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AIR QUALITY DIVISION
GRAND RAPIDS DISTRICT

Consumers Energy

J.H. CAMPBELL - Unit 1

MAINTENANCE AND MALFUNCTION ABATEMENT PLAN AIR QUALITY CONTROL SYSTEMS (AQCS)

December 6, 2017

Revision: 3.0

1. INTRODUCTION

1.1 SCOPE

This Maintenance and Malfunction Abatement Plan (MMAP) covers the monitoring, maintenance and operational requirements associated with the air quality control systems (AQCS) and ancillary equipment for Boiler Unit 1 at the J.H. Campbell (JHC) Generating Complex. The AQCS covered by this MMAP includes the Pulse Jet Fabric Filter (PJFF) for particulate matter control, Dry Sorbent Injection (DSI) for acid gas and sulfur dioxide control, and Activate Carbon Injection (ACI) for mercury (Hg) control. The MMAP also covers all supporting material handling and waste ash/byproduct handling control systems. This MMAP will assist in preventing, detecting and correcting malfunctions or equipment failures which could result in emissions exceeding applicable limitations.

1.2 PURPOSE

The J.H. Campbell Permit to Install (PTI) Number 18-15, condition EUBOILER1, III.2, states that "The permittee shall not operate EUBOILER1 unless a malfunction abatement plan (MAP) as described in Rule 911(2), for the new emission control equipment is implemented and maintained." The permit also requires MAPs for the particulate matter control devices for material handling equipment.

1.3 SOURCE DESCRIPTION

J.H. Campbell 1 is a coal fired 2,490 mmBtu per hour wet bottom, dual furnace tangential fired boiler with fuel oil startup capabilities. Emission controls include: Low Pressure/High Volume Pulse Jet Fabric Filter (PJFF) for particulate emission control, Dry Sorbent Injection (DSI) which is the flue gas desulfurization unit (FGD), and Activated Carbon Injection (ACI) for mercury control. The ash system for Unit 1 will utilize the existing transfer tank and vacuum exhausters included in ROP requirement EUASHNEW until incorporation of Permit 18-15 into the ROP.

Equipment	**ROP Emission Unit ID**	**Description**	**Control**	**Equip. Covered under this MMAP**
Boiler Unit 1	EUBOILER1	2490 mmBtu/hr, Coal fired	PJFF, DSI, ACI	PJFF, DSI, ACI
Unit 1 DSI Sorbent Silos (3)	EUDSI_U12	Unit 1 Hydrated Lime Sorbent Storage	Bin Vent Filters	Yes
#1 Transfer Tank	EUASHNEW	Unit 1 Ash System	Filter Separator, Bin Vent Filter	Yes
Unit 1 ACI Sorbent Silo	EUACI_U123	Silos for Sorbent for Hg Control	Bin Vent Filters	Yes
Byproduct Transfer/Storage	EUBYPRODUCT	Transfer Tanks, Vacuum Exhausters, Disposal Silos	Filter Separator, Bin Vent Filters	Yes

2. REGULATORY ANALYSIS

The table below identifies the emission limits for J.H. Campbell Boiler Unit 1:

Emission Limits	Regulatory Driver
PM Limits	
0.15/1000 lbs, of exhaust gas @ 50% excess air	ROP
0.015 lbs/mmBtu	EPA Consent Decree
0.03 lbs/mmBtu	MATS regulation
SO_2 Limits	
0.35 lbs/mmBtu (30 day rolling average 8/29/16)	EPA Consent Decree
0.29 lbs/mmBtu (30 day rolling average 12/30/16)	EPA Consent Decree
1.2 lbs/mmBtu	ROP
HCl Limit	
0.0020 lbs/mmBtu	MATS regulation
Mercury Limit	
1.2 lbs/TBtu	MATS regulation

The boiler is subject to the State's opacity standard, Rule 336.1301(1) (a), which limits opacity to not exceed a 6-minute average of 20% opacity, except for one (1) 6-minute average per hour of not more than 27% opacity. The Unit utilizes a Continuous Opacity Monitoring System (COMS) for opacity compliance determinations, and is used as an indicator of compliance with the particulate matter emission limit.

The ancillary silos and transfer equipment also have particulate emission limits associated with the bin vent filter exhausts, with an opacity restriction of 5%.

3. PULSE JET FABRIC FILTER

One (1) dedicated PJFF is installed on Unit 1 Boiler to control particulate emissions. As flue gas leaves the boiler it passes through the air heaters, then enters two separate ducts where the activated carbon and hydrated lime are injected. The flue gas then enters the PJFF through interconnecting ductwork where an inlet manifold distributes the gas into compartments where fabric filter bags are held. As the flue gas enters the compartments, the gas velocity decreases and some of the larger particles fall into the fly ash hopper. The remainder of the particulate laden flue gas passes through the fabric filter bag, accumulating the particulate on the exterior surface of the filter bags. The filtered flue gas leaves each compartment into the clean side outlet plenum and through the outlet ductwork to the ID fans for discharge to the atmosphere through the stack.

The PJFF has 8 compartments that hold 1,176 bags per compartment, for a total of 9,408 bags. The particulate matter that accumulates on the exterior of the bag increases the differential pressure between the clean and dirty side of the fabric filter tube sheet. The particulate is periodically removed by directing a pulse of clean air down the inside of the bag. The pulse directed down through the bag momentarily stops the flow of particulate laden flue gas and flexes the bag; this resulting acceleration/deceleration of the bag surface dislodges the collected particulate which falls into the fly ash hopper. A rotating manifold/nozzle assembly is used to deliver the cleaning air pulse to the bags in each fabric filter

compartment. Only a very small percentage of the filter bags are cleaned at any given time (a single pulse). A low-pressure positive displacement blower is used for the supply of clean air to pulse the bags.

The unit is equipped with bypass poppet dampers; these dampers provide an alternate gas passage around the temperature-sensitive filter bags in the event of emergency upset conditions. The collected ash is conveyed from the bottom of the hoppers to the dry fly ash transfer towers. The PJFF is controlled and monitored from a central Distributed Control System (DCS), which records differential pressure readings and system alarms, along with other operational parameters.

The site documents for operation, maintenance and malfunction abatement of the PJFF are System Description (SD) and Standard Operating Procedure (SOP) 1.187, as well as the Alarm Response Procedures (ARPs). These documents are found on the Campbell Share-Point site or shared plant network drive.

3.1 OPERATION OF THE PJFF SYSTEM

A. START-UP

1. Leak Test

Upon completion of major filter bag replacements, a leak detection test will be completed. The purpose of this test is to locate any areas where particulate laden flue gas may reach the clean side of the fabric filter tube sheet. The leak test will be performed by injecting a fluorescent powder into the flue gas upstream of the fabric filter, and using a black light to look for the powder on the clean side of the bags. Wherever this powder is found denotes the location of a fabric filter bag leak.

2. Pre-coat Procedure – for new bags

New filter bags after a major replacement initiative may require pre-coating prior to the initial operation to facilitate proper operation and longevity of the fabric filter. The pre-coat of the new bags provides protection during initial start-up in the event of boiler upsets and/or acid condensation.

3. Boiler Start-up

System (PJFF) Operating and General Boiler Operating Procedures for Start-up shall be followed.

B. OPERATION

In order to maintain a high level of effectiveness and efficiency, the PJFF system will be operated in accordance with the guidelines and instructions in the vendor manual, unless otherwise deemed appropriate based on operational experience or system conditions. Plant System Operating Procedures will be followed.

C. SHUT-DOWN

1. Normal Shut-down

Shut-down of the PJFF is operator initiated and integrated into the boiler shutdown procedures.

2. Emergency Bypass Shut-down

This shut-down method is intended to protect the filter bags from upset conditions. It can be initiated manually by an Operator from the DCS screen. Additionally, an emergency bypass shut-down will be initiated when either of the two following conditions exists:

a. Fabric Filter inlet temperature is at the High-High set point for 10 minutes before going into emergency bypass which then initiates the boiler shut-down procedure controlled by an operator. The alarm has a delay to avoid nuisance shutdowns/alarms.

b. Fabric Filter inlet temperature is at the High-High-High set point any length of time. This will override the High-High temperature timer and initiate a sequence shutdown. There is a delay to avoid nuisance shut-downs.

3.2 PJFF MONITORING PARAMETERS

The PJFF operation is controlled and monitored from a central Distributed Control System (DCS). Alarms are an integral part of the system instrumentation. They warn Operators of impending problem situations. In all cases, alarms will be investigated and responded to in accordance with the Manufacturer's procedures and Owner's Alarm Response Procedures (ARPs).

A PJFF unit overview report will be recorded weekly, when in operation. The overview report will contain the PJFF operating parameters identified in Section VI at the time of the report generation. These weekly reports will be retained for a period of not less than 5 years.

A. EQUIPMENT TO BE MONITORED:

1. Differential pressure (dP) transmitters

Differential pressure (dP) transmitters are installed at the inlet and outlet of the PJFF and on each of the eight (8) filter compartments. They will be monitored continuously and logged through the DCS. Automatic bag cleaning frequency is based on the overall PJFF unit dP cleaning set point. There is a "start cleaning" set point, and a "stop cleaning set point." All available compartments are cleaned in a programmed sequence, which repeats until the differential pressure across the PJFF falls below a lower set point value, at which time the cycle will stop. These cleaning set points for the fabric filter are based upon actual operating conditions. There is high alarm and a high-high alarm for differential pressure. Operators will acknowledge all alarms and respond according to the ARPs. A sequence for automatic cleaning also exists, based on timing of last cleaning event and dP.

2. Broken bag detectors

Broken bag detectors are installed on the clean side of each of the eight filter compartments and will be monitored continuously and logged through the DCS. Operators will utilize the broken bag detectors as a trouble shooting tool and acknowledge all alarms and respond according to the ARPs.

3. Ash Hopper Levels

Each ash hopper is equipped with a high level alarm; the hopper levels are monitored continuously and logged through the DCS. Operators will utilize the ash hopper alarms as a trouble shooting tool and acknowledge all alarms and respond according to the ARPs.

4. **Filter Compartment Temperature Sensors**
Temperature sensors are installed on the inlet of the eight filter compartments and will be monitored continuously and logged through the DCS. Alarms are generated for high inlet temperature. Additionally, a high-high set point will initiate flue gas bypass of the filter compartment within 10 minutes, if not resolved, initiating an operator controlled boiler shutdown by procedure. The high-high-high set point will initiate flue gas bypass of the PJFF and a shutdown after a 3 second delay. Operators will acknowledge all alarms and respond according to the ARPs.

5. **Cleaning Air System Pressure**
The cleaning air system is equipped with pressure indicating transmitters that will be monitored and logged through the DCS system. An alarm will be generated for low pressure cleaning air. A spare blower will automatically start if the low pressure alarm is activated. Operators will acknowledge all alarms and respond according to the ARPs.

3.3 MALFUNCTION ABATEMENT

During otherwise normal operation, an operator may experience some abnormal conditions that will require immediate attention. Prompt response to alarms or abnormal conditions can save the system from an emergency bypass of flue gas and equipment damage. The PJFF will be restored to normal operation as quickly as possible in response to any noted abnormal condition.

A. POTENTIAL MALFUNCTIONS

The following section identifies abnormal process conditions or operating problems, possible causes, and corrective actions to recover from the condition.

1. **High Fabric Filter Differential Pressure**

CAUSE	CORRECTIVE ACTION(S)
Loss of cleaning function	Initiate a cleaning cycle. If the pressure drop responds, check dP instrumentation and DCS for an explanation to the loss of auto cleaning. If the pressure drop does not respond, check the air supply and diaphragm valves.
dP instrument malfunction	Check compartment dP sensing lines for blockage and blow out if necessary. Check & calibrate dP instrument.
Excessive dust concentration in gas stream	Check for change in boiler operation or fuel.
Decrease in bag permeability	Inspect bags at first opportunity. Pull samples and analyze filter cake. Examine process operation prior to increase in pressure drop.
Compartment damper problem	Check damper, limit switches and actuators, where

	applicable.
Over filled hoppers	Check hopper levels for blockage of gas stream to bags. Check hopper valves and ash pipe for blockage.

2. Low Fabric Filter Differential Pressure

CAUSE	CORRECTIVE ACTION(S)
Bag failures or loss	Inspect compartments at first opportunity, replace or refit bags as required.
dP instrument malfunction	Check compartment dP sensing lines & dP instrument.
Reduced gas volume	Check boiler load.

3. Dust Detected in Compartment Outlet

CAUSE	CORRECTIVE ACTION(S)
Instrument Malfunction	Check and calibrate instrument.
Incorrectly installed bag or bag failure	Attempt to identify the compartment at fault by observing the broken bag detector indication trends on the DCS. If identification is possible, isolate that compartment and take corrective action, as warranted. If bag failure confirmed, inspect compartments at first opportunity and replace or refit bags as required.
Tube Sheet Damage	Check the tube sheet for holes, cracks, loose bolts, or loose bag cage assemblies and correct.
Insufficient filter cake	Allow more dust to build up on bags by cleaning less frequently.

4. Premature Bag Failure

CAUSE	CORRECTIVE ACTION(S)
Fabric Attack	Have bag samples analyzed. Evaluate for protection by residual cake, and effects of operating below the acid dew point.

5. **Low Bag Cleaning Pressure**

CAUSE	CORRECTIVE ACTION(S)
Clean Air Blower Problem	Check cleaning air blower and repair as required.
Clean Air Header Problem	Check header relief and bypass valve. Check for piping leak.

6. **Increasing Opacity**

CAUSE	CORRECTIVE ACTION(S)
Bypass Damper Problem	Check damper and actuator position. Check limit switches. Check seal air header. Inspect dampers at first opportunity, repair as required.
Broken Bag	Isolate compartment.

3.4 PREVENTATIVE AND PREDICTIVE MAINTENANCE

A. RESPONSIBLE PERSON(S) FOR PREVENTATIVE/PREDICTIVE MAINTENANCE

1. The System Engineer has designated responsibilities for determining and establishing predefined Maintenance Plans.

2. The Maintenance Lead for the respective PJFF equipment will ensure that the activities defined in the Maintenance Plans are carried out and documented on the schedule identified, or more frequently, as needed.

The PJFF Maintenance Plans will include at a minimum the following inspections, which will be conducted during scheduled periodic outages. The inspection results and maintenance activities/corrective actions will be documented appropriately.

Scheduled Periodic Outage Inspections:

- Check for signs of corrosion, moisture, or in-leakage to the Fabric Filter System.
- Check man ways, doors, dampers and expansion joints for leaks.
- Inspect the condition of insulation and exterior of the unit.
- Check access door gaskets. Repair or replace hard or deteriorated gaskets, as required.
- Check for ash build-up on the tube sheet. Remove any accumulations and investigate the source of the leak.
- Check operation and seating of bypass dampers. Check bolted parts and actuators.
- Check for bag failure. Record type and location of failures.

- Check filters bag for proper installation. Inspect from the hopper to see that bags are hanging properly and not touching the wall or each other.
- Visually inspect all critical instrument air piping.
- Check hoppers and manifolds to assure they are free of debris.

4. OPERATION OF ACI / DSI / ASH HANDLING SYSTEMS

The ACI and DSI systems both inject dry sorbents into the flue gas. Requirements for these systems are included in the permit under emission units EUACI_U123 and EUDSI_U12. Hydrated lime is the sorbent for DSI and is injected into the ductwork after the air heater. The activated carbon is injected in the duct at the air heater outlet as well. Pollutant reduction starts in the gas stream and the reduction efficiency increases as the sorbents coat the pulse jet bags. The site documents for operation, maintenance and malfunction abatement of the ACI and DSI are SD and SOP 1.188 (ACI) and 1.193 (DSI) and are located on the Campbell Share-Point site in the procedures section.

The DSI systems consist of the following major equipment:

- 3 – sorbent storage vessels
- 2 – sorbent injection blowers
- 2 – injection air dehumidifiers with bypass

The ACI system consists of the following major equipment:

- 1 – sorbent storage vessel
- 2 – sorbent injection blowers

The Dry Fly Ash Handling System that services both Unit 1 and 2, consists of two (2) transfer tanks (TT#1 and TT#2), and three (3) vacuum exhausters (2 operating, one true spare). A third transfer tank (TT#3) with 2 vacuum exhausters (one operating, one true spare) will be installed in 2018 which will operate under this MMAP as well. TT#3 will be configured to accept ash from Unit 1 or Unit 2.

The vacuum conveyance system pulls ash from each Boiler Unit's PJFF hoppers, and transports the ash in hard piping through a filter separator and into a transfer tank where the conveyance air is then discharged through a vacuum exhauster. The vacuum exhausters that serve TT#1 and TT#2 will normally discharge to the Unit 1 PJFF inlet ductwork. When Boiler Unit 1 and the corresponding PJFF are off-line and "tagged out" due to safety and OSHA requirements, if Unit 2 is in operation, one vacuum exhauster may discharge to atmosphere through a dedicated stack when drawing from the Unit 2 PJFF hoppers or from the in-plant dust line. In that scenario, one vacuum exhauster will intermittently discharge controlled emissions to atmosphere, bypassing the Unit 1 PJFF inlet ductwork while "tagged out" for maintenance. The operational vacuum exhauster for transfer tank #3 will discharge only to the inlet of the Unit 2 PJFF. The displacement air due to material drop into the transfer tank is released through a bin vent filter to atmosphere.

4.1 START-UP

The operating parameters described in this MMAP can be changed through the site change management process in alignment with the site operating procedures for this equipment. The ACI and DSI systems are started when the coal mill feed is initiated and therefore are operating when coal is fired into the boiler units.

4.2 OPERATION

In order to maintain a high level of effectiveness and efficiency, the AQCS systems (ACI and DSI) will be operated in accordance with the guidelines and instructions in the vendor manuals and plant operating procedures, unless otherwise deemed appropriate based on operational experience or system conditions.

A. EQUIPMENT TO BE MONITORED:

1. Sorbent Storage Silos (carbon / lime)

a. **Bin Vent Differential Pressure (dP) transmitter:** Differential pressure (dP) transmitters are installed on the bin vent filters and are monitored continuously and logged through the DCS. There is a high set point alarm.

b. **Visible Emissions:** Non-certified visible emission observations of the sorbent storage silo bin vent filter exhaust will be performed daily when the ACI and DSI systems are in operation. The observations will be recorded in the proper system log.

c. **Silo Levels:** Each Sorbent Storage silo is equipped with a high level alarm; the hopper levels are monitored continuously and logged through the DCS. The alarm set-points are as follows:

- high high set point 100% full
- high set point 90% full
- low set point 10% full

2. Dry Sorbent Injection

a. **SO_2 Emission Levels:** Outlet emission targets are set by Plant Operations to ensure a compliance margin with regulatory limits. Alarms from the SO_2 CEMS are set in the DCS accordingly. Operators shall respond to alarms as indicated in the appropriate alarm response procedure.

b. **Sorbent Injection Rate:** The injection rates of hydrated lime shall be adequate to meet the SO_2 emission limits for each unit and can be monitored on the DCS.

3. Activated Carbon Injection

a. **Mercury (Hg) Emission Levels:** Outlet emission targets are set by Plant Operations to ensure a compliance margin with regulatory limits. Alarms from the Hg CEMS are set in the DCS accordingly. Operators shall respond to alarms as indicated in the appropriate alarm response procedure.

b. **Carbon Injection Rate:** The injection rates of carbon shall be adequate to meet the Hg emission limit for each unit and can be monitored on the DCS.

4. Ash Byproduct Transfer Tanks

a. **Bin Vent Differential Pressure (dP) transmitters**
Differential pressure (dP) transmitters are installed locally on the bin vent filters and will be monitored by operations. There are alarm set points for high dP.

b. Visible Emissions
Non-certified visible emission observations of bin vent filter exhaust will be performed daily when the ash system is in operation on all emission points to atmosphere. The observations will be recorded in the proper system log.

c. Silo Levels
Each silo is equipped with a high level alarm; the hopper levels are monitored locally and will be monitored by operations.

5. Filter Separator / Vacuum Exhausters

a. Differential Pressure (dP) transmitters
Differential pressure (dP) transmitters are installed locally on filter separators and will be monitored by operations. There are alarm set points for high dP.

b. Visible Emissions
The normal operational mode for the vacuum exhausters is to discharge the conveying air to the PJFF Inlet on either Unit 1 or Unit 2. Non-certified visible emission observations will be performed daily when the vacuum exhauster discharges to atmosphere when there is a Boiler Unit 1 and PJFF outage. The observations will be recorded in the proper system log.

4.3 MALFUNCTION ABATEMENT

During otherwise normal operation, an operator may experience some abnormal conditions that will require immediate attention. Prompt response to alarms or abnormal conditions can save the system from equipment damage and non-compliance with environmental regulations. All control equipment will be restored to normal operation as quickly as possible in response to any noted abnormal condition, according to the vendor manuals and site specific standard operating procedures and alarm response procedures.

4.4 PREVENTATIVE AND PREDICTIVE MAINTENANCE

A. RESPONSIBLE PERSON(S) FOR PREVENTATIVE/PREDICTIVE MAINTENANCE

1. The AQCS System Engineer has designated responsibilities for determining and establishing predefined Maintenance Plans.
2. The Maintenance Lead for the respective equipment will ensure that the activities defined in the Maintenance Plans are carried out and documented on the schedule identified, or more frequently, as needed. For the ash/byproduct handling system:

    i. On a weekly basis, review differential pressure readings associated with each bag filter and determine when the bags need to be replaced.

    ii. As needed, inspect bags to determine their condition.

iii. Keep spare filter bags for all Units in the stock system.

iv. After each year of operation, perform ultrasonic inspection of 50% of all elbows and 10 straight sections of pressure pipe.

- Based on rate of wall loss, reinforce the elbows and pipe if wall loss is localized, OR
- replace when wall loss exceeds 70%.
- If experience shows that wear is confined to less than one-half the circumference of the pipe, it may be rotated when wall loss exceeds 50%.

3. The maintenance plans will include vendor recommended periodic maintenance (including preventative) activities to be performed for each piece of equipment on an appropriate schedule or during system outages of adequate length.

4. The inspection results and maintenance activities/corrective actions will be documented and maintained electronically.

5. All appropriate information, including vendor manuals shall be maintained for reference and training.

B. CRITICAL SPARE PARTS

The System Engineer along with the supply chain lead is responsible for ensuring that the necessary critical spare parts are available for replacement as needed.

5. RECORD KEEPING

A. All maintenance activities (including preventative/predictive maintenance and maintenance related to malfunctions) related to the control equipment will be documented electronically and maintained for a period of not less than five years. If some activities occur at frequencies of greater than five year intervals, the history will be extended for those activities such that as a minimum the last maintenance activity performed is retained.

B. All appropriate vendor information, as well as operations and maintenance (O&M) manuals, shall be maintained for reference and training. These documents will also be referenced for supply parts and proper maintenance practices. This information shall be maintained for the life of the equipment.

C. Malfunctions of the Control Equipment that is used for the Material and Air Toxics Standard (MATS) and/or Consent Decree compliance shall be documented in the appropriate log. Malfunctions that caused or could have caused an exceedance with a MATS emission limit, as well as their appropriate corrective action, shall be included in the semi-annual reports (refer to AQ-127).

D. Documentation of visible emission readings shall be kept on file for a period of not less than five years.

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J.H. CAMPBELL - Unit 2

MAINTENANCE AND MALFUNCTION ABATEMENT PLAN AIR QUALITY CONTROL SYSTEMS (AQCS)

December 6, 2017

Revision: 3.0

1. INTRODUCTION

1.1 SCOPE

This Maintenance and Malfunction Abatement Plan (MMAP) covers the monitoring, maintenance and operational requirements associated with the air quality control systems (AQCS) and ancillary equipment for Boiler Unit 2 at the J.H. Campbell (JHC) Generating Complex. The AQCS covered by this MMAP includes the Pulse Jet Fabric Filter (PJFF) for particulate matter control, Dry Sorbent Injection (DSI) for acid gas and sulfur dioxide control and Activated Carbon Injection (ACI) for mercury (Hg) control. The MMAP also covers all supporting material handling and waste ash/byproduct handling control systems. This MMAP will assist in preventing, detecting and correcting malfunctions or equipment failures which could result in emissions exceeding applicable limitations. This MMAP does not cover the selective catalytic reduction (SCR) emission control equipment as it is not required by permit.

1.2 PURPOSE

The J.H. Campbell Permit to Install (PTI) Number 18-15, condition EUBOILER2, III.2, states that "The permittee shall not operate EUBOILER2 unless a malfunction abatement plan (MAP) as described in Rule 911(2), for the new emission control equipment is implemented and maintained." The permit also requires MAPs for the particulate matter control devices for material handling equipment.

1.3 SOURCE DESCRIPTION

J.H. Campbell 2 is a coal fired 3,560 mmBtu per hour dry wall-fired boiler with fuel oil startup capabilities. Emission controls include: low-NOx burners and Selective Catalytic Reduction (SCR) for NOx control, and the Low Pressure/High Volume Pulse Jet Fabric Filter (PJFF) System for particulate emission control, Dry Sorbent Injection (DSI) which is the flue gas desulfurization unit (FGD), and Activated Carbon Injection (ACI) for mercury control. The ash system for Unit 2 will utilize the existing transfer tank and vacuum exhausters included in ROP requirement EUASHNEW until incorporation of Permit 18-15 into the ROP.

Equipment	Emission Unit ID (in ROP)	Description	Control	Equip. Covered under this MMAP
Boiler Unit 2	EUBOILER2	3560 mmBtu/hr, Coal fired	SCR, PJFF, DSI, ACI	PJFF, DSI, ACI
Unit 2 DSI Sorbent Silos (3)	EUDSI_U12	Unit 2 Hydrated Lime Sorbent Storage	Bin Vent Filters	Yes
#2 Transfer Tank	EUASHNEW	Unit 2 Ash System	Filter Separator, Bin Vent Filter	Yes
Unit 2 ACI Sorbent Silo	EUACI_U123	Silos for Sorbent for Hg Control	Bin Vent Filters	Yes
Byproduct Transfer/Storage	EUBYPRODUCT	Transfer Tanks, Vacuum exhausters, Disposal Silos	Filter Separator, Bin Vent Filters	Yes

2. REGULATORY ANALYSIS

The table below identifies the emission limits for J.H. Campbell Boiler Unit 2:

Emission Limits	Regulatory Driver
PM Limits	
0.15/1000 lbs, of exhaust gas @ 50% excess air	ROP
0.015 lbs/mmBtu	EPA Consent Decree
0.03 lbs/mmBtu	MATS regulation
SO_2 Limits	
0.32 lbs/mmBtu (365 day rolling average)	EPA Consent Decree
1.0 lbs/mmBtu (30 day rolling average)	EPA Consent Decree
1.2 lbs/mmBtu	ROP
HCl Limit	
0.0020 lbs/mmBtu	MATS regulation
Mercury Limit	
1.2 lbs/TBtu	MATS regulation

The boiler is subject to the State's opacity standard, Rule 336.1301(1) (a), which limits opacity to not exceed a 6-minute average of 20% opacity, except for one (1) 6-minute average per hour of not more than 27% opacity. The Unit utilizes a Continuous Opacity Monitoring System (COMS) for opacity compliance determinations, and is used as an indicator of compliance with the particulate matter emission limit.

The ancillary silos and transfer equipment also have particulate emission limits associated with the bin vent filter exhausts, with an opacity restriction of 5%.

3. PULSE JET FABRIC FILTER

One (1) dedicated PJFF is installed on the Unit 2 Boiler to control particulate emissions. As flue gas leaves the boiler it passes through the air preheaters then enters two separate ducts where the hydrated lime and activated carbon are injected. The flue gas then enters the PJFF through interconnecting duct work, and an inlet manifold distributes the gas into compartments where fabric filter bags are held. As the flue gas enters the compartments, the gas velocity decreases and some of the larger particles fall into the ash hopper. The remainder of the particulate laden flue gas passes through the fabric filter bag, accumulating the particulate on the exterior surface of the filter bags. The filtered flue gas leaves each compartment into the clean side outlet plenum and through the outlet ductwork to the ID fans for discharge to the atmosphere through the common stack.

The PJFF has 10 compartments that hold 1,176 bags per compartment, for a total of 11,760 bags. The particulate matter that accumulates on the exterior of the bag increases the differential pressure between the clean and dirty side of the fabric filter tube sheet. The particulate is periodically removed by directing a pulse of clean air down the inside of the bag. The pulse directed down through the bag momentarily stops the flow of particulate laden flue gas and flexes the bag; this resulting acceleration/deceleration of the bag surface dislodges the collected particulate which falls into the fly ash hopper. A rotating

manifold/nozzle assembly is used to deliver the cleaning air pulse to the bags in each fabric filter compartment. Only a very small percentage of the filter bags are cleaned at any given time (a single pulse). A low-pressure positive displacement blower is used for the supply of clean air to pulse the bags.

The unit is equipped with bypass poppet dampers; these dampers provide an alternate gas passage around the temperature-sensitive filter bags in the event of emergency upset conditions. The collected ash is conveyed from the bottom of the hoppers to the dry fly ash transfer towers. The PJFF is controlled and monitored from a central Distributed Control System (DCS), which records differential pressure readings and system alarms, along with other operational parameters.

The site documents for operation, maintenance and malfunction abatement of the PJFF are System Description (SD) and Standard Operating Procedure (SOP) 2.187, as well as the Alarm Response Procedures (ARPs). These documents are found on the Campbell Share-Point site or shared plant network drive.

3.1 OPERATION OF THE PJFF SYSTEM

A. START-UP

1. Leak Test

Upon completion of a major filter bag replacement, a leak detection test will be completed. The purpose of this test is to locate any areas where particulate laden flue gas may reach the clean side of the fabric filter tube sheet. The leak test will be performed by injecting a fluorescent powder into the flue gas upstream of the fabric filter, and using a black light to look for the powder on the clean side of the bags. Wherever this powder is found denotes the location of a fabric filter bag leak.

2. Pre-coat Procedure – for new bags

New filter bags after a major replacement initiative may require pre-coating prior to the initial operation to facilitate proper operation and longevity of the fabric filter. The pre-coat of the new bags provides protection during initial start-up in the event of boiler upsets and/or acid condensation.

3. Boiler Start-up

System (PJFF) Operating and General Boiler Operating Procedures for Start-up shall be followed.

B. OPERATION

In order to maintain a high level of effectiveness and efficiency, the PJFF system will be operated in accordance with the guidelines and instructions in the vendor manual, unless otherwise deemed appropriate based on operational experience or system conditions. Plant System Operating Procedures will be followed.

C. SHUT-DOWN

1. Normal Shut-down

Shut-down of the PJFF is operator initiated and integrated into the boiler shutdown procedures.

2. Emergency Bypass Shut-down

This shut-down method is intended to protect the filter bags from upset conditions. It can be initiated manually by an Operator from the DCS screen. Additionally, an emergency bypass shut-down will be initiated when either of the two following conditions exists:

a. Fabric Filter inlet temperature is at the High-High set point for 10 minutes before going into emergency bypass which then initiates the boiler shut-down procedure controlled by an operator. The alarm has a delay to avoid nuisance shutdowns/alarms.

b. Fabric Filter inlet temperature is at the High-High-High set point any length of time. This will override the High-High temperature timer and initiate a sequence shutdown. There is a delay to avoid nuisance shut-downs.

3.2 PJFF MONITORING PARAMETERS

The PJFF operation is controlled and monitored from a central Distributed Control System (DCS). Alarms are an integral part of the system instrumentation. They warn Operators of impending problem situations. In all cases, alarms will be investigated and responded to in accordance with the Manufacturer's procedures and Owner's Alarm Response Procedures (ARPs).

A PJFF unit overview report will be recorded weekly, when in operation. The overview report will contain the PJFF operating parameters identified in Section VI at the time of the report generation. These weekly reports will be retained for a period of not less than 5 years.

A. EQUIPMENT TO BE MONITORED:

1. Differential pressure (dP) transmitters

Differential pressure (dP) transmitters are installed at the inlet and outlet of the PJFF and on each of the ten (10) filter compartments. They will be monitored continuously and logged through the DCS. Automatic bag cleaning frequency is based on the overall PJFF unit dP cleaning set point. There is a "start cleaning" set point, and a "stop cleaning set point." All available compartments are cleaned in a programmed sequence, which repeats until the differential pressure across the PJFF falls below a lower set point value, at which time the cycle will stop. These cleaning set points for the fabric filter are based upon actual operating conditions. There is a dP high alarm a high-high alarm set-point. Operators will acknowledge all alarms and respond according to the ARPs. A sequence for automatic cleaning also exists, based on timing of last cleaning event and dP.

2. Broken bag detectors

Broken bag detectors are installed on the clean side of each of the ten filter compartments and will be monitored continuously and logged through the DCS. Operators will utilize the broken bag detectors as a trouble shooting tool and acknowledge all alarms and respond according to the ARPs.

3. Ash Hopper Levels

Each ash hopper is equipped with a high level alarm; the hopper levels are monitored continuously and logged through the DCS. Operators will utilize the ash hopper alarms as a trouble shooting tool and acknowledge all alarms and respond according to the ARPs.

4. **Filter Compartment Temperature Sensors**
   Temperature sensors are installed on the inlet of the ten filter compartments and will be monitored continuously and logged through the DCS. Alarms are generated for high inlet temperature. Additionally, a high-high set point will initiate flue gas bypass of the filter compartment within 10 minutes, if not resolved, initiating an operator controlled boiler shutdown by procedure. The high-high-high set point will initiate flue gas bypass of the PJFF and a shutdown after a 3 second delay. Operators will acknowledge all alarms and respond according to the ARPs.

5. **Cleaning Air System Pressure**
   The cleaning air system is equipped with pressure indicating transmitters that will be monitored and logged through the DCS system. An alarm will be generated for low pressure cleaning air. A spare blower will automatically start if the low pressure alarm is activated. Operators will acknowledge all alarms and respond according to the ARPs.

3.3 MALFUNCTION ABATEMENT

During otherwise normal operation, an operator may experience some abnormal conditions that will require immediate attention. Prompt response to alarms or abnormal conditions can save the system from an emergency bypass of flue gas and equipment damage. The PJFF will be restored to normal operation as quickly as possible in response to any noted abnormal condition.

A. POTENTIAL MALFUNCTIONS

The following section identifies abnormal process conditions or operating problems, possible causes, and corrective actions to recover from the condition.

1. High Fabric Filter Differential Pressure

CAUSE	CORRECTIVE ACTION(S)
Loss of cleaning function	Initiate a cleaning cycle. If the pressure drop responds, check dP instrumentation and DCS for an explanation to the loss of auto cleaning. If the pressure drop does not respond, check the air supply and diaphragm valves.
dP instrument malfunction	Check compartment dP sensing lines for blockage and blow out if necessary. Check & calibrate dP instrument.
Excessive dust concentration in gas stream	Check for change in boiler operation or fuel.
Decrease in bag permeability	Inspect bags at first opportunity. Pull samples and analyze filter cake. Examine process operation prior to increase in pressure drop.
Compartment damper problem	Check damper, limit switches and actuators, where applicable.

Over filled hoppers	Check hopper levels for blockage of gas stream to bags. Check hopper valves and ash pipe for blockage.

2. Low Fabric Filter Differential Pressure

CAUSE	CORRECTIVE ACTION(S)
Bag failures or loss	Inspect compartments at first opportunity, replace or refit bags as required.
dP instrument malfunction	Check compartment dP sensing lines & dP instrument.
Reduced gas volume	Check boiler load.

3. Dust Detected in Compartment Outlet

CAUSE	CORRECTIVE ACTION(S)
Instrument Malfunction	Check and calibrate instrument.
Incorrectly installed bag or bag failure	Attempt to identify the compartment at fault by observing the broken bag detector indication trends on the DCS. If identification is possible, isolate that compartment and take corrective action, as warranted. If bag failure confirmed, inspect compartments at first opportunity and replace or refit bags as required.
Tube Sheet Damage	Check the tube sheet for holes, cracks, loose bolts, or loose bag cage assemblies and correct.
Insufficient filter cake	Allow more dust to build up on bags by cleaning less frequently.

4. Premature Bag Failure

CAUSE	CORRECTIVE ACTION(S)
Fabric Attack	Have bag samples analyzed. Evaluate for protection by residual cake, and effects of operating below the acid dew point.

5. Low Bag Cleaning Pressure

CAUSE	CORRECTIVE ACTION(S)
Clean Air Blower Problem	Check clean blower and repair as required.
Clean Air Header Problem	Check header relief and bypass valve. Check for piping leak.

6. **Increasing Opacity**

CAUSE	CORRECTIVE ACTION(S)
Bypass Damper Problem	Check damper and actuator position. Check limit switches. Check seal air header. Inspect dampers at first opportunity, repair as required.
Broken Bag	Isolate compartment.

3.4 PREVENTATIVE AND PREDICTIVE MAINTENANCE

A. RESPONSIBLE PERSON(S) FOR PREVENTATIVE/PREDICTIVE MAINTENANCE

1. The System Engineer has designated responsibilities for determining and establishing predefined Maintenance Plans.

2. The Maintenance Lead for the respective PJFF equipment will ensure that the activities defined in the Maintenance Plans are carried out and documented on the schedule identified, or more frequently, as needed.

The PJFF Maintenance Plans will include at a minimum the following inspections, which will be conducted during scheduled periodic outages. The inspection results and maintenance activities/corrective actions will be documented appropriately.

Scheduled Periodic Outage Inspections:

- Check for signs of corrosion, moisture, or in-leakage to the Fabric Filter System.
- Check man ways, doors, dampers and expansion joints for leaks.
- Inspect the condition of insulation and exterior of the unit.
- Check access door gaskets. Repair or replace hard or deteriorated gaskets, as required.
- Check for ash build-up on the tube sheet. Remove any accumulations and investigate the source of the leak.
- Check operation and seating of bypass dampers. Check bolted parts and actuators.
- Check for bag failure. Record type and location of failures.
- Check filter bags for proper installation. Inspect from the hopper to see that bags are hanging properly and not touching the wall or each other.
- Visually inspect all critical instrument air piping.
- Check hoppers and manifolds to assure they are free of debris.

4. OPERATION OF ACI / DSI / ASH HANDLING SYSTEMS

The ACI and DSI systems both inject dry sorbents into the flue gas. Requirements for these systems are included in the permit under emission units EUACI_U123 and EUDSI_U12. Hydrated lime is the

sorbent for DSI and is injected into the ductwork after the air heater. The activated carbon is also injected in the duct at the air heater outlet. Pollutant reduction starts in the gas stream and the reduction efficiency increases as the sorbents coat the pulse jet bags. The site documents for operation, maintenance and malfunction abatement of the ACI and DSI are SD and SOP 2.188 (ACI) and 2.193 (DSI) and are located on the Campbell Share-Point site in the procedures section.

The DSI systems consist of the following major equipment:

- 3 – sorbent storage vessels
- 2 – sorbent injection blowers
- 2 – injection air dehumidifiers with bypass

The ACI system consists of the following major equipment:

- 1 – sorbent storage vessel
- 2 - sorbent injection blowers

The Dry Fly Ash Handling System that services both Unit 1 and 2, consists of two (2) transfer tanks (TT#1 and TT#2), and three (3) vacuum exhausters (2 operating, one true spare). A third transfer tank (TT#3) with 2 vacuum exhausters (one operating, one true spare) will be installed in 2018 which will operate under this MMAP as well. TT#3 will be configured to accept ash from Unit 1 or Unit 2.

The vacuum conveyance system pulls ash from each Boiler Unit's PJFF hoppers, and transports the ash in hard piping through a filter separator and into a transfer tank where the conveyance air is then discharged through a vacuum exhauster. The vacuum exhausters that serve TT#1 and TT#2 will normally discharge to the Unit 1 PJFF inlet ductwork. When Boiler Unit 1 and the corresponding PJFF are off-line and "tagged out" due to safety and OSHA requirements, if Unit 2 is in operation, one vacuum exhauster may discharge to atmosphere through a dedicated stack when drawing from the Unit 2 PJFF hoppers or from the in-plant dust line. In that scenario, one vacuum exhauster will intermittently discharge controlled emissions to atmosphere, bypassing the Unit 1 PJFF inlet ductwork while "tagged out" for maintenance. The operational vacuum exhauster for transfer tank #3 will discharge only to the inlet of the Unit 2 PJFF. The displacement air due to material drop into the transfer tank is released through a bin vent filter to atmosphere.

4.1 START-UP

The operating parameters described in this MMAP can be changed through the site change management process in alignment with the site operating procedures for this equipment. The ACI and DSI systems are started when the coal mill feed is initiated and therefore are operating when coal is fired into the boiler units.

4.2 OPERATION

In order to maintain a high level of effectiveness and efficiency, the AQCS systems (ACI and DSI) will be operated in accordance with the guidelines and instructions in the vendor manuals and plant operating procedures, unless otherwise deemed appropriate based on operational experience or system conditions.

A. EQUIPMENT TO BE MONITORED:

1. Sorbent Storage Silos (carbon / lime)

a. **Bin Vent Differential Pressure (dP) transmitter:** Differential pressure (dP) transmitters are installed on the bin vent filters and are monitored continuously and logged through the DCS. There is a high set point alarm.

b. **Visible Emissions:** Non-certified visible emission observations of the sorbent storage silo bin vent filter exhaust will be performed daily when the ACI and DSI systems are in operation. The observations will be recorded in the proper system log.

c. **Silo Levels:** Each Sorbent Storage silo is equipped with a high level alarm; the hopper levels are monitored continuously and logged through the DCS. The alarm set-points are as follows:

- high high set point 100% full
- high set point 90% full
- low set point 10% full

2. Dry Sorbent Injection

a. **SO_2 Emission Levels:** Outlet emission targets are set by Plant Operations to ensure a compliance margin with regulatory limits. Alarms from the SO_2 CEMS are set in the DCS accordingly. Operators shall respond to alarms as indicated in the appropriate alarm response procedure.

b. **Sorbent Injection Rate:** The injection rates of hydrated lime shall be adequate to meet the SO_2 emission limits for each unit and can be monitored on the DCS.

3. Activated Carbon Injection

a. **Mercury (Hg) Emission Levels:** Outlet emission targets are set by Plant Operations to ensure a compliance margin with regulatory limits. Alarms from the Hg CEMS are set in the DCS accordingly. Operators shall respond to alarms as indicated in the appropriate alarm response procedure.

b. **Carbon Injection Rate:** The injection rates of carbon shall be adequate to meet the Hg emission limit for each unit and can be monitored on the DCS.

4. Ash Byproduct Transfer Tanks

a. **Bin Vent Differential Pressure (dP) transmitters**
Differential pressure (dP) transmitters are installed locally on the bin vent filters and will be monitored by operations. There are alarm set points for high dP.

b. **Visible Emissions**
Non-certified visible emission observations of bin vent filter exhaust will be performed daily when the ash system is in operation on all emission points to atmosphere. The observations will be recorded in the proper system log.

c. **Silo Levels**
Each silo is equipped with a high level alarm; the hopper levels are monitored locally and will be monitored by operations.

5. **Filter Separator / Vacuum Exhausters**

a. **Differential Pressure (dP) transmitters**
Differential pressure (dP) transmitters are installed locally on filter separators and will be monitored by operations. There are alarm set points for high dP.

b. **Visible Emissions**
The normal operational mode for the vacuum exhausters is to discharge the conveying air to the PJFF Inlet on either Unit 1 or Unit 2. Non-certified visible emission observations will be performed daily when the vacuum exhauster discharges to atmosphere when there is a Boiler Unit 1 and PJFF outage. The observations will be recorded in the proper system log.

4.3 MALFUNCTION ABATEMENT

During otherwise normal operation, an operator may experience some abnormal conditions that will require immediate attention. Prompt response to alarms or abnormal conditions can save the system from equipment damage and non-compliance with environmental regulations. All control equipment will be restored to normal operation as quickly as possible in response to any noted abnormal condition, according to the vendor manuals and site specific standard operating procedures and alarm response procedures.

4.4 PREVENTATIVE AND PREDICTIVE MAINTENANCE

A. RESPONSIBLE PERSON(S) FOR PREVENTATIVE/PREDICTIVE MAINTENANCE

1. The AQCS System Engineer has designated responsibilities for determining and establishing predefined Maintenance Plans.
2. The Maintenance Lead for the respective equipment will ensure that the activities defined in the Maintenance Plans are carried out and documented on the schedule identified, or more frequently, as needed. For the ash/byproduct handling system:

i. On a weekly basis, review differential pressure readings associated with each bag filter and determine when the bags need to be replaced.

ii. As needed, inspect bags to determine their condition.

iii. Keep spare filter bags for all Units in the stock system.

iv. After each year of operation, perform ultrasonic inspection of 50% of all elbows and 10 straight sections of pressure pipe.

- Based on rate of wall loss, reinforce the elbows and pipe if wall loss is localized, OR

- replace when wall loss exceeds 70%.
- If experience shows that wear is confined to less than one-half the circumference of the pipe, it may be rotated when wall loss exceeds 50%.

3. The maintenance plans will include vendor recommended periodic maintenance (including preventative) activities to be performed for each piece of equipment on an appropriate schedule or during system outages of adequate length.

4. The inspection results and maintenance activities/corrective actions will be documented and maintained electronically.

5. All appropriate information, including vendor manuals shall be maintained for reference and training.

B. CRITICAL SPARE PARTS

The System Engineer along with the local supply chain lead is responsible for ensuring that the necessary critical spare parts are available for replacement as needed.

5. RECORD KEEPING

A. All maintenance activities (including preventative/predictive maintenance and maintenance related to malfunctions) related to the control equipment will be documented electronically and maintained for a period of not less than five years. If some activities occur at frequencies of greater than five year intervals, the history will be extended for those activities such that as a minimum the last maintenance activity performed is retained.

B. All appropriate vendor information, as well as operations and maintenance (O&M) manuals, shall be maintained for reference and training. These documents will also be referenced for supply parts and proper maintenance practices. This information shall be maintained for the life of the equipment.

C. Malfunctions of the Control Equipment that is used for Mercury and Air Toxics Standard (MATS) and/or Consent Decree compliance shall be documented in the appropriate log. Malfunctions that caused or could have caused an exceedance with a MATS emission limit, as well as their appropriate corrective action, shall be included in the semi-annual reports (refer to AQ-127).

D. Documentation of visible emission readings shall be kept on file for a period of not less than five years.