KARN FACILITY
DE Karn 1 and 2 Plant

MAINTENANCE AND MALFUNCTION ABATEMENT PLAN
LOW PRESSURE HIGH VOLUME PULSE JET FABRIC FILTERS

April 2019
Revision 2

I. INTRODUCTION

A. SCOPE

This Maintenance and Malfunction Abatement Plan (MMAP) covers the monitoring, maintenance and operational requirements associated with the two (2) Low Pressure High Volume (LPHV) Pulse Jet Fabric Filters (PJFF's) that control particulate emissions from the boilers at the DE Karn 1 & 2 Plant. 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 and Karn's ROP (No. MI-ROP-B2840-2014c) Monitoring/Recordkeeping requirement pertaining to the installation of the PJFFs. Specifically addressed are the Rule 911 (R 336.1911) Malfunction Abatement Plans requirements and ROP condition III.1 and IV.1 for EUKARN1-S1 and EUKARN2-S1, which state that the PJFF shall be operated and maintained in accordance with an approved MAP.

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. The particulate emissions are control by a Low Pressure/High Volume Pulse Jet Fabric Filter System. Additionally, nitrogen oxide (NOx) emissions are controlled by the SCR, sulfur dioxide (SO_2) emissions are controlled by a Spray Dryer Absorber (SDA) system, and 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. The particulate emissions are controlled by a Low Pressure/High Volume Pulse Jet Fabric Filter System. Additionally, nitrogen oxide (NOx) emissions are controlled by low NOx burners and the SCR, sulfur dioxide (SO_2) emissions are controlled by a Spray Dryer Absorber (SDA) system, and mercury (Hg) emissions are controlled on an as needed basis by injection of activated carbon.

III. REGULATORY ANALYSIS

Karn boilers Nos. 1 and 2 each have the following Particulate Matter (PM) emission limits:

- 0.16 lbs /1000 lbs, of exhaust gas corrected to 50% excess air,
- 0.015 lb/MMBtu, and
- 0.030 lb/MMBtu

Both boilers are also subject to the State's opacity standard, Rule 301(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.

Each Unit utilizes a Continuous Opacity Monitoring System (COMS) for opacity compliance determinations and a PM Continuous Emissions Monitoring System (CEMS) for continuous PM compliance monitoring and/or compliance determinations.

IV. LOW PRESSURE/HIGH VOLUME PULSE JET FABRIC FILTER SYSTEM DESCRIPTION

One (1) dedicated PJFF is installed on each boiler at the Karn 1 and 2 Plant. The PJFF controls particulate emissions from each boiler. As flue gas leaves the boiler, it flows through the SCR and SDA, and then it 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 Unit ID fan for discharge to the atmosphere through the stack.

Each PJFF has 10 compartments that hold 1,016 bags per compartment, for a total of 10,160 bags; this provides a total cloth area of 320,950 sq. ft.

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 ash hopper. A rotating manifold/nozzle assembly is used to deliver the cleaning air pulse to the bags in each fabric filter compartment. A low-pressure positive displacement blower is used for the supply of clean air to pulse the bags.

The units are 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 silos.

The PJFF's are controlled and monitored from a central Distributed Control System (DCS), which records differential pressure readings and system alarms, along with other operational parameters.

V. OPERATION OF THE PJFF SYSTEM

A. START-UP

1. Leak Test

   Upon completion of the filter bag installation or during the initial startup, 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

   All new filter bags will be pre-coated 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. Optimization

   Pending any scheduled or unscheduled Unit outage of sufficient length, the PJFF system is to be inspected and repairs made for optimization as necessary. Ensure the PJFF is restored to proper operation prior to unit start-up.

B. OPERATION

1. Normal Operation

   In order to maintain a high level of effectiveness and efficiency, each compartment of the PJFF system will be operated as designed for Full Stream Operation, to the extent practicable, in accordance with the guidelines and instructions in the vendor manual, unless otherwise deemed appropriate based on operational experience or system conditions.

   The PJFF is required to be operated all times that the Unit it serves is in operation, consistent with the technological limitations, manufacturers' specifications, applicable Standard Operating Procedures (SOPs)/Emergency Operating Procedures (EOPs), good engineering and maintenance practices, and good air pollution control practices for minimizing emissions (as defined in 40 C.F.R. § 60.11(d)), as applicable, for such equipment and the Unit.

C. SHUT-DOWN

1. Normal Shut-down

   The Fabric Filter shut-down is integrated into the boiler shut down sequence by DCS initiation.

2. Emergency Bypass Shut-down

   This shut-down method is intended to protect the filter bags from upset conditions and/or minimize potential safety issues. It can be initiated manually by an Operator

from the DCS screen. Additionally, an emergency bypass shut-down will be automatically initiated when either of the two following conditions exists:

a. Fabric Filter inlet temperature is at the High-High set point for 10 minutes.

b. Fabric Filter inlet temperature is at the High-High-High set point for 3 seconds.

VI. PJFF MONITORING PARAMETERS

The PJFF operation is controlled and monitored from a central 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. EQUIPMENT TO BE MONITORED:

1. Differential pressure (Dp) gauges

   Differential pressure (Dp) gauges are installed on each of the ten (10) filter compartments and 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”. The cleaning set points for the fabric filter are based upon actual operating conditions. There are alarm set points for high and low Dp. Operators will investigate and respond to all alarms.

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 investigate and respond to all alarms.

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 investigate and respond to all alarms.

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, and a high-high-high set point will initiate flue gas bypass of the PJFF after a 3 second delay. Operators will investigate and respond to all alarms.

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. Operators will investigate and resolve all alarms; a spare blower will automatically start if the low pressure alarm is activated.

6. COMS / PM CEMS Alarms

The Unit Control Operators (UCOs) continuously monitor the COMS opacity values for trending opacity which may be an indication of PJFF operation. UCOs promptly respond to all COMS 6-minute average opacity alarms and log corrective actions. Additionally, UCOs have access to monitor the real-time PM CEMS values and promptly respond to all PM CEMS alarms.

VII. 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 DP cell 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 dampers; limit switches and actuators, where applicable.
Over filled hoppers	Check hopper levels for blockage of gas stream to bags

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 sensing lines & DP cell
Reduced gas volume	Check boiler load.

3. Dust detected in compartment

CAUSE	CORRECTIVE ACTION(S)
Incorrectly installed bag or bag failure.	Identify the module at fault by observing the broken bag detector indication on the DCS. Isolate that module and take corrective action.
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. Startup standby clean air blower.

VIII. PREVENTATIVE AND PREDICTIVE MAINTENANCE

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

1. The System Owner has designated responsibilities for determining and establishing predefined Maintenance Plans which optimize the operation of the equipment and maximize the PM emission reductions at all times the Unit is operating. 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 respective PJFF 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 PJFF 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 appropriately.

Scheduled Periodic Outage Inspections:

a. Check for signs of corrosion, moisture, or in-leakage to the Fabric Filter System

b. Check man ways, doors, dampers and expansion joints for leaks.

c. Inspect the condition of insulation and exterior of the unit.

d. Check access door gaskets. Repair or replace hard or deteriorated gaskets, as required.

e. Check for ash build-up on the tube sheet. Remove any accumulations and investigate the source of the leak.

f. Check operation and seating of all dampers. Check bolted parts and actuators.

g. Check for bag failure. Record type and location of failures.

h. 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.

i. Visually inspect all critical air instrument piping.

The Maintenance Lead will also ensure that at each planned Unit outage or unplanned outage of sufficient length, the PJFF system will be inspected for any failed PJFF baghouse compartments and failed bags will be replaced to the extent practicable to maximize collection efficiency.

B. CRITICAL SPARE PARTS

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

IX. RECORD KEEPING

A. MAINTENANCE

1. All maintenance activities (including preventative/predictive maintenance and maintenance related to malfunctions) related to the PJFF system at the Karn 1 and 2 Plant 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.

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 control equipment that is subject to compliance reporting shall be documented in the appropriate log.

B. OPERATIONS

1. A PJFF unit overview report will be recorded electronically every week when in operation. The overview report will contain all PJFF operating parameters at the time of the report generation. These weekly reports will be retained for a period of not less than 5 years.

2. 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 PJFF was limited or did not adhere to the Unit's operating procedures.