emissions. The CO emission rates from the boilers shall not exceed 0.3 pound per million Btu heat input or 115.2 pounds per hour, based on a 24-operating hour average, or 1,009.2 tons per 12-month rolling time period (for both boilers combined). The CO lb/mmBTU emission limit does not apply during periods of startup and shutdown.

D. SO_2

Each SO_2 analyzer is designed to accurately monitor and record the SO_2 concentration levels from the boilers. For each boiler, an SO_2 analyzer is installed both upstream of the spray dryer absorber control device and in the stack flue. The inlet and stack SO_2 concentration data is used in conjunction with the diluent gas levels to calculate SO_2 lb/mmBtu emissions rates, while the stack data is also used in conjunction with the Flow CEMS data to calculate SO_2 mass emissions. The SO_2 emission rates from the boilers shall not exceed the following:

1. 0.5 pound per million Btu heat input, based on a 30-day rolling average.
2. 10 percent of the potential SO_2 emission rate, based on a 30-day rolling average rate. Note that there are varying percent reduction requirements depending upon outlet SO_2 emission rates and the relative heat input fraction from solid and gaseous fuels.
3. 0.7 pounds per million Btu heat input, based on a 24-hour daily average.
4. 6.45 tons per day for both boilers combined.
5. 1,681.9 tons per 12-month rolling time (for both boilers combined).

6. 0.200 pound per million Btu heat input, based on a 30-day rolling average, excluding periods of startup and shutdown.

E. CO_2
Each CO_2 analyzer is designed to accurately monitor and record the CO_2 concentration levels from the boilers. For each boiler, a CO_2 analyzer is installed both upstream of the spray dryer absorber control device and in the stack flue. This data is used for purposes of calculating lb/mmBtu emission rates and allowing the calculation of heat input when used in conjunction with the Flow CEMS and appropriate fuel factors.

F. Flow
Each Flow analyzer is designed to accurately monitor and record the wet standard cubic feet per minute exhaust flow rate in the stack flue. This data is used for purposes of calculating mass emission rates and allowing the calculation of heat input when used in conjunction with the stack CO_2 CEMS and appropriate fuel factors.

It should be noted that Particulate, Total non-methane hydrocarbons (NMHC) and Mercury are not monitored by CEMS. Periodic stack testing for these pollutants is conducted for purposes of demonstrating compliance with the ROP and other emission limits.

Inspections
Daily, weekly, monthly and quarterly inspections will be performed on the CEM equipment to ensure that the equipment is operating properly and to observe various changes that may indicate potential malfunction. In accordance with the manufacturer's recommendations, a preventive maintenance program will be followed for the emissions monitoring equipment. The maintenance is listed below for each analyzer type as well as general maintenance.

SO_2 Analyzers

- Clean fan filter on rear panel quarterly
- Rebuild pump once per year

NO_X Analyzer

- Clean photomultiplier tube cooler fins every 6 months
- Clean fan filter on rear panel quarterly
- Rebuild pump yearly

CO Analyzer

- Replace IR source as needed
- Clean fan filter on rear panel quarterly
- Rebuild pump yearly
- Blow dust off wheel yearly
- Change Purafil, charcoal and molecular filter media yearly

CO_2 Analyzers

- Clean fan filter quarterly
- Rebuild pump yearly

Flow Analyzers

- Leak test impulse lines quarterly
- Check for liquid in lines

Opacity Monitors

- Change air filters quarterly
- Clean optical windows and reflector quarterly
- Check alignment quarterly
- Test output with optical filters quarterly and calibrate if necessary.

Sampling System

- Flush lines with acetone as needed
- Replace heated filters as needed

General Checks

- Change air supply filter yearly
- Change air dryer columns every 5 years
- Daily checks of the system (M-F):
    1. Check printouts for indication of problems
    2. Check visual indicators on analyzers
    3. Check calibration drift
    4. Check instrument air pressure
    5. Check printer paper supply
    6. Check computer operation
    7. Check pressure of calibration gas cylinders

Checks performed once per week:

- Perform Weekly Diagnostic Checklist

Maintenance

Maintenance on the CEMS and opacity equipment will be performed to the manufacturer's recommendations and past practices. Normal maintenance of the equipment will be performed during the spring and fall plant outages with replacement of worn or defective parts. Other maintenance will be performed to either replace or rebuild various pieces of equipment should a malfunction occur.

Spare Parts

Spare parts will be purchased and stored in inventory based on MSI's recommendations and plant operating experience (see tab #4).The spare parts inventory list is stored in the Computerized Maintenance Management System.

Malfunction Abatement Measures

In the event that a malfunction should occur to CEMS or opacity equipment that affects monitoring, recording and reporting of the plant emissions, specific action will be taken to correct the equipment malfunction. This action, in cooperation with EGLE, will be either one or more of the following steps:

1. Based on a stable operation of the boiler and being in compliance with the required emission levels at the time of the malfunction, continue to run the boiler at steady state operation and repair the CEMS or opacity failure immediately.
2. Should it be determined that equipment replacement is required in lieu of repairs, continue to run the boiler at a steady state of operation and replace the equipment immediately.
3. Should it be determined that replacement of the equipment is going to take an excessive length of time, continue to run the boiler at a steady state of operation and arrange for rental of CEMS or opacity equipment or the use of other acceptable test / measurement methods in the interim period.
4. Should all of the above efforts not be acceptable, as a last resort, shutdown the boiler until the CEMS or opacity equipment can be repaired and placed into service.

5.0 REPORTING

Operating reports including T.E.S. Filer City Station emission levels and plant operating data are submitted quarterly by written report to the EGLE district supervisor within 30 days following the end of the quarter. The quarterly report includes a detailed analysis of all recording, reporting and record keeping requirements in compliance with the current Renewable Operating Permit (ROP).

In addition to the quarterly reports, notifications will be provided to the EGLE district supervisor of any abnormal conditions or malfunctions of the process or control equipment that results in emissions in excess of the ROP limits for more than two hours. This notice will be made as soon as reasonably possible, but no later than two (2) business days following the day of the incident. Also, within 10 calendar days, a written detailed report including probable causes, duration of violation, remedial action taken, and the steps which are being taken to prevent a reoccurrence will be submitted to the EGLE district supervisor. Further, all monitoring data for T.E.S. Filer City Station will be kept on file at the plant for a period of five years and made available to the EGLE district supervisor upon request.

6.0. OPERATING PHILOSOPHY

The operating philosophy implemented at T.E.S. Filer City Station is to operate the plant within the emission levels required by the Renewable Operating Permit (ROP). To achieve these goals, the boilers are operated in the most efficient manner possible, which in turn, provides for complete combustion. The operation of the plant is maintained by utilizing properly trained and experienced operators. In addition to proper operation, it is equally important to establish inspection and maintenance procedures that allow the plant to continue running in an optimum operating condition. These procedures include regular scheduled inspections. Properly trained and experienced plant operators and maintenance personnel perform the inspections. To ensure that maintenance is performed in a timely manner, an inventory of appropriate spare parts is available at the plant for normal scheduled maintenance. The quantity and type of spare parts selected for inventory is based on the manufacturer's recommendations and plant operating experience.