**KARN FACILITY**
DE Karn 1 and 2 Plant

# MAINTENANCE AND MALFUNCTION ABATEMENT PLAN
## SPRAY DRYER ABSORBER SYSTEMS
## and
## ACTIVATED CARBON INJECTION SYSTEMS

**April 2019**
**Revision 1**

## I. INTRODUCTION

### A. SCOPE

This Maintenance and Malfunction Abatement Plan (MMAP) covers the monitoring, maintenance and operational requirements associated with the two (2) Spray Dryer Absorbers (SDAs) retrofitted to each of the D.E. Karn (DEK) Units 1 & 2, primarily for Sulfur Dioxide ($SO_2$) emission control. In addition, the MMAP will cover the equipment and processes of Activated Carbon Injection (ACI) (i.e., Sorbent Injection) for the purpose of mercury control. The MMAP also covers all supporting material handling and waste ash/byproduct handling and disposal system control devices. This MMAP will assist in preventing, detecting and correcting malfunctions or equipment failures which could result in emissions exceeding applicable limitations.

### B. PURPOSE

This plan has been developed to address the Michigan Department of Environmental Quality - Air Quality Division (MDEQ-AQD) Air Pollution Control (APC) Part 9 requirements, specifically Rule 336.1911 (Rule 911) - Malfunction Abatement Plans, and MI-ROP-B2840-2014c Section 1 - Karn 1 and Karn 2 Emission Unit Tables, EU-KARN1 and EU-KARN2, as well as the requirements under EU-LIMEPREP, EU-BPRECYCLE, EU-BPDISPOSAL and EU-SORBENT.

EU-KARN1 and EU-KARN2, Special Condition III.1, Process/Operational Restrictions requirement, states in part that "the permittee shall not operate the Unit or specified process equipment unless a Malfunction Abatement Plan (MAP) as described in Rule 911(2), for the emission control equipment is implemented and maintained". Minimum requirements for Rule 911 compliance are listed in Part 1 (a, b, c) of Special Condition III.1.

Additionally, Special Condition IV.1, Design / Equipment Parameters, states the Unit / process equipment shall not be operated unless the equipment is installed, maintained and operated in a satisfactory manner. Satisfactory manner includes operating and maintaining the control device in accordance with an approved MAP.

Similar provisions requiring operation of the material handling portions of the SDA and ACI in accordance with a MAP are contained in each of the tables for EU-LIMEPREP, EU-BPRECYCLE, EU-BPDISPOSAL and EU-SORBENT, under Special Conditions III.2 and IV.1.

## II. SOURCE DESCRIPTION

Karn boiler No. 1 is a 2500 million BTU per hour dry bottom tangential coal fired boiler with fuel oil startup capabilities and supplemental co-firing for flame stabilization and mill outages. NOx is controlled by utilizing Selective Catalytic Reduction (SCR) with ammonia. The particulate emissions are control by a Low Pressure/High Volume Pulse Jet Fabric Filter System (PJFF). Sulfur Dioxide (SO2) emissions are controlled by a Spray Dryer Absorber (SDA) system. Mercury (Hg) emissions are controlled on an as needed basis by injection of Activated Carbon.

Karn boiler No. 2 is a 2540 million BTU per hour dry bottom wall coal fired boiler with fuel oil startup capabilities and supplemental co-firing for flame stabilization and mill outages. NOx is controlled by utilizing Low-NOx burner tips in addition to Selective Catalytic Reduction (SCR) with ammonia. The particulate emissions are controlled by a Low Pressure/High Volume PJFF. Sulfur Dioxide (SO2) emissions are controlled by a Spray Dryer Absorber (SDA) system. Mercury (Hg) emissions are controlled on an as needed basis by injection of Activated Carbon.

The following table presents source descriptions and control equipment.

| Equipment | Emission Unit ID | Control(s) Description | Control Equipment ID in ROP (if necessary) | Equip. Covered under this MMAP |
|---|---|---|---|---|
| Boilers - Units 1&2 | EU-KARN1, EU-KARN2 | PJFF, SCR, Low NOx Burners (DEK2), SDA, ACI | n/a | SDA, ACI |
| SDA - Lime Storage Silos A&B | EU-LIMEPREP | Lime Storage Silos A&B - Bin Vent Filters for Truck Unloading | LSABV-1, LSBBV-2 | Yes |
| SDA - Lime Detention Slakers & Product Tanks | EU-LIMEPREP | Spray Scrubbers | LSADVS-5, LSBDVS-6 | Yes |
| Byproduct Recycle System Vacuum Transport Blowers | EU-BPRECYCLE | Vacuum transport blowers filter separators (exhaust to PJFF) | R1AFSA-11, R1BFSA-12, R2AFSA-13, R2BFSA-14 | Yes |
| Byproduct System Storage Bins | EU-BPRECYCLE | Bin Vent Filters for Recycle Storage bins | R1BV-8, R2BV-10 | Yes |
| Byproduct System Recycle Slurry Mix Tanks | EU-BPRECYCLE | Spray Scrubbers for Recycle Slurry Mix Tanks | R1ADVS-15, R1BDVS-16, R2ADVS-17, R2BDVS-18 | Yes |
| Byproduct Disposal System Vacuum Transport Blowers | EU-BPDISPOSAL | Vacuum transport blowers filter separators | K1ABPFSA-23, K1BBPFSA-24, K2ABPFSA-25, K2BBPFSA-26 | Yes |

**(table continued)**

| Equipment | Emission Unit ID | Control(s) Description | Control Equipment ID in ROP (if necessary) | Equip. Covered under this MMAP |
|---|---|---|---|---|
| Byproduct Disposal System Silos | EU-BPDISPOSAL | Bin Vent Filters for Disposal Storage silos | K1BPBV-19, K2BPBV-20 | Yes |
| ACI - Sorbent Storage Silos | EU-SORBENT | Bin Vent Filters for Sorbent Storage silos | K1ACIBV-30, K2ACIBV-31 | Yes |

## III. REGULATORY ANALYSIS

Karn boilers Nos. 1 and 2 each have the following applicable $SO_2$ and mercury emission limits:

- 1.67 lbs $SO_2$ / mmBtu, based on a monthly calendar average
- 0.090 lbs $SO_2$/mmBtu, based on a 30-day rolling average
- 0.075 lbs $SO_2$/mmBtu, based on a 365-day rolling average
- 0.20 lbs $SO_2$/mmBtu, based on 30-day rolling average
- 1.2 lbs Hg/TBtu, based on 30-boiler operating day average

Each Unit utilizes a Continuous Emissions Monitoring System (CEMS) (i.e., $SO_2$ CEMS and Hg CEMS) for compliance determinations.

The ACI and SDA ash/byproduct silos and transfer equipment also have particulate emission limits associated with the bin vent filter and scrubber exhausts, with an opacity restriction of 5%.

## IV. SPRAY DRYER ABSORBER (SDA)

Each unit's spray dryer absorber system consists of a lime slurry system, recycle ash slurry system, absorber vessel and atomizer and a waste byproduct handling system. The boiler flue gases are pulled into the absorber vessel through plant ductwork via induced draft fans. Feed slurry is directed into the atomizer which removes $SO_2$ from the flue gas. The treated flue gas and particulates are then directed to the pulse jet fabric filter (PJFF) which removes and collects the solid SDA waste byproduct for reuse within the SDA system or it is sent to be landfilled as solid waste. The cleaned flue gas is then discharged through the plant's stack.

A. Spray Dry Absorber Vessel and Associated Ductwork

The SDA inlet duct is split with flue gas entering the SDA roof gas disperser and the central gas disperser. The gas accelerates through the dispersers and mixes with the fine feed slurry mist that is sprayed by the high speed rotating atomizer. The lime in the slurry reacts with the acid gases and the heat of the flue gas causes the water droplets to evaporate leaving a dry particulate that is suspended in the gas stream as it exits the SDA Absorber Vessel.

The SDA is designed to operate continuously and the control system alarms are actuated as early warning indicators as well as when any serious equipment malfunctions occur. Operators also remain alert for possible problems by routine oversight of operating parameters and regular inspection of the equipment for leaks, unusual noises, over-heating, etc., in order to prevent operational problems.

The Spray Dry Absorber for each unit consists of the following major equipment:

- 1 Atomizer Head Tank and associated piping and valves
- 2 Rotary Atomizers; one operating and one spare
- 2 Atomizer Lube Oil Chillers; one operating and one spare
- 2 Atomizer Cooling Air Fans; one operating and one spare
- 1 SDA Absorber Vessel and associated gas dispersers

B. Lime Slurry System

The SDA Lime System consists of a common lime slurry preparation system and individual Unit lime systems. The common lime system receives and stores pebble lime, meters and slakes the pebbles into hydrated lime slurry, and transports the prepared slurry to Unit specific lime slurry feed systems. The unit specific lime feed systems pump hydrated lime slurry to each unit's respective head tank where it is mixed with recycle slurry and fed through a flow control valve into the atomizer. Lime slurry is supplied to the SDA head tank via a supply/return feed loop. Only a small portion of the lime is bled off the loop by a control valve and fed into the SDA. This flow rate is controlled in response to the $SO_2$ emissions requirement.

The Common Lime Slurry Preparation System consists of the following major equipment:

- 2 Pebble Lime Storage Silos and associated bin vent filters
- 2 Lime Detention Slakers and associated spray scrubbers
- 2 Vibrating Grit Screens
- 2 Lime Slurry Transfer Tanks
- 3 Lime Slurry Transfer Pumps and associated piping and valves

Each Unit Specific Lime Slurry Feed System consists of the following major equipment:

- 1 Lime Slurry Storage Tank
- 2 Lime Slurry Feed Pumps and associated piping and valves
- 1 Lime Slurry Feed Control Valve

C. Recycle Ash Slurry System

The recycle ash slurry system converts SDA waste solids which are collected by the PJFF to slurry which is pumped to the head tank. The comingled lime and recycle slurry, referred to as Feed Slurry, are directed into the atomizer and then sprayed into the absorber vessel to treat $SO_2$. Reuse of the SDA waste solids within the SDA enhances utilization of the lime and fly ash alkalinity.

The PJFF waste solids are transported pneumatically via vacuum exhauster to one of two filter separators which deposits the solids into the Recycle Ash Silo. To prevent buildup of solids, the bottom of the recycle ash silo is continuously fluidized by heated dry instrument air. Dust emissions from the silo are controlled by a bin vent filter.

The solids in the recycle ash silo are then metered into one of two mix tanks to prepare slurry that is approximately 40% solids. Each mix tank is furnished with a scrubber/vent fan assembly to control airborne dust. The slurry passes through a vibrating grit screen before entering the storage tank.

The recycle slurry flow to the atomizer head tanks is held constant by the continuously operating slurry feed pumps. As the lime slurry feed to the atomizer head tanks changes, the levels in the atomizer head tanks are fixed by means of a continuous overflow, returning the unused recycle slurry back to the recycle slurry storage tank.

Each Unit Specific Recycle Slurry Feed System consists of the following major equipment:

- 2 Ash Transport Vacuum Exhausters
- 2 Filter Separators
- 1 Recycle Ash Storage Silo and associated bin vent filter
- 2 Mix Tanks and associated spray scrubbers
- 2 Vibrating Grit Screens
- 1 Recycle Slurry Storage Tank
- 2 Recycle Slurry Feed Pumps

D. Waste Byproduct Handling System

Solid waste byproduct from the PJFF is intermittently transported to the Byproduct Disposal Silos. The solids are transported by vacuum exhausters to one of two filter separators that discharge into the silo. The system design includes a cross-tie between each unit's respective vacuum conveying lines so that waste byproduct can be moved between Units if necessary. The byproduct is conditioned, loaded into haul trucks and then landfilled on-site.

Each Unit Specific Recycle Slurry Feed System consists of the following major equipment:

- 2 Ash Transport Vacuum Exhausters
- 2 Filter Separators
- 1 Byproduct Storage Silo and associated bin vent filter
- 2 Byproduct Conditioning Mixers

## V. ACTIVATED CARBON INJECTION SYSTEM (ACI)

Each Unit has a dedicated Activated Carbon Injection System to remove mercury from the flue gas stream. The system is based on dilute-phase pneumatic conveying of powdered activated carbon (PAC) from a bulk storage silo to injection lances in the flue gas ductwork, where it mixes with the flue gas, adsorbs mercury, and is then captured in the PJFF system.

Each Unit's ACI consists of the following major equipment:

- 1 Sorbent Storage Silo with associated bin vent filter
- 2 PAC Hopper Feed Trains; one operating and one spare
- 2 PAC Conveying Blowers; one operating and one spare
- 1 Distribution and Injection Lance System

## VI. OPERATION OF THE SDA & ACI SYSTEMS

A. START-UP / SHUTDOWN

1. SDA System

The SDA atomizers will be placed in-service as quickly as possible in accordance with plant operating procedures and within technical limitations once the boilers begin burning coal. However, atomization and spraying of slurry cannot occur until a boiler flue gas temperature of at least 230°F is achieved. Once spraying begins, the level of spray down is restricted by SDA outlet temperature to avoid depositing slurry on the absorber vessel walls.

The SDA atomizers can be taken out of service for required maintenance when meeting boiler permissives in accordance with the plant operating procedures and emission rate targets.

System shutdown will follow plant operating procedures and safe operating requirements.

2. ACI System

When deemed necessary, the ACI system is initiated by Operators for compliance with emission rate targets.

B. OPERATION

1. SDA System

In order to maintain a high level of effectiveness and efficiency, the SDA system will be operated at all times the Unit is operating, in accordance with the guidelines and instructions in the vendor manual, manufacturers' specifications, applicable operating procedures, good engineering and maintenance practices, and good air pollution control practices for minimizing emissions, as applicable, for such equipment and the Unit.

2. ACI System

The ACI System is operated as needed in accordance with plant operating procedures, unless otherwise deemed appropriate based on operational experience or system conditions.

## VII. MONITORING PARAMETERS

Control equipment for the SDA & ACI 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 accordingly.

DE Karn Plant reserves the right to change the identified monitoring parameters and/or alarm set points based on manufacturer specifications, good engineering practices and operational experiences.

A. SDA ABSORBER VESSEL EQUIPMENT TO BE MONITORED:

1. SDA Process

i. SDA Outlet $SO_2$ Emission Rate

The $SO_2$ emission rate is managed via operator set-point and controlled by opening or closing the lime slurry feed into the head tank. The plant targets an $SO_2$ set point that ensures compliance with its applicable emission limits stated in Section III while also providing time to troubleshoot and make repairs during system interruptions.

ii. SDA Outlet Temperature

The process logic identifies the lowest allowable SDA outlet temperature based on various operating parameters (feed slurry solids concentration, etc.) to prevent depositing slurry on the vessel walls. This is known as the drying curve. The SDA is operated such that the outlet temperature remains above the drying curve.

The following are critical alarm points for the SDA Outlet Temperature:

a. SDA Outlet Temperature Low: <165°F
b. SDA Outlet Temperature Low-Low: <154°F
c. SDA Outlet Temperature Below Drying Curve

iii. Atomizer Operation

Atomizer operation requires adequate lube oil pressure (typically 75-85 psig) and temperature (typically 120°F) and sufficient wheel protection water flow (typically 1.8 gpm). It also requires that elevated spindle vibrations and motor bearing vibrations are avoided.

The following are critical alarm points for the atomizer:

a. Lube Oil Pressure Low: <44 psig
b. Lube Oil Pressure Low-Low: <36 psig
c. Lube Oil Temperature High: >145°F
d. Lube Oil Temperature High-High: >153°F
e. Wheel Protection Water Low: <1.2 gpm
f. Spindle Oil Level Low: <0.4 gal
g. Spindle Oil Level High: >1.05 gal
h. Spindle Vibration High: >16 Mils
i. Spindle Vibration High-High: >19 Mils
j. Motor Bearing Vibration High: > 0.2 In/Second (In/S)
k. Motor Bearing Vibration High-High: > 0.3 In/S

B. EU-LIMEPREP EQUIPMENT TO BE MONITORED:

1. Lime Storage Silo (A and B): (LSABV-1, LSBBV-2)

i. Bin Vent Pressure (dP) indicators

Differential pressure (dP) indicators are installed on each of the two (2) bin vent filter compartments and will be monitored continuously and logged through the DCS. There are alarm set points for high dP (>10 inches water column (INWC)).

ii. Visible Emissions

Non-Certified visible emission observations of bin vent filters exhaust and the pressure/vacuum relief devices exhaust will be performed daily when EULIMEPREP is in operation. The observations will be recorded in the proper system log.

iii. Lime Storage Silo Levels

Each Lime Storage silo is equipped with a high level alarm to prevent overfilling (>90%).

2. Lime Slaker Dust and Vapor (D&V) Scrubbers (A and B): (LSADVS-5, LSBDVS-6):

i. Lime Slaker Temperature

Temperature is controlled to approximately 185°F to ensure adequate slaking of the pebble lime and to avoid generating excess heat which can boil the water creating an unstable mixture of lime slurry within the slaker. A high temperature alarm of 195°F is in place to prevent this condition.

The slaking temperature can be adjusted based on lime quality if necessary.

ii. Visible Emissions

Non-Certified visible emission observations of the lime slaker D&V scrubber exhaust will be performed daily when EULIMEPREP is in operation. The observations will be recorded in the proper system log.

C. EU-BPRECYCLE EQUIPMENT TO BE MONITORED:

1. Recycle Ash Silos:

i. Bin Vent Filters - Differential Pressure (dP) indicators (RIBV-8, R2BV-10)

Differential pressure (dP) indicators are installed on each of the two (2) bin vent compartments and will be monitored continuously and logged through the DCS. There are alarm set points for high dP (>3 INWC).

ii. Visible Emissions

Non-Certified visible emission observations of the bin vent filters exhaust will be performed daily when EU-BPRECYCLE is in operation. The observations will be recorded in the proper system log.

iii. Filter Separators for the vacuum transport blowers - Differential Pressure (dP) indicators: (R1AFSA-11, R1BFSA-12, R2AFSA-13, R2BFSA-14)

Differential pressure (dP) indicators are installed on each of the two (2) filter separators per unit and will be monitored continuously and logged through the DCS. There are alarm set points for high dP (>12 INWC). A bag leak detector is installed in the vacuum piping between each filter separator and the vacuum exhauster that is monitored by DCS.

iii. Recycle Ash Storage Silo Level:

The Recycle Ash Storage Silo is equipped with a high level alarm (>85%) to prevent overfilling.

2. Recycle Slurry Mix Tanks:

i. Spray Scrubbers - Visible Emissions: (R1ADVS-15, R1BDVS-16, R2ADVS-17, R2BDVS-18)

Non-Certified visible emission observations of Recycle Slurry Mix Tanks scrubber

exhaust will be performed daily when EU-BPRECYCLE is in operation. The observations will be recorded in the proper system log.

D. EU-BPDISPOSAL EQUIPMENT TO BE MONITORED:

1. Byproduct Disposal Silos

i. Bin Vent Filters - Differential Pressure (dP) indicators (K1BPBV-19, K2BPBV-20)

Differential pressure (dP) indicators are installed on each silo and will be monitored continuously and logged through the DCS. There are alarm set points for high dP (>8 INWC).

ii. Visible Emissions

Non-Certified visible emission observations of bin vent filter exhaust will be performed daily when EU-BPDISPOSAL is in operation. The observations will be recorded in the proper system log.

iii. Filter Separators for the vacuum transport blowers - Differential Pressure (dP) indicators (K1ABPFSA-23, K1BBPFSA-24, K2ABPFSA-25, K2BBPFSA-26)

Differential pressure (dP) indicators are installed on each of the two (2) filter separators per unit and will be monitored continuously and logged through the DCS. There are alarm set points for high dP (>12 INWC). A bag leak detector is installed in the vacuum piping between each filter separator and the vacuum exhauster that is monitored by DCS.

iv. Byproduct Disposal Silo Levels:

Each Byproduct Disposal Silo is equipped with a high level alarm (>51.3 ft) to prevent overfilling that is monitored by DCS.

E. EU-SORBENT (ACI) EQUIPMENT TO BE MONITORED:

2. ACI Sorbent Storage Silos

i. Bin Vent Filters - Differential Pressure (dP) indicators (K1ACIBV-30, K2ACIBV-31)

Differential pressure (dP) indicators are installed on both bin vent filters and will be monitored continuously and logged through the DCS. There are alarm set points for high dP (>4 INWC).

ii. Visible Emissions

Non-Certified visible emission observations of the sorbent storage silo bin vent filter exhaust will be performed daily when EU-SORBENT is in operation. The observations will be recorded in the proper system log.

iii. Sorbent Storage Silo Levels

Each Sorbent Storage Silo is equipped with a high level alarm (>97%) to prevent overfilling that is monitored by DCS.

## VIII. MALFUNCTION ABATEMENT

During otherwise normal operation, an operator may experience some abnormal conditions that will require immediate attention. The process has been set up to avoid catastrophic events through the use of equipment trips and system interlocks. However, prompt operator response to alarms or abnormal conditions can save the system from equipment damage and non-compliance with emission limits. The SDA and ACI 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. This list may not be all inclusive.

#### 1. SDA PROCESS

| CAUSE | CORRECTIVE ACTION(S) |
|---|---|
| Increased $SO_2$ emission rate | Investigate atomizer operation, feed slurry flow (head tank/piping/strainer plugged) and density; lime slurry feed pump operation and instrumentation. Correct any deficiencies found or reduce boiler load to maintain emission rate compliance. |
| Low atomizer head tank level | Ensure slurry pump operating and that the head tank drain valve is closed. Switch to single level detector operation, remove and clean affected detector and reinstall. If malfunction continues, calibrate or replace instrument. |

#### 2. ATOMIZER TRIP

| CAUSE | CORRECTIVE ACTION(S) |
|---|---|
| Atomizer breaker tripped or open | Re-latch or repair / replace breaker |
| Mechanical failure of atomizer | Investigate and repair or swap to backup atomizer |
| Failure of atomizer motor | Investigate and repair or swap to backup atomizer |
| Atomizer flooding | Investigate slurry, protection water and coolant hose connections. Refasten, repair, or replace broken hoses. Swap to backup atomizer if needed. |
| Atomizer gear box oil pressure low | Check pressure instrumentation and replace if needed. Repair or replace dual oil pump or swap to backup atomizer. |
| Atomizer gear box oil temperature high | Investigate lube oil chiller and swap to backup if necessary. |
| Atomizer gear box oil level low | Gear oil can migrate to spindle sump. Investigate both sump levels, adjust oil level as needed and restart atomizer. If issue continues, swap to backup atomizer and inspect / repair removed atomizer. |

**(table continued)**

| CAUSE | CORRECTIVE ACTION(S) |
|---|---|
| Atomizer spindle vibration | Vibration is higher at certain feed slurry flow rates. Adjust spray down temperature to avoid these injection rates. If this does not resolve the vibration, there may be mechanical issues with the atomizer or wheel that will need investigation. Swap to backup atomizer and repair removed atomizer as needed. |
| Atomizer spindle lube oil level high | Verify level instrumentation; inspect oil for slurry ingress. If slurry in oil, swap to backup atomizer and repair removed atomizer. If no slurry, remove oil by hand pump and place atomizer back in service. |
| Atomizer spindle oil contaminated with slurry | Slurry can overflow into oil sump from wheel due to high vibration, plugged nozzles or upon opening flow control valve too quickly. Swap to backup atomizer and repair removed atomizer. |
| Atomizer oil filter *dP* high | Inspect and change out oil filters as needed. If slurry is found in housing, swap to backup atomizer. Repair removed atomizer. |
| Atomizer motor bearing temperature high | Check bearing thermocouples to verify temperatures. Swap to backup atomizer and investigate motor bearings and shaft; repair as needed. |
| Atomizer motor bearing vibration high | Check vibration probes and wiring and repair or replace if necessary. If vibration does not improve, swap to backup atomizer and investigate motor bearings and shaft; repair as needed. |

### 3. OBSERVED VISIBLE EMISSIONS (LIME SLAKER or MIX TANK)

| CAUSE | CORRECTIVE ACTION(S) |
|---|---|
| Plugged spray nozzles | Inspect and clean or replace nozzles if necessary |

### 4. OBSERVED VISIBLE EMISSIONS (LIME, RECYCLE, BYPRODUCT SILOS)

| CAUSE | CORRECTIVE ACTION(S) |
|---|---|
| Storage silo full | Inspect and clean or replace failed level sensor |
| Silo bin vent filter malfunction | Inspect system for over cleaning, broken bags, *proper* bag installation and correct. |

**5. HIGH BIN VENT DIFFERENTIAL PRESSURE (dP)**

| 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. Note, cartridges may be sufficiently aged requiring replacement to assure adequate cleaning. |
| dP instrument malfunction | Check instrument sensing lines for blockage and blow out if necessary. Check & calibrate instrument. |

**6. LOW BIN VENT DIFFERENTIAL PRESSURE (dP)**

| CAUSE | CORRECTIVE ACTION(S) |
|---|---|
| Bags over cleaned | Correct cleaning cycle timing to ensure 3-6 inwc when system is in service. |
| Bag failures or loss | Inspect bag filters at first opportunity, replace or refit bags as required. |
| dP instrument malfunction | Check dP cell sensing lines for blockage and blow out if necessary. Check & calibrate instrument as required. |

**7. RECYCLE ASH or BYPRODUCT DISPOSAL SILO FILTER SEPARATOR ALARMS**

| CAUSE | CORRECTIVE ACTION(S) |
|---|---|
| Tube Sheet Damage | Check tube sheet for damage and repair as needed. |
| Broken Bag | Remove filter separator from service and replace broken bag. |
| Insufficient filter cake | Allow more dust to build up on bags by cleaning less frequently. |
| Dust Detector Instrument Malfunction | Inspect dust detector and clean / repair. |

**8. EU-SORBENT (ACI)**

| CAUSE | CORRECTIVE ACTION(S) |
|---|---|
| Silo Bin Vent Filter dP high | Check instrumentation; cleaning air pressure and filter cartridges. Repair/replace as necessary. |
| Silo Bin Vent Filter dP low | Check for visible emissions, cartridge installation, failures or cleaning cycle timing. Repair/replace as necessary. |
| Silo Level high level instrument malfunction | Remove instrument and clean, blow down sensing lines and reinstall. |

**(table continued)**

| CAUSE | CORRECTIVE ACTION(S) |
|---|---|
| Activated carbon injection mechanical issues | Verify weigh hopper weight is decreasing. If it is, investigate piping and injection lances for leaks. If weight is not changing, check screw feeder, weigh hopper and injection lances for plugging. Repair/replace as necessary. |
| Mercury emission rate not decreasing when system in service | Adjust activated carbon injection rate as needed to achieve emission rate targets. Ensure activated carbon is being metered into transport piping. If not, remove from service and check for system plugging. |

## VIII. PREVENTATIVE AND PREDICTIVE MAINTENANCE

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

1. The System Engineer has designated responsibilities for determining and establishing the SDA and ACI Maintenance Plans. As necessary, Maintenance Plans will be updated to include preventative/predictive maintenance and best practices resulting from malfunctions experienced.

2. The Maintenance Lead for the SDA and ACI equipment will ensure that the activities defined in the Maintenance Plans are carried out and documented on the schedule identified (based on frequency, interval, manufacturer / engineering recommendations, etc.) during scheduled periodic outages of adequate length.

   The Maintenance Plans include the following inspections, which will be conducted during scheduled periodic outages of adequate length. The inspection results and maintenance activities/corrective actions will be documented and maintained electronically.

   **Scheduled Periodic Outage Inspections:**

   a. Inspect SDA Vessel and Thermocouple Chain for evidence of ash deposits. Remove/clean as necessary.

   b. Inspect the SDA inlet and Outlet Ductwork and Expansion Joints for corrosion or damage. Repair as necessary.

   c. Inspect slurry piping and tanks and clean as necessary.

3. The System Engineer or delegate will periodically inspect the SDA equipment during planned outages of sufficient duration. This includes SDA absorber vessel and associated ductwork, tank and piping internals, etc.

### B. CRITICAL SPARE PARTS

The System Engineer will identify the necessary spare parts to be maintained in stock for quick replacement.

The SDA Original Equipment Manufacturer also stores critical spare parts through an Assured Stock Program to minimize lead times and reduce system out of service durations.

## IX. RECORD KEEPING

A. MAINTENANCE

1. All maintenance activities (including preventative/predictive maintenance and maintenance related to malfunctions) related to the SDA system 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 at a minimum the last maintenance activity performed is retained.

2. 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.

3. Malfunctions of the *c*ontrol *e*quipment that is subject to the Mercury and Air Toxics Standard (MATS) and/or Consent Decree/ROP compliance reporting shall be documented in the appropriate log. Malfunctions that caused an exceedance of a MATS emission limit, as well as their appropriate corrective action, shall be included in the semi-annual reports.

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

B. OPERATIONS

1. Responses to critical alarms and corrective actions will be documented in electronic logs. Additionally, Operators should log the date and time of event and corrective action, applicable notifications / work orders, and if the control equipment was limited or did not adhere to the Unit's operating procedures.