Malfunction Abatement Plan

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1. Project Description

The Cadillac Renewable Energy facility is a 40MW single train wood-fired electric generating plant located in Vanderjact industrial park, in Cadillac Michigan.

The generating plant consists of one steam generator equipped with a travel-grate stoker, one condensing steam turbine generator, one condenser, two Feedwater heaters, a cooling tower, electrostatic precipitator, electrical distribution system, and instrumentation and control systems.

The super heated steam from the boiler is routed to the steam turbine generator, which is designed with two uncontrolled extractions to supply steam for deaeration and condensate heating.

Exhaust steam from the steam turbine will be condensed in the surface condenser with a design operating pressure of 2.0 HgA. The resulting condensate will be pressurized, heated, deaerated, and routed back to the boiler for reuse. The circulating water leaving the condenser will be cooled in a multiple-cell cooling tower and pumped back to the condenser.

Hot flue gas from the steam generator will be used to preheat the combustion air in the bare tube heater.

After leaving the preheater, the flue gas will be stripped of particulate matter by a multiple clone dust collector followed by a electrostatic precipitator. The cleaned flue gas will be discharged to the atmosphere through the stack.

Fuel is received from semi-trailer trucks. After weighing in at the scale house, the trucks dump their wood fuel load by mean of a back –in tilt trailer dump.

The as received wood is screened and resized as necessary in order not to exceed the boiler maximum fuel resizing criteria.

After screening, the fuel is conveyed to an outdoor fuel storage area. From the fuel storage area the fuel is conveyed to the boiler, where it is feed into the furnace by variable feed screw feeders.

The plant is controlled by a system of local instrumentation and a central programmable controller. The system allows the plant to operate down to about 50% rated electrical output.

2. Continuous Emissions Monitoring System (CEMS)

a. Description

The Continuous Emissions Monitoring System is supplied by Custom Instrumentation Services Corporation (CISCO) and is designed to monitor the flue gas for Oxygen (O2), Carbon Monoxide (CO), Oxides of Nitrogen (NOx), and Opacity.

O2 analysis is accomplished through a Servomex Paramagnetic analyzer and has a full-scale range of 0-10%/ 0-25%.

CO analysis is accomplished through a Siemens Ultramat Non-Disperative Infrared (NDIR) analyzer and has a full-scale range of 0-1000 / 0-5000 ppm.

NOx analysis is accomplished through a Beckman Chemiluminescent analyzer and has a range of 0-250/ 0-1000 ppm.

Opacity analysis is accomplished through a DURAG D-R290 Compliance monitoring system. A transceiver and retro reflector are mounted 180º apart on the stack. A control unit located in the analysis rack generates a signal proportional to 0-100% opacity.

The samples are then transported to a shelter via heated sample lines that maintain the sample temperatures for proper conditioning. The samples pressure and flow are then regulated before being supplied to the analyzers for analysis. Automatic calibration is also included and performed on the O2, CO and NOx analyzers every 24 hours. During calibration the actual analyzers values are recorded by the system. A data acquisition system is located in the control room to collect and store all data and generates the

required reports. Analog and digital information is supplied to the DARS by the CEMS via a serial communication link with the PLC. A mounted CRT displays real time data, while a printer generates reports.

b. Maintenance/Inspections

CEMS SUMMARIZED SCHEDULED MAINTENANCE
CADILLAC RENEWABLE ENERGY

Maintenance Item	MONTHLY	QUARTERLY	SEMI-ANNUAL	ANNUAL
Exercise Flow meters	X			
Exercise Pressure Regulators	X			
Exercise System Alarms	X			
Change Sample Filters		X		
Change Primary Inst. Air Filters		X		
Change Sec. Inst. Air Filters		X		
Check/ Clean/Replace A/C Filters		X		
Check/Clean/Replace Probe Filter Gasket		X		
Check/Replace Probe O-Rings		X		
Check/Change Filter Holder Seal			X	
Clean Heated Sample Line				X
Change Air Dryer Desiccant Towers				X
Replace Membrane Element				X
Check/Replace Dryer/Scrubber Flow Lines				X

c. Operation

The CEMS is designed to operate with minimal operator intervention on a continuous basis. The system was properly set up and is designed to compensate for most plant operational changes. The operators primary responsibility is to monitor the various indicators and changes or drifts as this could be an indication of a problem or component failure.

2.4 Critical Criteria

Monitoring and Reporting

The operational parameters for the critical criteria are not requirements of the air use permit, however they are requirements for status of critical areas within the system. These areas are as follows; monitoring equipment shelter temperature, shelters smoke alarm, sample line temperature, probe power, sample water alarm, power fail alarm, instrument air pressure alarm, and bath temperature alarm.

A copy of the CEMS start up and shut down procedure is provided as attachment

2.5 Abnormal Conditions or Malfunctions

1. Analyzer of DARS failure

2. Monitor Failure/Malfunction

3. Exhausted calibration bottle

4. CEMS will not Calibrate

2.6 Abatement Measure

1. In the event of an analyzer or DARS failure the Plant Manager as well as the Operation & Maintenance Supervisor shall be notified.

2. If the DARS cannot collect data the readings can be taken directly from the monitors in the CEMS shelter every 30 minutes until the problem is corrected.

3. If a monitor fails and the plant has been stable with acceptable emissions then maintain current status until the monitor can be repaired.

4. During situations of exceeding emissions and a monitor failure exists then the plant load must be reduced to an acceptable level in order to comply with emission limits.

From past experience, under normal operating conditions it can be assumed that emissions are in compliance if. When at full load:

a. Steam flow is at or below 320 kpph

b. Boiler O2 is at or above 2%

c. Undergrate flow is at or above 180 kpph

d. Over Fire Air flow is at or above 300 kpph

e. Reduced load 14 mw

f. Steam flow at or below 160 kpph

g. Undergrate air flow at or above 90 kpph

h. Boiler O2 at or above 7.0%

i. Over Fire Air flow at or above 150 kpph

j. If NOx indication is lost the output of the pump controller can be locked in manual at 30 gph.

2.7 Standard Operating Procedure/ Spare Parts

See Appendix

3. Electrostatic Precipitator

3.1 Description

The electrostatic precipitator is custom designed by Research Cottrell to maintain particulate matter emissions at or below limits as specified in the facilities Air Use Permit. The major equipment included are as follows; Transitions Sections, Flue Gas Treatment Area, Three High Voltage Transformer-Rectifiers, Discharge Electrodes, Collector Electrodes, Electrode Rappers, Penthouse, Hoppers, Ash Removal Conveyor, Interlocks/ Safeties and, Electrical Controls.

Flue gas enters the transition sections, which are located between the precipitator inlet and the flue gas treatment area. The exiting flue gas is evenly distributed thought the gas treatment area. The flue gas treatment area consists of collecting and discharge electrodes that impart a charge on each flyash particle. The charged particles are then attracted to the collecting electrodes. The collector plates also contain baffles that produce a stagnant zone adjacent to the plate surface to improve collecting and reduce re-entrainment.

A magnetic impulse gravity impact (MIGI) drop hammer is used to clean both collecting and discharge electrodes. The devise uses heavy-duty solenoids to lift the hammer and drop it onto the electrode hanger. The impact causes fly ash that has accumulated on the electrode to fall into the hopper. Screw conveyors then remove the ash from the trough hoppers and deposit it the ash distribution conveyor. The ash

distribution transfers the fly ash to be conditioned and properly stored in an ash storage building.

The precipitator is fully accessibly to allow personnel to perform inspections, routine and scheduled maintenance, and tests. Access doors provide entry to hot sections of the roof, high voltage compartments, hoppers, and the inlet and outlet transitions. To prevent personnel from entering the high voltage areas of the precipitator while it is energized, safety key interlocks have been provided. Danger signs are also installed to inform all operations and maintenance personnel of the high voltage conditions inside the equipment when energized.

3.2 Operations

The precipitator is operated by the manufacturer's recommendations and plant operations procedures. The precipitator controls are pre set to allow for optimum power levels for maximum collection efficiency. Operations consist of simply turning on the precipitator controls in the correct sequence when process conditions are suitable. The precipitator operation varies constantly with changing gas conditions. Therefore the operator frequently compares current reading with prior operating records for similar boiler loads and fuel consistency.

3.3 Critical Criteria

The operational parameters for the critical criteria are not requirements of the air use permit but are requirements for safe operating conditions. The ESP controls the final particulate emissions from the plant and operates in a manner to satisfy the following.

a. Particulate emissions from the ESP shall not exceed limits as stated in the Air Use Permit #373-86B

b. Visible emissions from the ESP/Ash Hopper shall not exceed the limits as stated in Air Use Permit #373-86B

c. Inlet dust loading shall not exceed the manufacturers limit of .75 gr/dscf @ 12%CO2

d. Outlet loading shall not exceed the manufacturers limit of .0092 gr/dscf @ 12% CO2

e. Flue gas temperature entering the ESP shall not exceed 360º

f. ESP shall not be operated with greater than 10% O2

A copy of the ESP startup and shutdown procedure is provided as attachment

3.4 Maintenance/ Inspection

PRECIPITATOR SUMMARIZED SCHEDULED MAINTENANCE

CADILLAC RENEWABLE ENERGY

INSPECTION	CONTINOUS	DAILY	WEEKLY	SEMI-ANNUAL
1. Maintain fuel gas temperature, O2, and combustible carry-over within design ratings	**X**			
2. Respond promptly to alarms	**X**			
3. Make visual inspections of critical components	**X**			
4. Record rectifier data				
5. Check operation of hopper operation		**X**		
6. Check precipitator control		**X**		

	room ventilation				
7.	Check operation of rapper systems		**X**		
8.	Check seal air system			**X**	
9.	Check calibration of level detectors, flows switches, pressure switches, and motion detectors			**X**	
10.	Simulate and check alarms from rappers, transformer-rectifier controls, and other equipment with alarm output				**X**

3.5 Abnormal Conditions or Malfunctions

a. Faulty Sensor

b. Precipitator Fire

c. ID Fan Trip

d. TR Failure

e. Rapper Failure

f. Hi O2

3.6 Abatement Measures

a. Faulty O2 sensor

2. If O2 sensor fails high the precipitator will be brought off line automatically

3. Notify Plant Manager and Operations and Maintenance Supervisor.

4. Reduce load until emissions are within acceptable limits

5. Repair faulty sensor

b. Fire in precipitator

1. A fire or explosions will occur when there are three conditions met simultaneously.

a. Combustible material is present.

b. Sufficient oxygen to support combustion

c. A source of ignition.

Note: Combustible material and source of ignition are present at all times when plant is on line. To extinguish a fire you must reduce oxygen levels in the flue gas below 4%.

2. Reduce Over Fire Air and Forced Draft Fan output

3. Ensure all precipitator rappers are working including hopper rappers.

4. Empty all hoppers of fly ash.

5. If this fails to bring O2 levels below 4% the plant must be brought off line in accordance with SOP 12.0

3.7 Standard Operating Procedure/Inventory

See Appendix

4. Selective Non-Catalytic Reduction System (SNCR)

Description

The SNCR system used by Cadillac Renewable Energy is a **NOxOUT A** system designed and manufactured by Nalco Fuel Tech. The system incorporates a Dry Reagent Mixing Tank, Liquid Reagent Storage Vessel, Circulation Module, Metering Module, Distribution Module, and Injectors and Atomizing Modules.

Dry reagent is mixed in a 1000 gal. Mixing tank. The tank consists of a mixer, heater and associated transfer pump. After the reagent is properly mixed it is transferred to a 12000 gal. liquid storage tank.. The circulation module mounted at the storage vessel serves two purposes. The primary purpose is to supply NOxOUT A to the metering module. Its secondary purpose is to maintain the chemical solution at 80ºF though constant circulation. The metering module is a skid-mounted unit used to supply mixed NOxOUT A to the Distribution Modules. The mina control for the Metering module is provided by Local Control Panel or through DCS control. Mixed NOxOUT A is transported from the Metering Module to the appropriate Distribution Module, which directs to one of the 10 injectors. The Injectors consists of atomizing chambers in which the NOxOUT A mixture and the air firsts combine. The atomized chemical then flows to the injector nozzle, then enter the boiler and mixes with the flue gases to form Nitrogen, Carbon Dioxide, and water.

Operation

The NOxOUT A system is operated by the manufacturer's recommendations and plant operations procedures. The NOxOUT A system controls are set to allow for optimum power levels for maximum NOx conversion and minimum chemical injection. The operator can manually control the output of the reagent flow pump or set the system to control NOx emissions from the stack to less than .1500 lb/mmbtu. This can be accomplished from the DCS or at the Control Module skid.

Critical Criteria

The operational parameters for the critical criteria are not requirements of the air use permit but are requirements for safe operating conditions. The NOxOUT A System controls the final NOx emissions from the plant and operates in a manner to satisfy the following.

a. Atomizing/Cooling air pressure greater than 20 psi

b. NOxOUT chemical flow rate does not fall below 10 gph for more than 10 seconds.

c. Dilution water flow does not fall below 2 gpm. For more than 10 seconds.

d. Liquid reagent storage tank must not fall below 10%

e. The circulation pump flow must be greater than 5 gpm.

f. Must maintain NOx emissions within the limits of the air use permit.

4.4 Maintenance/Inspections

NOx OUT SYSTEM SUMMARIZED SCHEDULED MAINTENANCE

CADILLAC RENEWABLE ENERGY

Maintenance Item	Continuous	Weekly	Monthly	Semi-Annual
1. Inspect distribution module flow and atomization	**X**			**X**

pressure and properly log				
2. Respond promptly to alarm	**X**			
3. Make visual inspections of critical components	**X**			
4. Remove and clean injectors		**X**		
5. Inspect injector orifices		**X**		
6. Complete system general inspection			**X**	
7. Drive housing oil change			**X**	
8. Check calibration of level detectors, flow switches.				**X**
9. Remove and clean strainers			**X**	

Abnormal Conditions or Malfunctions

a. Restricted Injector Orifice

b. Pump Failure

c. Loss of Power at control Panel

d. Sensor Failure

e. Failed check valve

f. Low atomizing air pressure

g. Inclement weather conditions with temperatures <0 degrees can cause system piping to freeze.

4.5 Abatement measure

1. In the event of a system failure the Plant Manager as well as the Operation & Maintenance Supervisor shall be notified.

2. If the pump fails or there is a loss of power first check the thermal overloads and fuses. If this does not resolve the issue, then switch to the standby system either unit “A” or “B”.

3. Reduce dispatch level down to a minimum of 10 MWh until system is restored to normal operations.

4. Adjust atomizing are pressures to maintain proper Urea flow.

5. If ambient temperatures drop <0 the NOx system piping system will be checked for freezing every two hours.

During situations of exceeding emissions and a total system failure exists then the plant load must be reduced to an acceptable level in order to comply with emission limits.

4.6 Standard Operating Procedure/Inventory

See Appendix

5. Mechanical Dust Collector

5.1 Description

The mechanical dust collector is manufactured by Zurn Air Systems. It is designed for first stage particulate removal and protection of the I.D. fan. The dust collector has no moving parts and consists of inlet and outlet tubes, inlet guide vanes, hopper, and an ash

removal system. The mechanical dust collector is designed to operate at 325 ºF with a design pressure drop of 2.5 in. w.g. The collection efficiency is rated at 80%.

5.2 Operation

Gases enter the collector through the inlet section and flow to an annular area between the inlet and the outlet tube. As the gases flow downward through the spinner vanes they reverse direction and flow upward through an inner tube and out of the collector. The combination of centrifugal force created by the spinning of the gases and the action of gravity when the flow is reversed separates the dust particles, and they fall into the hopper.

5.3 Critical Criteria

The operational parameters for the critical criteria are not requirements of the air use permit but are required for safe and efficient operation of the mechanical dust collector.

b. There should be no leaks in the casing from outside to inside.

c. Collected material should never be allowed to completely fill the hopper.

d. Prevent draft loss and leakage of air into the hopper zones through the flanges.

e. Collector temperatures do not exceed 325º F.

f. The pressure drop across the collector does not exceed 2.5 in, w.g.

5.4 Inspection/Maintenance

MECHANICAL DUST COLLECTOR SUMMARIZED MAINTENANCE
CADILLAC RENEWABLE ENERGY

5.4 Abnormal Conditions and Malfunctions

a. Hopper Bin Level Hi

b. Differential Pressure High

5.5 Abatement Measures

h. If Dust Collector hoppers fill up to the cyclones, shut down the boiler in accordance with the plant procedure SOP12.0.

i. If differential pressure is high 5.0 in w.g., shut down the boiler in accordance with the plant procedure SOP 12.0.

5.6 Standard Operating Procedure/Inventory

See Appendix

6.0 Steam Generator (Boiler)

6.1 Description

Zurn Industries Inc manufactures the steam generation system. Major steam generator components are Boiler Drums, Travel Grate Stoker, Steam Purifier, Furnace, Superheater, Economizer, Air Preheater, Soot- blowers,

j. Boiler Drums: There is one steam drum and one lower drum. The drums are fusion welded, stress relieved, and radiographed.

k. Travel Grate: The unit consists of a dual type travel grate with front ash discharge with an effective grate area of 602.3 Sq. Ft. The grates are capable of

being adjusted from0 to 24 feet per hour for maximum efficiency of the combustion.

l. Deaerator: The Deaerator consists of distribution baffles; vortex separators and chevrons designed to limit dissolved solid carryover.

m. Furnace: The furnace is of welded wall construction., and provides adequate water holding capacity, providing high heat absorption and stability during load changes.

n. Superheater: There is one pendant type superheater designed to raise the temperature of the steam to the desired design temperatures of the wood fired boiler.

o. Economizer: The entire economizer is supported in a structural steel frame and enclosed within 10 gauges material.

p. Air Heater: The air heater is of tubular type and is supported in a structural steel frame and enclosed within a 10 gauge welded steel casing

q. Soot Blowers: The Sootblowers are a combination of retractable and rotary operated. Sootblowers are designed to maintain boiler efficiency and capacity by the periodic removal of ash and slag from the heated surfaces. The sequence of operation is readily changeable from the control panel or DCS.

6.2 Operation

The steam generator and its associated auxiliary equipment are operated by a properly trained staff through a distributed control system in accordance with the manufacturer's recommendations and plant standard operating procedures. Please refer to Boiler SOP

6.3 Critical Criteria

The operational parameters for the critical criteria are not requirements of the air use permit but are requirements for safe operating conditions. The efficient operation of the steam generator system controls the final CO, NOx, Particulate, and emissions and Opacity indications from the plant. The steam generator and associated auxiliary equipment operates in a manner to satisfy the following:

a. Fuel distribution system is in operation.

b. Maintain proper water supply and levels.

c. Maintain an even fuel bed and keep minimum amount of air for good combustion.

d. Do not exceed maximum continuous rating of 334,085 pounds of steam /hr, 1075 psig drum pressure.

e. Cooling water system is in operation.

f. Ash handling system is in operation.

g. Chemical injection system is in operation

h. Steam turbine generator and electrical distribution systems properly aligned.

6.4 Inspections/Maintenance

STEAM GENERATOR SUMMARIZED MAINTENANCE
CADILLAC RENEWABLE ENERGY

6.5 Abnormal Conditions

a. Hi NOx

b. Hi CO

c. Hi Opacity

d. Fuel Feed System Trip

e. Boiler Feed Water Pump Trip

f. Combustion Air Fan Trip

g. Grate Drive Failure

h. Boiler Tube Failure

i. Ash Handling System Trip

j. NOxOut System Malfunctions

k. Changes in Fuel Quality

6.6 Abatement Measures

a. Hi NOx

1. Increase Urea output.
2. Open bottom front Over Fire Air damper on the Boiler.
3. Open bottom back Over Fire Air damper on the Boiler.
4. Decrease the Forced Draft Fan damper.
5. Notify the O&M Supervisor and Plant Manager.
6. Reduce the Plant load to such a point where the NOX is in compliance with the limits of the permit.

b. Hi CO

1. Open middle and top Over Fire Air dampers on the Boiler.
2. Increase the Over Fire Air Fan damper.
3. Reduce the Wood Master Bias.
4. Switch the intake air damper to outside air.
5. Notify O&M Supervisor and Plant Manger.

c. Opacity Control

1. Verify Precipitator operation.
2. Notify O&M Supervisor and Plant Manger.
3. Shut down the Plant.

d. Fuel Feed System Trip/Malfunction

Reclaimer failure

1. Start Standby Reclaimer
2. Boiler Feed Conveyor trip
3. If problem cannot be resolved immediately, start reducing the plant load.
4. If problem cannot be resolved within 10 minutes, start the Gas Burner in accordance with Plant procedure SOP 26.0

Cross Feed Conveyor

1. If problem cannot be resolved immediately, start reducing plant load.
2. If problem cannot be resolved within 10 minutes, start the Gas Burner in accordance with Plant procedure 26.0

Boiler Feedwater Pump Trip/Malfunction

1. Start standby Boiler Feed water Pump.

2. Reset breaker.
3. Set Fan damper output to 0%.

Combustion Air Fan Trip

1. Start Fan.
2. Increase Combustion air as needed to control emissions.
3. Start Wood feeders.
4. Bring Plant up to normal operating load.
5. If Combustion Air Fan can not be restarted, Shut boiler down in accordance with Boiler Shut down portion of this procedure.

Grate Drive Failure

1. Use Wood Feeder Bias to reduce the amount of fuel on the stalled grate.
2. Increase Combustion Air as required to control emissions.
3. If necessary start the Gas Burner in accordance with Plant procedure 26.0 to aid with emission control.

Boiler Tube Failure

1. Shut down Boiler.

Ash Handling System Trip/Malfunction

Bottom Ash Conveyor

1. If problem cannot be resolved within two hours shut down the Boiler in accordance with the shut down portion of this procedure.

Fly Ash system

1. If the problem cannot be resolved by the time the Dust Collector Hopper high alarm comes in, start reducing the plant load.
2. After one hour at reduced load the Fly Ash system is still out of service, start the Gas Burner in accordance with Plant procedure 26.0 and secure the Wood Feeders.

Char Re-injections Plugged

1. After one hour, one or more Char re-injections are still plugged, start reducing plant load.
2. If the plugged re injections can not be cleared, shut the Boiler down in accordance with this procedure

NOxOUT System Trip/Malfunction

Pump Failure

1. Replace pump.
2. Increase pump output to bring NOx emissions back in limits of permit.

NOx system piping restriction

1. Clean piping in accordance with Plant procedure SOP 29.0

NOx Control System Failure

1. Reduce plant load to a point where NOx can be maintained within the limits of the emissions permit with out using Urea injection. Maintain reduced load until the Control system is back in service.