Example Electrostatic Precipitator Agency O&M's

Below are two examples of Agency Approved Operation and Maintenance (O&M) Plans for an electrostatic precipitator. Examples of monitoring techniques which are used to evaluate electrostatic precipitator performance may be found in the "Electrostatic Precipitator Periodic Monitoring Literature Review" located at the end of this document.

Example 1

Monitoring Guidelines

The facility makes a commitment to take timely corrective action during periods of excursion where the indicators are out of range. A corrective action may include an investigation of the reason for the excursion, evaluation of the situation and necessary follow-up action to return operation within the indicator range**.** An excursion is determined by the averaged discrete data point over a period of time. An excursion does not necessarily indicate a violation of an applicable requirement. If the corrective action measures fail to return the indicators to the appropriate range, the facility will report the exceedance to the department and conduct source testing within 90 days of the exceedance to demonstrate compliance with applicable requirements. If the test demonstrates compliance with emission limits then new indicator ranges must be set for monitoring and the new ranges must be incorporated in the operating permit. If the test demonstrates noncompliance with emission limits, then the facility, within 60 days, proposes a schedule to implement corrective action to bring the source into compliance and demonstrate compliance.

Monitoring Methods & Corrective Actions

General

- Periodic Monitoring is not required during periods of time greater than one day in which the source does not operate.

Continuously

- Opacity Monitoring
  Corrective action measures will be implemented when the opacity exceeds [*insert value*] percent for any six (6) minute average. The appropriate measures for remediation will be implemented within eight (8) hours plus the period of time required to shut down the process without damaging the process equipment or control equipment. **OR** The appropriate measures for remediation will be implemented within eight (8) hours plus the period of time until generating capacity is available to meet consumer demand. *[Chose the appropriate statement above, and delete the other]*

- Audible Precipitator Malfunction Alarm
  The precipitator malfunction alarm will continuously monitor T-R set failure and rapper control malfunction. Corrective action measures will be implemented on the occurrence of a precipitator malfunction alarm. The appropriate measures for remediation will be implemented within eight (8) hours plus the period of time required to shut down the process without damaging the process equipment or control equipment. **OR** The appropriate measures for remediation will be implemented within eight (8) hours plus the period of time until generating capacity is available to meet consumer demand. *[Chose the appropriate statement above, and delete the other]*

Daily
- Inspection of rapper operation
- Inspection of T-R set operation
- Inspection of ash removal system operation

Corrective action measures will be implemented on the occurrence of an abnormal condition. Abnormal conditions will include the following: a T-R set failure, rapper system failure, ash transport system failure, and high ash hopper level. The appropriate measures for remediation will be implemented within eight (8) hours plus the period of time required to shut down the process without damaging the process equipment or control equipment. **OR** The appropriate measures for remediation will be implemented within eight (8) hours plus the period of time until generating capacity is available to meet consumer demand. *[Chose the appropriate statement above, and delete the other]*

Each Major Unit Overhaul
- Check and correct plate electrode alignment
- Inspect for collection surface fouling
- Inspect T-R set mechanical condition
- Inspect internal structural components

Corrective action measures will be devised and implemented on the occurrence of an abnormal condition. The appropriate measures for remediation will be implemented in a timely manner.

Record Keeping and Reporting
- Opacity reports and supporting data
- Maintain a written or electronic record of all inspections and any action resulting from the inspection.
- Maintenance and inspection records will be kept for five (5) years and available upon request.

Quality Control

- The continuous opacity monitor will be automatically calibrated for zero and span adjustments daily.
- All instruments and control equipment will be calibrated, maintained, and operated according to the manufactures specifications.
- A spare parts inventory is maintained by a computerized inventory management system. Parts are automatically queued for re-order when the inventory level falls below a minimum re-order point.

Example 2

Electrostatic Precipitator Operation & Maintenance

MONITORING GUIDELINES

The facility makes a commitment to take timely corrective action during periods of excursion where the indicators are out of range. A corrective action may include an investigation of the reason for the excursion, evaluation of the situation and necessary follow-up action to return operation within the indicator range. An excursion is determined by the averaged discrete data point over a period of time. An excursion does not necessarily indicate a violation of an applicable requirement. If the corrective action measures fail to return the indicators to the appropriate range, the facility will report the exceedance to the department and conduct source testing within 90 days of the exceedance to demonstrate compliance with applicable requirements. If the test demonstrates compliance with emission limits then new indicator ranges must be set for monitoring and the new ranges must be incorporated in the operating permit. If the test demonstrates noncompliance with emission limits, then the facility, within 60 days, proposes a schedule to implement corrective action to bring the source into compliance and demonstrate compliance.

START-UP PRACTICES

The following ESP start-up procedures shall be used during plant re-start activities:

A) When preparing for start-up, assure that all tools and safety devices (including lock out/tag out) have been removed from or taken off of the controls of the ESP. The plant superintendent or his designated representative shall be responsible for final inspection of the ESP to determine that the unit is ready for start-up.

B) During the final pre-start-up inspection, the inspector shall assure that the ESP has been properly closed up and the keys for the interlock system have been returned to their appropriate locations.

C) Conduct an air load test for each T-R set and if possible, for each bus section. This activity is used to determine that maintenance has been completed, all foreign matter has been removed and that the ESP is ready for operation.

D) If the insulator heaters have been inspected during the shut-down, make sure that they have been turned back on at least 2 - 12 hours prior to ESP start-up. Purge air systems will also be activated at this time. Be aware of the potential for particulates to pass through the system and be emitted to the atmosphere when the purge air is activated.

E) The rapping system will be in operation during start-up to remove any settled dust.

F) Energize the ESP according to procedures established during previous plant turnarounds.

SHUTDOWN PRACTICES

Except in the instance of an emergency shutdown, this process should be essentially the reverse of the start-up procedure.

A) Deenergization usually begins at the inlet fields and progresses toward the outlet. At the point that the boiler is off-line, the fields (T-R sets) should be deenergized. This should be done sequentially toward the ESP outlet and as quickly as possible to prevent unnecessary sparking, condensation or insulator build-up.

B) The rappers should be allowed to operate for several hours to remove residual dust.

OPERATIONS

Routine Operations

Daily operating requirements include parameter monitoring and recordkeeping (hourly recording of voltage and amp levels during ESP operations), preventative maintenance, evaluation of applicable data for malfunctions and response to any malfunctions. The appropriate measures for remediation will be implemented within eight (8) hours plus the period of time required to shut down the process without damaging the process equipment or control equipment. **OR** The appropriate measures for remediation will be implemented within eight (8) hours plus the period of time until generating capacity is available to meet consumer demand. *[Chose the appropriate statement above, and delete the other]*

Preventative Maintenance

A) Daily inspection and maintenance - This activity will be a follow up to the hourly recording of voltage and amp levels at the ESP and observation of other relevant operating data. A review of several of the hourly data sets will give the inspector an indication of any abnormal conditions. If the operating voltages or amperages of any of the ESP fields show considerable variation, the inspection should focus on identifying a cause for reading fluctuations. The following items will be checked during a routine daily inspection:

1. Operation of the dust discharge system: All conveyors, airlocks, valves and other associated equipment should be operating so that ash removal is continuous.

2. Vacuum system: Check vacuum gauges. This gauge will be used as a reference during ash and dust removal with the ash equipment system (ash removal occurs 3 times per day).

3. Check indicator lights on the hopper level alarm system.

4. Check hopper access doors for air leaks or dust discharge.

5. If possible, check the operation of each rapper.

6. Check for air leaks around the ESP.

7. Check for sparking or arcing in the T-R high voltage bus duct and localized sparking (usually reflected by T-R readings).

B) Weekly inspection and maintenance - Begin this activity with a review of the daily and/or shift inspection data. Any apparent adverse trends in operating parameters need to be noted and a determination made as to whether or not an operating procedure needs changing or maintenance/repair is necessary. This review will also confirm that all requested or required maintenance has been completed or scheduled. Weekly operating data will be checked and compared to normal/baseline values. Physical inspection of the ESP will include:

1. Check, clean or replace T-R cabinet air filters. Also check circuit boards and heat sinks for dust build-up and clean if necessary.

2. A thorough check of rapper operation will be conducted. Each rapper or rapper system should activate. Those that do not will need to be scheduled for repair or replacement.

3. Changes in rapper operating parameters can be made at this time. All new settings need to be recorded and special attention paid to performance during the following week.

4. Check the operating temperature and oil level in the high voltage transformer.

5. Check insulator purge air and heating systems. Clean or replace air filters as necessary.

6. Check insulator pressurization and heating system in negative pressure systems.

7. Check all access hatches for air leaks, make sure that the hatch door is fully closed and locked. Inspect the door gasket for cracks or tears.

C) Semi-annual inspections and maintenance – During the semi-annual inspection quarterly and annual inspection activities will be conducted.

1. Before anyone enters the ESP, conduct an air load check of each field. This data will be compared with the post maintenance air load check to assure that proper maintenance has been performed.

2. Clean control cabinets for rappers and T-R sets. Check the gaskets on the rapper control cabinet for cracks and tears. Clean all switch contacts in the rapper control cabinet.

3. Check and clean all T-R sets. All contacts will be removed, cleaned and adjusted. After replacement all electrical connections will be checked for proper tightness.

4. Check and clean high voltage lines, bushings and insulators. Check and replace surge arrestors as necessary. Check the high voltage bus duct for dust build up and corrosion.

Check and replace bus duct insulators as necessary. Check and tighten high voltage bus duct connections. Clean and adjust transformer switch gear.

5. Check all rappers for proper operation. Check the rapper rod connections (anvils) for loose, broken or bent connections. Check anvils for proper lift, energy transfer and striking. Adjust pneumatic systems and vibrators to assure a proper amount of rapping energy is applied to the collection or discharge system.

6. Empty the ash hopper and remove any residual buildup of ash on internal parts. Check and repair all level detectors. Check, clean and repair dust discharge valves.

7. Check and calibrate ESP instrumentation, including all voltage and current meters. The transmissometer will also be cleaned and realigned.

8. Conduct an interior inspection of the ESP during the initial walk through, check the collection and discharge electrode system. Look for the presence of ash build-up. Generally there will be 1/8 to 1/4 inch of material build-up.

9. Check the alignment of the wires and plates. Any bowing or skewing of their alignment will need correction. This check must be conducted for each lane of each field within the ESP.

10. If a short circuit has been detected in a field, check for a broken wire. The broken wire will be removed or replaced as necessary.

11. Check the upper and lower discharge guide frame assembly for alignment so that equal spacing is maintained. Spacing should be equal from top to the bottom of the plate and from the leading edge to the trailing edge of the plates. The frames should be level in both parallel and perpendicular planes to the gas flow.

12. Check and clean all insulators while looking for insulator tracking. Be sure to include the inside of the large support bushing insulators at the top of the ESP and the discharge rapper insulators. Any insulators that are broken, chipped, cracked, or glaze damaged will be removed and replaced.

13. General maintenance items can include: Checks of door gaskets for proper seal, check the inlet and outlet system including duct work for plugging and dust build-up, inspect expansion joint seals for integrity, lubrication of door hinges and closure mechanisms, cleaning and lubrication of key interlocks, check all ground connections, sampling and testing of transformer oil for dielectric strength.

Equipment Monitoring Methods

Voltage and amps at each T-R set will be recorded hourly during ESP operation. Continuous opacity monitoring takes place via a stack continuous equipment monitor (CEM). Data from this CEM is reduced to six minute averages.

Performance Criteria

Performance evaluation of this ESP will be done via analysis of the hourly recorded T-R set voltage and amperage data and by review of opacity monitoring data. Corrective actions will be implemented within eight (8) hours plus the period of time required to shut down the process without damaging the process equipment or control equipment in the following instances: **OR** Corrective actions will be implemented within eight (8) hours plus the period of time until generating capacity is available to meet consumer demand in the following instances:
[Chose the appropriate statement above, and delete the other]

1. Opacity levels exceed *[insert value]* percent for more than one six minute averaged period.

2. T-R set voltages have decreased *[insert value]* DC kilovolts (under a predetermined baseline) or *[insert value]* AC volts (under a predetermined baseline).

CORRECTIVE ACTION

During daily inspections or while recording operational data, plant personnel may observe a problem with the ESP. Solutions to mechanical type problems are presented in this section of the Operations and Maintenance Plan.

Dust Accumulation

The most common cause of excessive dust accumulation on electrodes is a failure of the rapper control system. Unless there is reason to suspect otherwise (known high resistivity potential of the ash or other indications of hopper plugging), this should be one of the first areas checked if power input to the ESP decreases markedly. Checks of the control system will include:

A) Make sure that the power is on and that the fuse or circuit breaker has not been opened.

B) Check for proper operation of the switch and drive on rotary switches.

C) Check manufacturer recommended procedures for testing rapper control systems.

Rapper failure is also a potential cause of dust accumulation. The ESP's use magnetic impulse/gravity impact type rappers. A common cause of failure of this type of rapper is a short in the coil that lifts the rapper. Methods for correcting this problem include:

A) Replace the defective rapper with a new one.

B) Rebuild the defective rapper.

When dust buildup is suspected and the rappers are or have been determined to be in good operating order, the following equipment control procedures can be used:

A) Increase rapping frequency

B) Increase rapping intensity

A good first choice is to increase rapping frequency. Frequent checks of electrical characteristics through the ESP will indicate the success of this procedure. If increased rapping intensity is required, the increase should not exceed 50% because of the potential for damage to the ESP.

Should either of the above activities fail to clear the dust accumulation, a procedure called "power-off" rapping can be employed. This technique involves removing the power from the field (usually one field is turned off and rapped at a time) and rapping that field for a period of 15 minutes to an hour.

Wire Breakage

Random wire breaks (up to 10 percent of the total wires in the ESP) will not significantly affect ESP performance. Wire breaks will be repaired during one of the twice yearly plant shut-downs. However, if more than 10 percent of the total wires are broken then corrective action will be implemented within eight (8) hours plus the period of time required to shut down the process without damaging the process equipment or control equipment. **OR**
However, if more than 10 percent of the total wires are broken then corrective action will be implemented within eight (8) hours plus the period of time until generating capacity is available to meet consumer demand. *[Chose the appropriate statement above, and delete the other]*
Records will be kept of wire failure locations and dates to confirm that they are indeed random. If records show that wire breaks occur in the same area of the ESP, additional troubleshooting and corrective action must be initiated.

Wire failure mechanisms include: electrical erosion, mechanical erosion, corrosion or a combination of the three. The most common of these is a failure at a plate/wire misalignment point or where the wire passes the edge of the plates in the collecting field (end effect). Correction of this problem involves realignment of the plates and/or placing a wire shroud that extends 6 to 18 inches from each end of the Plugged Ash Hopper

When a plugged ash hopper is detected, immediate action needs to be taken to clear and empty the unit. This problem will be given a high priority for correction because long term ESP performance can be reduced. Causes of hopper plugging include: obstructions due to

fallen wires and/or bottle weights, inadequately sized solids removal equipment, use of the hopper for dust storage, inadequate insulation or heating of the hopper and air infiltration through access doors. Corrective actions include:

A) Place the T-R controller for the field above the hopper in the manual mode to reduce the collection rate until the hopper is emptied. If the hopper is completely filled and the T-R has not tripped automatically, it should be turned off until the hopper has been cleared.

B) Reduce cooling effects around the hopper so that ash remains heated and free flowing.

C) Installation of striker plates on the hopper wall or throat to be used during emptying to dislodge ash build-up.

If dust is suspected to have reached the plates and wires during hopper plugging, a gas load V-I (voltage-current test) curve should be generated to determine that no buildup, clinkers, or serious misalignment has occurred in the fields. The T-R should then be returned to normal operation.

Misalignment

Corrective action for misalignment can only be done during a complete ESP shutdown. Corrective actions include:

A) Plate straightening by: hydraulic press, localized heating with an oxy/acetylene torch followed by water quench, remove the warped section of a plate with a cutting torch and replace it. Major rebuilding will require removal of the top of the ESP and replacement of entire plates.

B) Wire correction: Bent wire frames or lower guide frames often cause the wires to slacken and bow towards the plates. Distorted lower guide frames are often difficult to straighten and may have to be replaced. If the distortion is not too serious and only a few wires are slack, then they can be removed. The wires can be tightened by crimping them <u>in the direction of gas flow</u>.

C) General misalignment caused by a shift in guide frame components can usually be corrected by realigning the frame.

Air Infiltration

Routine inspections of the ESP will reveal any locations of air infiltration into the unit. Correction of this problem involves simple sealing of the leaking joint, surface or door/hatch gasket.

RECORDKEEPING AND REPORTING

Operational records will be kept and maintained at the power plant for a period of five years and will be available for review upon request by a regulating agency. Records to be kept include:

A) T-R set data - Hourly records of voltage and amp levels.

B) Visible emission observation (as necessary). (There is a CEM that monitors opacity continuously).

C) Operations and maintenance checklists, wire breakage record and repair work orders.

D) Reports - Semi-annual reports will be generated that include times and duration of all instances of data recorded that were outside of an indicated performance range. The report will also include a certification that corrective actions were promptly taken or a statement that all readings were within the performance range.

E) Submit all reports and petitions required by 40 CFR 75 to the Iowa DNR in order to demonstrate compliance with continuous emission monitoring under the acid rain program.

QUALITY CONTROL

The following quality control measures will be implemented in association with the operation of the ESP's:

A) All instruments and equipment will be calibrated, maintained and operated according to manufacturer specifications.

B) Visible emission observations taken in accordance with 40 CFR 60, Appendix A, Method 9 will be by a certified reader.

C) This Operation and Maintenance Plan will be available for review at the facility including:

1. Inspection Checklists
2. Standard Operating Procedures

D) The corrective action measures in this plan will be implemented within eight (8) hours plus the period of time required to shut down the process without damaging the process

equipment or control equipment. **OR** The corrective action measures in this plan will be implemented within eight (8) hours plus the period of time until generating capacity is available to meet consumer demand. *[Chose the appropriate statement above, and delete the other]*

Electrostatic Precipitator Periodic Monitoring Literature Review

Preventive maintenance checklist for a typical fly ash precipitator. APTI - 412B Table 6-5.

Daily
1. Take and record electrical readings and transmissometer data.
2. Check operation of hoppers and ash removal system.
3. Examine control room ventilation system.
4. Investigate cause of abnormal arcing in T-R enclosures and bus duct.

Weekly
1. Check rapper operation.
2. Check and clean air filter.
3. Inspect control set interiors.

Monthly
1. Check operation of standby top-housing pressurizing fan and thermostat.
2. Check operation of hopper heaters.
3. Check hopper level alarm operation.

Quarterly
1. Check and clean rapper and vibrator switch contacts.
2. Check transmissometer calibration.

Semiannual
1. Clean and lubricate access-door dog bolt and hinges.
2. Clean and lubricate interlock covers.
3. Clean and lubricate test connections.
4. Check exterior for visual signs of deterioration, and abnormal vibration, noise, leaks.
5. Check T-R liquid and surge-arrestor spark gap.

Annual
1. Conduct internal inspection.
2. Clean top housing or insulator compartment and all electrical insulating surfaces.
3. Check and correct defective alignment.
4. Examine and clean all contactors and inspect tightness of all electrical connections.
5. Clean and inspect all gasketed connections.
6. Check and adjust operation of switchgear.
7. Check and tighten rapper insulator connections.
8. Observe and record areas of corrosion.

Situational
1. Record air-load and gas-load readings during and after each outage.
2. Clean and check interior of control sets during each outage of more than 72 hours.
3. Clean all internal bushings during outages of more than 5 days.
4. Inspect condition of all grounding devices during each outage over 72 hours.

5. Clean all shorts and hopper buildups during each outage.
6. Inspect and record amount and location of residual dust deposits on electrodes during each outage over 72 hours.
7. Check all alarms, interlocks, and all other safety devices during each outage.