STARTUP, SHUTDOWN, AND MALFUNCTION PLAN

Michigan Public Power Agency

Kalkaska CT #1

1750 Prough Road
Kalkaska, Michigan

NTH Project No. 74-180093
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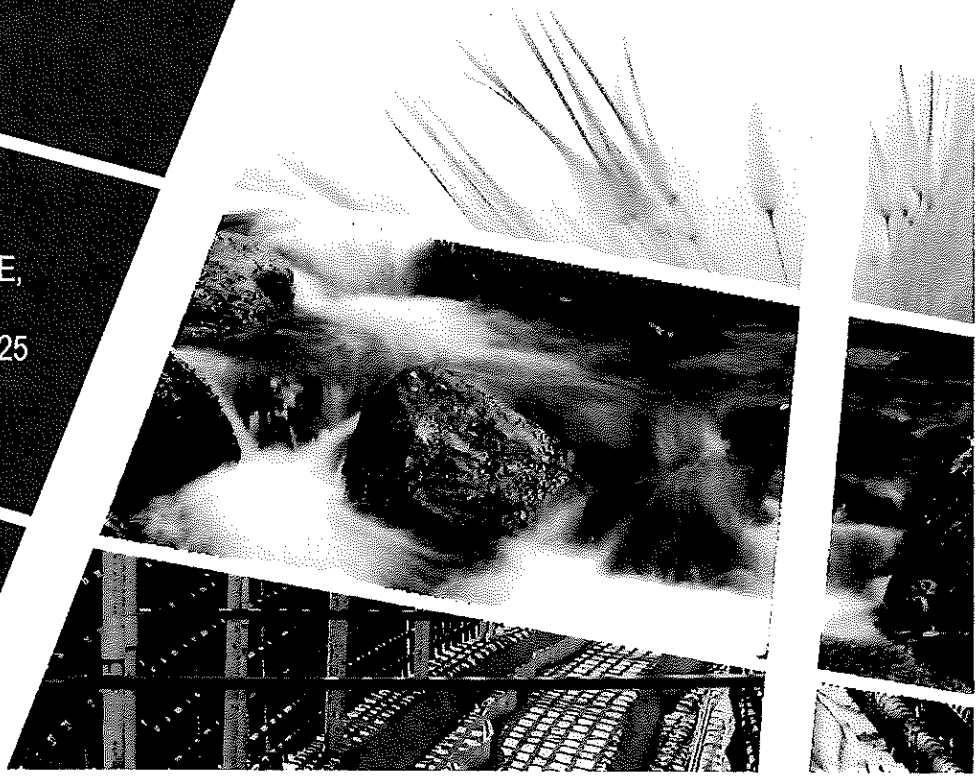

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1.0 INTRODUCTION

Michigan Public Power Agency (MPPA) owns Kalkaska CT #1, a natural gas-fired peaking plant located in Kalkaska, Michigan. Kalkaska CT #1 is a Pratt & Whitney FT8 TWINPAC™ that consists of two (2) natural gas-fired simple-cycle combustion turbines serving a single generator. The nominal gross output of each turbine is 27.5 megawatts (MW), for a combined nominal gross output of 55 MW. The turbines utilize water injection for nitrogen oxide (NO_x) emissions control. The plant is operated by Traverse City Light and Power (TCLP) under contract to MPPA.

Kalkaska CT #1 operates in accordance with Renewable Operating Permit (ROP) No. MI-ROP-N7113-2016a. Special Condition (SC) III.2 under flexible group FG-TURBINES requires MPPA to maintain a Startup, Shutdown, and Malfunction (SSM) Plan for operation of the turbines that describes how emissions will be minimized during startups, shutdowns, and malfunctions. The SSM Plan incorporates the following:

- Definitions of startup and shutdown
- Standard operating procedures for startup and shutdown
- Procedures recommended by the equipment manufacturer and standard industry practices
- Preventative maintenance program and corrective actions
- Recordkeeping and reporting requirements

Section 2.0 of this document outlines procedures to be followed during SSM events, and the recordkeeping and reporting requirements are listed in Sections 3.0 and 4.0, respectively.

2.0 PLAN PROCEDURES

During startup, shutdown, and malfunction events involving the turbines, plant personnel will follow the procedures in this document for proper operation to minimize emissions. The procedures in this document incorporate equipment manufacturer recommendations and standard industry practices to help ensure that:

- The turbines are operated and maintained in a manner consistent with good air pollution control practices during startup, shutdown, and malfunction events;
- Plant personnel are prepared to correct malfunctions as soon as it is safe and practicable, in order to minimize potential excess emissions; and
- The plant meets the recordkeeping and reporting requirements associated with startup, shutdown, and malfunction events (including documentation of corrective actions taken to restore malfunctioning process and air pollution control equipment to a normal manner of operation).

2.1 Startup and Shutdown Procedures

This section provides details regarding operation of the turbines during startup and shutdown. Startup and shutdown must be defined to identify applicability of emissions limits and proper operation of the turbines and water injection system.

Definition of Startup

Startup commences when fuel flow begins and ends 5 minutes after the commencement of water flow. Fuel flow normally begins within 2 minutes after the manual initiation of the startup sequence described below. Water injection for emission control begins when the exhaust gas temperature exceeds 900 °F, which typically occurs 8 to 10 minutes after the start of fuel flow.

An audible alarm sounds in the control room if water injection has not commenced 15 minutes after fuel flow has begun. The control operators must abort the startup within 25 minutes after the fuel flow begins if the water-to-fuel ratio (WFR) is insufficient. The maximum duration of a startup (for data flagging purposes) is 30 minutes.

Startup Procedures

The standard operating procedure (SOP) applied during startup follows the manufacturer's recommendations, which have been programmed into the data control system (DCS). The DCS is controlled by Citect® software and is intended to provide an automated sequence with little input from an operator. The following are the programmed sequence of events that occur after turbine startup has been initiated, as described in SOP:

1. Permissive control parameters are verified OK.
2. A start is initiated by an operator.
3. The turbine is activated using hydraulic power and brought up to 1,800 rpm.
4. The pipeline natural gas (PNG) supply is purged with air for a period of 120 seconds.
5. The PNG valve is opened and fuel flows to the combustion chamber.
6. The combustion chamber igniters are activated (the igniters are active for only 6 seconds).
7. If the turbine fails to ignite, the DCS closes the fuel valve and shuts the system down.
8. If the combustion chamber fires, the turbine then ramps to idle at a rate of approximately 1,000 rpm.
9. The turbine continues its ramp to sync-idle (~3,600 rpm) at the same rate.
10. Once sync-idle has been achieved and the unit is synchronized with the power grid, the main breaker closes.
11. The turbine is ramped to the load level preset by the operator.
12. Once the turbine has achieved an exhaust temperature of 900 ^{o}F to 925 ^{o}F, the water injection valve is opened, which automatically adjusts the pressure and flow rate of water into the combustion chamber based on that load.
13. If the WFR is insufficient at 15 minutes following commencement of fuel flow, an audible alarm occurs in the control room and the operator must identify and correct the problem.
14. If the WFR is still insufficient at 25 minutes following commencement of fuel flow, the operator must initiate the turbine shutdown procedures described below.

Definition of Shutdown

Shutdown commences with the initiation signal from the DCS (triggered by an operator or automatically due to system protection software in the DCS) and ends when fuel flow to the turbine has ceased. The maximum duration of a shutdown (for data flagging purposes) is 30 minutes.

Shutdown Procedures

Shutdown of the turbines is handled in a manner similar to that of startup; shutdown is initiated by an operator and carried out by the DCS. The following is the general shutdown sequence:

1. An operator initiates a stop.
2. The turbine is then ramped down at a rate between 1 and 50 MW per minute (preset by the operator, typically 5 to 10 MW per minute).
3. Once the turbine output drops below 2 megavolt amperes (MVA), the main breaker opens.
4. The water injection valve is then closed when the exhaust gas temperature drops below 900°F.
5. The turbine then switches to hydraulic power while the compressor continues to cool the turbine for 2-6 minutes. If the turbine is not cooled sufficiently after this period, another cool-down cycle is initiated (this process continues through as many as three (3) cycles).
6. The DCS closes the fuel valve.
7. The DCS shuts the system down. Note that the turbine blades will continue to spin for 45 minutes or more due to angular momentum. The oil pumps will continue to run during this period to prevent bearing damage.

Emergency shutdown procedures can be implemented automatically or by the operator due to the process control loops. An emergency shutdown will cut the fuel and water flow and trip the breaker immediately.

2.2 Malfunction Abatement

This section provides details regarding preventative maintenance, turbine and water injection system variables, and corrective procedures taken in the event of a malfunction at the turbines.

Preventative Maintenance Program

MPPA implements the preventative maintenance program, which is detailed within the inspection and maintenance schedule maintained on file at the facility. The schedule contains a description of the items or conditions that are to be inspected at a specified frequency and also

identifies major replacement parts to be kept in inventory for quick replacement. MPPA maintains a log of the inspection and maintenance activities for the turbines at Kalkaska CT #1. The on-site operator is responsible for overseeing the inspection, maintenance, and repair of the turbines and air cleaning devices.

Turbine and Water Injection System Variables

Turbine and control device operating variables are monitored by the DCS and used to detect a malfunction. Michigan Air Pollution Control Rule 113(a) defines "malfunction" as:

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

The normal operating ranges for key turbine operating variables and the water-to-fuel ratios for the water injection system based on the most recent stack test for the turbines are provided in Tables 2-1 and 2-2, respectively.

Table 2-1: Normal Operating Variables for the Turbines

Operating Parameter	Units	Unit 1A Range	Unit 1B Range
Compressor Discharge Pressure	psia	0 – 320	0 – 320
Exhaust Gas Temperature	°F	0 – 1,400	0 – 1,400
Ambient Temperature	°F	-20 – 104	-20 – 104
Water Injection Flow Rate	lb/hr	0 – 16,500	0 – 16,500
Water-to-Fuel Ratio	lb/lb	Refer to Table 2-2	

Table 2-2: Minimum Water-to-Fuel Ratio (April 2018)

Load (%)	Unit 1A		Unit 1B	
	Heat Input (MMBtu/hr)	Water-to-Fuel Ratio (lb/lb)	Heat Input (MMBtu/hr)	Water-to-Fuel Ratio (lb/lb)
70	222.3	0.944	230.8	0.955
80	248.0	0.999	256.5	0.996
90	270.6	0.985	284.0	1.006
100	305.2	1.081	312.8	1.091

Operational parameters are monitored with thermocouples, flowmeters, pressure gauges, and other devices; the monitoring data is transmitted to the DCS. The DCS notifies operators when operational parameters are outside of the optimal ranges. Alarms are reviewed by trained operators to determine the required action(s), if necessary, to continue operation of the turbines.

The alarm system allows for automatic shutdown of the turbines when normal operating variables are exceeded to prevent potential excess emissions and unit damage.

Response to Malfunctions

When operation of a turbine must continue during a malfunction event, plant personnel will document the reason(s) for continuing operation. If shutdown of the turbine(s) is necessary due to a malfunction, plant personnel will follow procedures related to abnormal or emergency shutdowns, as applicable.

3.0 RECORDKEEPING REQUIREMENTS

MPPA will maintain the current SSM Plan on site and will maintain records of startup, shutdown, and malfunction events in Kalkaska CT #1 logs. During an abnormal startup, shutdown, or malfunction, records of the event shall be recorded pursuant to Rule 912(5), including:

- The time and date
- Probable cause(s) of the event
- Event duration
- Equipment affected
- Estimated emissions from the event
- Corrective action(s) taken in response to the abnormal event

These records will be maintained by MPPA for 5 years, in accordance with the facility record retention policy.

4.0 REPORTING REQUIREMENTS

The following sections provide details of the state and federal reporting requirements related to the SSM Plan.

4.1 Notice of Abnormal Condition or SSM

Michigan Rule 912 requires that MPPA operate its source, process, or process equipment in a manner consistent with good air pollution control practices for minimizing emissions during periods of abnormal conditions, startup, shutdown, and malfunctions. A source, process, or process equipment that complies with all applicable emission standards and limitations during periods of abnormal conditions, startup, shutdown, and malfunctions shall be presumed to have been operated in a manner consistent with good air pollution control practices for minimizing emissions. However, there could be instances of equipment upset during a startup or shutdown, or an abnormal startup or shutdown not consistent with manufacturer specifications.

As outlined below, MPPA must provide notice to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality Division (AQD) including a written report of an abnormal condition, startup, shutdown, or malfunction which results in emissions of nitrogen oxide (NO_x) which continue for longer than 2 hours in excess of permitted limits.

Notice of an event should be by "reasonable means" including electronic, telephonic, or oral communication as soon as reasonably possible, but not later than two (2) business days after the event occurred. The telephone and fax numbers for EGLE Cadillac District Office are (231) 775-3960 and (231) 775-4050, respectively.

A written report, using the SSM form in Appendix A, or a similar format, must also be certified and submitted to EGLE within 10 days after the startup or shutdown occurred, within 10 days after the abnormal conditions or malfunction has been corrected, or within 30 days of discovery of abnormal conditions or malfunction, whichever is first. The written report shall include the required information, as follows:

- Time, date, duration, and probable cause, or reason for, the abnormal condition, startup, shutdown, or malfunction
- An identification of the turbine or associated equipment, including the water injection system (source, process, or process equipment) that experienced abnormal conditions, was started up or shut down, or which malfunctioned, including, where known or where it is reasonably possible to estimate, the quantity or magnitude of NO_x emissions in excess of permitted limits
- Description of the measures taken, and air pollution control practices followed to minimize emissions
- Summary of corrective actions taken to correct and to prevent a reoccurrence of the abnormal condition/ malfunction and the time taken to correct the malfunction

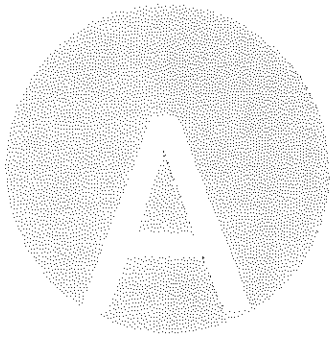
Pursuant to 40 CFR §60.334(j)(1), semi-annual excess emissions and monitor downtime reports must be submitted in accordance with 40 CFR §60.7(c) for the turbines and associated monitoring systems for all periods of unit operation, including periods of startup, shutdown, and malfunction.

5.0 PLAN REVISIONS

The SSM Plan will be revised, as needed, if it is determined that the plan:

- Does not address a startup, shutdown, or malfunction event which has occurred
- Fails to provide sufficient operational procedures for each turbine and water injection system to operate in a manner consistent with the general duty to minimize emissions during startup, shutdown, and malfunction events
- Inadequately addresses provision for correcting turbine and water injection system malfunctions.

APPENDIX



// SSM Report Form

(DATE OF REPORT)

EGLE - Air Quality Division
Cadillac District Office
120 W. Chapin Street
Cadillac, MI 49601

Re: NO_x Excess Emissions During SSM Events
Michigan Public Power Agency (MPPA) Kalkaska CT#1
ROP No. MI-ROP-N7113-2016a

This report is submitted to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality District (AQD) pursuant to Michigan Air Pollution Control Rule 912 in response to an abnormal condition, startup, shutdown, or malfunction that results in emissions of NO_x which continue for longer than two (2) hours in excess of the permitted limits.

Identifying Information:	
SSM Event # (YY-###):	
Process Unit:	
Equipment ID:	
Phone:	
Fax:	

Event Details (Description of Event and Date/Time):						
Event was a:	Startup		Shutdown		Malfunction	
Date/Time of Event	Start:		End:			
Description of the event and Probable Cause:						
Magnitude of NO_x emissions in excess of permitted limits:						
Response/Corrective action taken:						
Reason(s) for not following the SOP, if applicable:						
Suggested measures to prevent reoccurrence of malfunction:						
Suggested SSM Plan/SOP revision or improvement:						