B.3 WET ELECTROSTATIC PRECIPITATORS[1,2,7,8,22,23]

B.3.1. Background

A wet electrostatic precipitator (WESP) typically is used to control PM emissions in exhaust gas streams containing sticky, condensible hydrocarbon pollutants, or where the potential for explosion is high. A WESP may be used to control a variety of emission points and pollutants, such as wood chip dryers; sulfuric acid mist; coke oven off-gas; blast furnaces; detarring operations; basic oxygen furnaces; cupolas; and aluminum potlines. In the wood products industry, WESPs often are used in combination with wet scrubbers or regenerative thermal oxidizers (RTOs) to control both PM and gaseous emissions. The general operating principles and components of ESPs and the specific features of dry ESPs are discussed in section B.2; this section focuses on the components and operation of WESPs that differ from those of dry ESPs.

The two primary differences between dry ESP and WESP design are the use of a prequench and the collector plate cleaning method. Unlike dry ESPs, WESP control systems typically incorporate a prequench (water spray) to cool and saturate the gases prior to entering the electrical fields. As PM accumulates on the collector plates of a WESP, the plates are cleaned by a continuous or intermittent film or spray of water. Major differences in the types of WESPs available include: the shape of the collector; orientation of the gas stream (vertical or horizontal); use of preconditioning water sprays; and whether the entire ESP is operated wet. Configurations include circular plate, concentric plate, tubular, and flat plate WESPs.

In circular-plate WESPs, the circular plates are irrigated continuously; this provides the electrical ground for attracting the particles and also removes them from the plates. Concentric-plate WESPs have an integral, tangential prescrubbing inlet chamber, followed by a vertical wetted-wall concentric ring ESP chamber. The discharge electrode system is made of expanded metal, with corona points on a mesh background.

Tube-type WESPs typically have vertical collecting pipes; electrodes are typically in the form of discs placed along the axis of each tube. The particles are charged by the high-intensity electric field, and, as they travel farther down the tube, they are forced to the tube walls by the electrostatic field. The tube walls remain wet because the fine mist entrained in the saturated gas is also collected on the tube surfaces and flows down along the tube walls. Flushing is performed periodically to clean the tube surfaces. The water is collected in a settling tank, and this water is used to quench the gaseous stream prior to its entering the WESP.

In rectangular plate WESPs (horizontal flow), water sprays precondition the incoming gas and provide some initial PM removal. Because the water sprays are located over the top of the electrostatic fields, collection plates are also continuously irrigated. The collected water and PM flow downward into a sloped trough. The last section of this type of WESP is sometimes operated dry to remove entrained water droplets from the gas stream.

The conditioning of the incoming gas stream and continual washing of the internal components with water eliminate re-entrainment problems common to dry ESPs. Efficiency is affected by particle size, gas flow rate, and gas temperature. Common problems with WESPs include: poor gas flow; high gas flow; poor water flow; low voltage; low current; and high dissolved solids in the flush or prequench water. Other common mechanical-type problems include: poor alignment of electrodes; bowed or distorted collecting plates; full or overflowing hoppers; plugged water sprays; corrosion of electrodes; and air inleakage.

B.3.2 Indicators of WESP Performance

The primary indicators of WESP performance are opacity, secondary corona power, secondary voltage, and secondary current. Other indicators of WESP performance are the spark rate, primary current, primary voltage, inlet gas temperature, gas flow rate, inlet water flow rate, solids content of flush water (when recycled water is used), and field operation. section B-2 describes each of these indicators with the exception of the inlet water flow rate and the flush water solids content, which are described below. For some systems, mist may be entrained in the exhaust gas. In such cases, opacity measurements would be misleading. Table B-3 lists these indicators and illustrates potential monitoring options for WESPs.

Inlet water flow rate. Because WESPs use water to clean collector plates, the water flow rate is an indicator that the cleaning mechanism is operating properly. If flow rates decrease, sections of the WESP may not be as effective. As a result, PM collection rates would decrease as material built up on the collectors. In addition, low flow rates increase the likelihood of ineffective spraying and distribution of water, as well as nozzle plugging.

Flush water solids content. When recycled water is used, the solids content of the water increases with each recycling. If the solids content becomes excessive, the effectiveness of the cleaning mechanism is reduced. Increased solids content also can lead to plugging of spray nozzles.

B.3.3. Illustrations

The following illustrations present examples of compliance assurance monitoring for WESPs:

- 3a: Monitoring secondary current, secondary voltage, spark rate, and inlet water flow rate.
- 3b: Monitoring secondary current, secondary voltage, inlet water flow rate, and flush water solids content.

B.3.4 Bibliography

TABLE B-3. SUMMARY OF PERFORMANCE INDICATORS FOR WESPs

	Approach No.	**1**	**2**	**3**	**4**	**5**	**6**
	Illustration No.	**3a**	**3b**				
	Example CAM Submittals					**A9a**	**A9b**
Parameter	**Performance indication** / **Comment**		✔	✔	✔		
Primary Indicators of Performance							
Opacity	Increased opacity or VE denotes performance degradation. COMS, opacity observations, or visible/no visible emissions. If mist is entrained in exhaust gas or a condensed plume is present, opacity measurements may be misleading.			X			
Secondary corona power	Performance usually increases as power input increases; indicates work done by WESP to remove PM. Product of voltage and current; can help identify any fields that are not operating.	a	a		a		
Secondary current	Partial indicator of power consumption; too low indicates malfunction. Can help identify any fields that are not operating properly.	X	X		X		
Secondary voltage	Partial indicator of power consumption; too low indicates problem such as grounded electrodes. Can help identify any fields that are not operating properly.	X	X	X	X	X	X
Other Performance Indicators							
Inlet water flow rate	Indicates cleaning mechanism is working properly; if low, can indicate plugging. As an alternative to water flow, the water pressure can be monitored.	X	X	X	X		
Flush water solids content	High solids may cause plugging, reduce collection efficiency. Applies to systems that use recycled water.		X				
Inlet/outlet gas temperature	Indicates water sprays and prequench (if applicable) are working. Also, temperature affects resistivity of particulate.			X			X

Comments:
- Approach No. 2 also corresponds to 40 CFR 60, subpart PPP (Wool Fiberglass).
- Approach No. 3 includes monitoring the voltage to indicate that the WESP is collecting particulate, VE as an indicator of PM emissions, water flow to indicate PM being removed, and outlet temperature to indicate sufficient water.

[a] Monitoring both secondary current and voltage is essentially the same as monitoring secondary corona power. Monitoring of corona power is not appropriate for WESPs with a large number of fields.

No Part 63 rules refer to WESP.

CAM ILLUSTRATION
No. 3a. WET ELECTROSTATIC PRECIPITATOR FOR PM

1. APPLICABILITY

1.1 Control Technology: Wet electrostatic precipitator (WESP) [010, 011, 012]
1.2 Pollutants
Primary: Particulate matter (PM)
Other:
1.3 Process/Emission units: Wood products dryers

2. MONITORING APPROACH DESCRIPTION

2.1 Parameters to be Monitored: Secondary current, secondary voltage, and inlet water flow rate.

2.2 Rationale for Monitoring Approach
- Secondary current: Current is generally constant and low; increase or drop in current indicates a malfunction. The current directly affects collection efficiency.
- Secondary voltage: Voltage is maintained at high level; drop in voltage indicates a malfunction. When the voltage drops, less particulate is charged and collected. The voltage directly affects collection efficiency.
- Inlet water flow rate: Indicates sufficient water flow for proper removal of particulate from the collection plates.

2.3 Monitoring Location
- Secondary current and secondary voltage: Measure after each transformer/rectifier set.
- Inlet water flow rate: Water line.

2.4 Analytical Devices
- Secondary current: Ammeter.
- Secondary voltage: Voltmeter.
- Inlet water flow rate: Liquid flow meter or other device for liquid flow; see section 4 for more information on specific types of instruments.

2.5 Data Acquisition and Measurement System Operation
- Frequency of measurement: Hourly, or continuously by strip chart or data acquisition system.
- Reporting units:
  - Current: Amps.
  - Voltage: Volts.
  - Inlet water flow rate: Gallons per minute (gpm) or cubic feet per minute (ft^3/min)
- Recording process: Operators log data manually, or recorded automatically on strip chart or data acquisition system.

2.6 Data Requirements
- Baseline secondary current, secondary voltage, and inlet water flow rate measurements concurrent with emission test.

- Historical plant records on secondary current, secondary voltage, and inlet water flow rate measurements.

2.7 Specific QA/QC Procedures: Calibrate, maintain, and operate instrumentation using procedures that take into account manufacturer's specifications.

2.8 References: 7, 8, 9, 13.

3. COMMENTS

3.1 Data Collection Frequency: For large emission units, a measurement frequency of once per hour would not be adequate; collection of four or more data points each hour is required. (See Section 3.3.1.2.)

CAM ILLUSTRATION
No. 3b. WET ELECTROSTATIC PRECIPITATOR FOR PM

1. APPLICABILITY

1.1 Control Technology: Wet electrostatic precipitator (WESP) [010, 011, 012]
1.2 Pollutants
Primary: Particulate matter (PM)
Other:
1.3 Process/Emission units: Insulation manufacturing, dryers

2. MONITORING APPROACH DESCRIPTION

2.1 Parameters to be Monitored: Secondary voltage and current, inlet water flow rate, and solids content of flush water.
2.2 Rationale for Monitoring Approach
- Secondary current:
- Secondary voltage: Low voltage or current indicates a problem in the WESP.
- Inlet water flow rate: Indicates sufficient water flow for proper removal of particulate from the collection plates.
- Flush water solids content: High solids content of recycled water reduces the efficiency of cleaning.

2.3 Monitoring Location
- Secondary current and secondary voltage: Measure after each transformer/rectifier set.
- Inlet water flow rate: Measure at inlet water inlet line or pump discharge.
- Flush water solids content: Measure at inlet line or recycle water tank.

2.4 Analytical Devices:
- Secondary current: Ammeter.
- Secondary voltage: Voltmeter.
- Inlet water flow rate: Liquid flow meter or other device for liquid flow; see section 4 for more information on specific types of instruments.
- Flush water solids content: Manual sampling of water.

2.5 Data Acquisition and Measurement System Operation
- Frequency of measurement: Hourly, or continuously on strip chart or data acquisition system; flush water solids, weekly.
- Reporting units:
  – Current: Amps.
  – Voltage: Volts.
  – Inlet water flow rate: Gallons per minute (gpm) or cubic feet per minute (ft^3/min).
  – Flush water solids content: Percent solids.
- Recording process: Operators log data manually, or recorded automatically on strip chart or data acquisition system.

2.6 Data Requirements
- Baseline secondary current, secondary voltage, inlet water flow rate, and solids content measurements concurrent with emission test.
- Historical plant records on secondary current, secondary voltage, inlet water flow rate, and solids content measurements.

2.7 Specific QA/QC Procedures: Calibrate, maintain, and operate instrumentation using procedures that take into account manufacturer's specifications.

2.8 References: 7, 8, 9, 11, 13.

3. COMMENTS

3.1 Data Collection Frequency: For large emission units, a measurement frequency of once per hour would not be adequate; collection of four or more data points each hour is required. (See Section 3.3.1.2.)