

	SYSTEM DESCRIPTION	FILE NO. 141643.43.0254
	FGD BYPRODUCT DEWATERING SYSTEM (ZD)	AEP 031006-D

AMERICAN ELECTRIC POWER

Big Sandy Unit 2

FGD Byproduct Dewatering System (ZD)

FILE NO: 141643.43.0254

SYSTEM DESCRIPTION

ISSUE DATE AND REVISION NO.
031006-D

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1.0 Description of Process

1.1 General

The function of the Flue Gas Desulfurization (FGD) Byproduct Dewatering System is to process the jet bubbling reactor (JBR) absorber bleed stream from the FGD Absorber System (ZA) and sluice the slurry to a flyash pond for disposal.

1.2 System Design

The system employs two independent, full-capacity primary dewatering trains. The absorber bleed slurry (at 20 weight percent solids) is discharged into the dewatering hydroclone feed tanks. Slurry from the dewatering hydroclone feed tanks is pumped to the hydroclone clusters by the dewatering hydroclone feed pumps for primary dewatering. The hydroclone cluster produces an underflow and overflow stream. The underflow stream (at 40 to 50 weight percent solids) contains the heavier/larger slurry particles, which are then directed to the byproduct slurry dilution tank before being pumped to the flyash pond. The overflow stream (at 2 to 3 weight percent solids) contains the lighter/smaller slurry particles and is drained by gravity into the hydroclone overflow tank. The slurry fines are then pumped to a water treatment area, provided by others. The overflows and drains of the hydroclone overflow tanks are sent to the reclaim water tank in the FGD Reclaim Water System (ZC) for reuse.

A dewatering area sump system is also provided. System components of each sump consist of the sump, two full-capacity submersible sump pumps, and a single top-entry agitator. Two 100 percent capacity sump pumps are provided in each sump based on the normal anticipated flow rate. In the event of excessive flow into the sump, both pumps are operated simultaneously.

The byproduct dewatering area sump collects equipment, piping, and maintenance drains from the FGD Byproduct Dewatering System (ZD) and the FGD Reclaim Water System (ZC) by means of trenches. Components within these systems that use the dewatering area sump are: drains and overflows from the hydroclone feed tanks, drains and overflows from the reclaim water tanks, and

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flushing of the hydroclone feed pumps and suction piping. The operator has the option to return the collected drains to either of the hydroclone feed tanks. The operator also has the option of discharging the wastewater to the Dilution tanks.

2.0 Description of Major Equipment

The FGD Byproduct Dewatering System includes the following major components:

- Dewatering hydroclone feed tanks
- Hydroclone feed tank agitators
- Dewatering hydroclone feed pumps
- Hydroclone clusters
- Hydroclone overflow tanks
- Hydroclone overflow blowdown pumps
- Slurry Piping
- Slurry Valves
- Dewatering Area Sump
- Sump Agitator
- Byproduct Dewatering Area Sump Pumps

2.1 Dewatering Hydroclone Feed Tanks

2.1.1 Component Identification

Component Name: Dewatering Hydroclone Feed Tanks
Component Identification No.: 02-ZD-TK-8001-01 and 02-ZD-TK-8001-02

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2.1.2 Function

The dewatering hydroclone feed tanks provide storage and surge capacity for gypsum slurry between the FGD absorber and the hydroclones as well as adequate net positive suction head (NPSH) for the dewatering hydroclone feed pumps.

2.1.3 Description

Two dewatering hydroclone feed tanks are provided. The absorber bleed pumps feed gypsum slurry to either of the dewatering hydroclone feed tanks. The JBR area and dewatering area sump pumps also discharge to either of the two dewatering hydroclone feed tanks.

Each dewatering hydroclone feed tank is an above grade, field erected, cylindrical, open-top tank. Each tank is equipped with a structural assembly/walkway and designed to support the hydroclone feed tank agitator and to provide maintenance access. The tanks are provided with an overflow, vent drain, 30 inch manway, and an 8 inch by 16 inch removable panel. The tanks are equipped with wall mounted anti-swirl baffles. Each tank is supported on a concrete ring wall foundation with compacted backfill, covered by lean concrete crowned at the tank center.

2.1.4 Sizing Criteria

Each dewatering hydroclone feed tank is sized to hold 4 hours of storage capacity at design conditions. The approximate size of each tank is 39 feet in diameter by 41 feet in straight side height. The total useful capacity of each tank is approximately 242,880 gallons. The gross capacity of each tank is approximately 366,382gallons, which allows adequate height to ensure that each agitator operates with the proper submergence during discharge of the entire useful volume of the tank. Each tank's overflow piping is sized to evacuate the maximum anticipated total inflow from the absorber bleed, JBR sump, and dewatering sump pumps to prevent the tanks from overflowing to grade.

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2.1.5 Materials Selection

Each dewatering hydroclone feed tank is constructed of ASTM A36 carbon steel and has a flake glass-reinforced resin interior lining to protect the tank interior from corrosion and erosion. The tank also has an exterior primer and finish coating to protect the tank exterior.

2.2 Hydroclone Feed Tank Agitators

2.2.1 Component Identification

Component Name: Hydroclone Feed Tank Agitators
Component Identification No.: 02-ZD-AG-8001-01 and 02-ZD-AG-8001-02

2.2.2 Function

The hydroclone feed tank agitators keep the slurry solids contained in each hydroclone feed tank in suspension.

2.2.3 Description

Two hydroclone feed tank agitators are provided, one for each hydroclone feed tank. Each hydroclone feed tank agitator is a top-entry, gear-driven, axial flow type agitator with a long, cantilevered shaft. Each agitator's electric motor drive, speed reducer, and shaft bearings are located on support steel at the top of the dewatering hydroclone feed tank.

Depending on the vendor and design selected, the agitator impeller is either three- or four-bladed.

The agitator mix pattern is downward toward the tank floor. The dewatering hydroclone feed tanks are fitted with two to four baffles designed to minimize swirl effects caused by the agitator mixing dynamics.

2.2.4 Sizing Criteria

Each hydroclone feed tank agitator is sized to produce off-bottom motion of all slurry particles. The design conditions for the agitators are 25 weight percent limestone slurry with a mean particle diameter of 70 μm . The specific gravity of the slurry is 1.13 with a specific gravity of the particles being 2.32.

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2.2.5 Materials Selection

The agitator shaft and blades are carbon steel covered with natural rubber.

2.3 Dewatering Hydroclone Feed Pumps

2.3.1 Component Identification

Component Name: Dewatering Hydroclone Feed Pumps

Component Identification No.: 02-ZD-PP-8001-01 and 02-ZD-PP-8001-02

2.3.2 Function

The dewatering hydroclone feed pumps transfer FGD byproduct slurry from the dewatering hydroclone feed tanks to the primary dewatering hydroclone clusters.

2.3.3 Description

Two dewatering hydroclone feed pumps are provided, with each pump capable of drawing slurry from either dewatering hydroclone feed tank. Each dewatering hydroclone feed pump is a vertically split case, end-suction, constant speed, belt-driven slurry pump that handles abrasive slurry with up to 25 weight percent solids. The pumps are equipped with mechanical shaft seals.

2.3.4 Sizing Criteria

Each dewatering hydroclone feed pump is sized to provide 100 percent of the design hydroclone feed requirements and maintain the velocity of the slurry in the dewatering hydroclone feed piping in the range of 4 to 10 ft/sec.

2.3.5 Materials Selection

The dewatering hydroclone feed pumps are fabricated from materials suitable for the corrosive and erosive nature of the slurry. Each pump casing is hard metal or hard metal-lined. The pump impeller is abrasion-resistant, high-chrome cast iron.

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2.4 Hydroclone Clusters

2.4.1 Component Identification

Component Name: Hydroclone Clusters
Component Identification No.: 02-ZD-HC-8101
02-ZD-HC-8201

2.4.2 Function

The hydroclone clusters take feed slurry from the dewatering hydroclone feed tanks (up to 25 percent solids by weight) and produce an underflow with a slurry concentration of approximately 40 to 50 percent solids by weight.

2.4.3 Description

Two hydroclone clusters are provided. A single hydroclone cluster consists of a group of hydroclones around a central slurry feed pipe. Each hydroclone is furnished with an inlet knife gate isolation valve, which is piston operated. Each hydroclone cluster consists of two collection troughs, one for the overflow and one for the underflow. The underflow is sent to the byproduct slurry dilution tank. The overflow drains by gravity to the dewatering hydroclone overflow tanks.

2.4.4 Sizing Criteria

Sizing is performed based on design condition mass balances and gypsum size distribution. Six operating hydroclones and two spare hydroclones are provided.

2.4.5 Materials Selection

Each individual hydroclone is carbon steel with replaceable rubber liners. The underflow and overflow collection troughs are carbon steel with rubber coatings.

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2.5 Hydroclone Overflow Tanks

2.5.1 Component Identification

Component Name: Hydroclone Overflow Tank
Component Identification No.: 02-ZD-TK-8103
02-ZD-TK-8203

2.5.2 Function

The hydroclone feed tanks provide surge capacity for reclaim water between the hydroclone clusters and the flyash pond, as well as adequate net positive suction head (NPSH) for the hydroclone overflow blowdown pumps.

2.5.3 Description

Two hydroclone overflow tanks are provided. The hydroclone overflows from each of the primary dewatering trains are gravity fed into the hydroclone overflow tanks.

The hydroclone overflow tanks are above grade, closed top, cylindrical, atmospheric tank with internal baffles that reduce the amount of entrained seal water exiting the tank with the airstream.

2.5.4 Sizing Criteria

The hydroclone overflow tanks are sized to hold 1 minute of storage capacity at design conditions. The approximate size of each tank is 3 feet in diameter by 4.5 feet in straight side height. The total useful capacity of each tank is approximately 170 gallons. The tank overflow piping is sized to evacuate the maximum anticipated total inflow from the hydroclone overflows to the reclaim water tanks. The overflow of the hydroclone overflow tanks will be gravity fed to the FGD Reclaim Water Tank (ZC).

2.5.5 Materials Selection

Each hydroclone overflow tank is fabricated from FRP or epoxy coated carbon steel.

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2.6 Hydroclone Overflow Blowdown Pumps

2.6.1 Component Identification

Component Name: Hydroclone Overflow Blowdown Pumps

Component Identification No.: 05-ZD-PP-8104 and 05-ZD-PP-8204

2.6.2 Function

The hydroclone overflow blowdown pumps transfer reclaim water/slurry from the hydroclone overflow tank to the flyash pond.

2.6.3 Description

One hydroclone overflow blowdown pump is provided per hydroclone overflow tank. Each hydroclone overflow blowdown pump is a vertically split case, end-suction, constant speed, belt-driven slurry pump that can handle abrasive slurry. Under normal operation, the pumps will see 2 to 3 weight percent slurry. The pumps are equipped with mechanical shaft seals.

2.6.4 Sizing Criteria

Each hydroclone overflow blowdown pump is sized to provide 100 percent of the design hydroclone overflow blowdown requirements and maintain the velocity of the slurry in the chloride bleed piping in the range of 4 to 10 ft/sec.

2.6.5 Materials Selection

The hydroclone overflow blowdown pumps are fabricated from materials suitable for the corrosive and erosive nature of the slurry. Each pump casing is hard metal or hard metal-lined. The pump impeller is abrasion-resistant, high-chrome cast iron.

2.7 Slurry Piping

2.7.1 Component Identification

Component Name: Slurry Piping

Component Identification No.: None

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2.7.2 Function

The slurry piping transports gypsum slurry and reclaim water between the components of the FGD Byproduct Dewatering System.

2.7.3 Description

The slurry piping is pressure piping with materials of construction specifically selected for the abrasive and corrosive nature of the process flows handled.

2.7.4 Sizing Criteria

For pipe conveying gypsum slurry, the pipe sizes are selected to maintain the slurry velocity in the range of 4 to 10 ft/sec. Where practical, the slurry velocity should be maintained in the more restrictive range of 5 to 8 ft/sec. Within the more restrictive range, there is less potential for the line to plug due to solids' settling and the rate of abrasive wear is lower.

For piping handling reclaim water, the pipe size is selected to maintain the water velocity in the range of 3 to 12 ft/sec. The higher velocity range is acceptable due to the much lower solids content of the filtrate.

2.7.5 Materials Selection

Piping handling slurries with greater than 3 weight percent solids is fabricated of FRP with an internal abrasion-resistant lining.

Piping handling slurries with 3 weight percent solids or less is fabricated of FRP without an internal abrasion-resistant lining.

Piping handling service water is fabricated of carbon steel or FRP without an internal abrasion-resistant lining.

2.8 Slurry Valves

2.8.1 Component Identification

Component Name: Slurry Valves
Component Identification No.: Various

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2.8.2 *Function*

Slurry valves are used for component isolation, flow control, or a combination of both services.

2.8.3 *Description*

Knife gate valves are preferred for component isolation in slurry service due to the erosive nature of the process fluid.

Flow control applications in slurry service require the use of pinch valves. Butterfly valves are considered acceptable for use in slurry flow control if the solids content is less than 5 weight percent.

2.8.4 *Sizing Criteria*

Valve sizing is compatible with the slurry line in which the valve resides. The maximum slurry velocity through the valve is 12 ft/sec.

2.8.5 *Materials Selection*

The typical materials for the slurry valves are listed in Table 2-3.

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Table 2-3: Slurry Valves – Materials of Construction

Component	Material
Knifegate Valves	
Valve body	Rubber-lined carbon steel
Valve gate	Alloy 2205 duplex stainless steel
Ball Valves (for instrumentation isolation)	
Valve body	FRP
Ball	FRP
Butterfly Valves	
Valve body	Rubber-lined carbon steel
Disc	Rubber-lined ductile iron
Pinch Valves	
Valve body	Ductile Iron
Elastomer sleeve	Gum rubber

2.9 Byproduct Dewatering Area Sump

2.9.1 Component Identification

Component Name: Byproduct Dewatering Area Sump

Component Identification No.: None

2.9.2 Function

The byproduct dewatering area sump collects wastewater via trenches from the reclaim water tank drains, hydroclone feed tank drains, reclaim pump suction piping, hydroclone feed pump suction piping, byproduct slurry discharge piping drains, byproduct slurry pumps, and byproduct slurry tank drains.

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2.9.3 Description

The sump is a below-grade, reinforced concrete structure coated with a lining suitable for the corrosive nature of the wastewater.

2.9.4 Sizing Criteria

The active volume of the byproduct dewatering area sump is (Later) gallons. The active volume of the sump is based on maintaining the sump pumps to a maximum of 4 starts per hour. The maximum drain flow for the sump is considered the hydroclone feed tank overflow. In setting the active tank volume, the minimum slurry level takes into consideration the minimum submergence of the byproduct dewatering sump agitator.

2.9.5 Material Selection

The sump is reinforced concrete structure coated with a protective lining suitable for the corrosive nature of the wastewater.

2.10 Sump Agitator

2.10.1 Component Identification

Component Name: Byproduct Dewatering Area Sump Agitator

Component Identification No.: 02-ZD-AG-8003:

2.10.2 Function

The sump agitator keeps the slurry solids contained in the sumps in suspension.

2.10.3 Description

One agitator is provided for each sump.

The sump agitator is a top-entry, gear-driven, axial flow type agitator with a long, cantilevered shaft. The agitator's electric motor drive, speed reducer, and shaft bearings are located on support steel over the sump. Depending on the vendor and design selected, the agitator impeller may be either three- or four-bladed. The agitator's mix pattern is downward toward the sump floor.

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2.10.4 Sizing Criteria

The agitator is sized to produce off-bottom motion of all slurry particles in the sump. For the dewatering area sump, the design conditions are 25 weight percent gypsum slurry with a mean particle diameter of 70 μm . The specific gravity of the slurry is 1.13 and the particle specific gravity is 2.32.

2.10.5 Materials Selection

The agitator shaft and blade is carbon steel covered with natural rubber.

2.11 Byproduct Dewatering Area Sump Pumps

2.11.1 Component Identification

Component Name: Sump Pumps
Component Identification No.: 02-ZD-PP-8006-01 and 02-ZD-PP-8006-02

2.11.2 Function

The function of the byproduct dewatering area sump pumps is to transfer the collected drains to either of the dewatering hydroclone feed tanks for re-use in the FGD System. The operator also has the option to discharge the wastewater to the byproduct slurry tank.

2.11.3 Description

Two 100 percent submersible sump pumps are provided for the byproduct dewatering area sump.

The sump pumps are submersible, constant-speed pumps designed for slurry service and fitted with mechanical seals. Motors are 460V.

2.11.4 Sizing Criteria

Each byproduct dewatering area sump pump is sized to provide 100 percent of the design transfer requirements for the sump. The pumps are sized to maintain the velocity of the slurry in the sump pump piping in the range of 4 to 10 ft/sec for

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the required maximum sump input flow rate. The maximum input flow rate for the byproduct dewatering area sump is the dewatering hydroclone feed tank overflow.

2.11.5 Materials Selection

Pumps are of heavy-duty design with metallurgy (28% Cr) designed for the given application. The pumps have mechanical seals. The pump discharge line is heavy-duty slurry hose from pump discharge to a flange located at the top of the sump.

3.0 Description of Major Interlocks and Alarms

Additional interlocks, trips, and alarms will be determined during detail design.

4.0 Description of System Operation and Control

4.1 Instrumentation and Control

The FGD Byproduct Dewatering System equipment is controlled by the FGD System DCS, which allows control of individual FGD Byproduct Dewatering System components in the remote automatic and remote manual modes.

The overall process control logic establishes the correct equipment start/stop sequences for placing a hydroclone cluster in or out of service in response to manually initiated commands from the FGD system operator.

In the remote automatic control mode, the DCS opens/closes or starts/stops the FGD Byproduct Dewatering System components according to programmed sequences and interlocks as directed by the control logic. In the remote manual control mode, individual pumps and valves can be opened/closed or started/stopped by the operator. The protective interlocks remain in service during remote manual operation.

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The feed rate of slurry to the dewatering hydroclone feed tanks is controlled by a flow control valve located in the FGD Absorber System. This control valve maintains the JBR absorber solids content at the set point by responding to a feed-forward signal comprised of the inlet flue gas flow rate and SO₂ concentration and to a feed-back signal based on measurement of the actual JBR absorber vessel slurry density. The slurry is then pumped from the dewatering hydroclone feed tanks to the hydroclones by the dewatering hydroclone feed pumps. The feed to the hydroclones is controlled by header pressure. As the hydroclone clusters are put into service, the isolation valve is opened and the pinch valve modulates as required to maintain pressure at the hydroclones. There are three operating conditions on the control valve: full flow, half flow and recirculation, and recirculation flow.

The dewatering area sump contains two pumps that are controlled by the Distributed Control System (DCS) based on a sump level measurement system suitable for service in an agitated slurry environment. The control scheme selects a duty pump based on an alternating mode that automatically cycles between pumps to ensure even run time. Each sump agitator is controlled by the DCS.

The level measurement system detects the sump level as follows.

- When sump level reaches the high set point, the DCS starts the duty pump and a signal is sent to the DCS informing the FGD System operator that the sump pump is running.
- When the sump level reaches the low set point, the DCS stops the duty pump and the automatic discharge isolation valve is closed. The automatic valve providing flush water from the Reclaim Water System (ZC) opens, allowing reclaim water to flow into the sump pump discharge. This valve remains open for a set amount of time to allow the reclaim water to flush the line to a slurry concentration of less than 5 percent by weight, and then closes.
- If the sump level reaches the high set point before the reclaim flush cycle is complete, the reclaim water automatic valve closes. Then the duty sump

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pump is started, and the sump pump discharge automatic isolation valve opens.

- If sump level reaches the high-high set point, the DCS starts the standby sump pump and a signal is sent to the DCS informing the FGD System operator that the second pump is running and to annunciate the high-high level. At the low set point both pumps are shut off and the line is flushed as indicated above.
- If sump level reaches the very-high set point, a signal is sent to the DCS to annunciate very-high level.
- If sump level reaches the low-low set point, a signal is sent to the DCS to annunciate low-low level. At this point, the operator needs to add liquid to the sump level.

The sump pump system trouble alarm is sent to the DCS if either sump pump trips due to motor overload.

4.2 System Operation

Specific information on system pre-startup, initial system fill, system startup, normal operation, and shutdown will be completed during detail design.

At design conditions, each FGD Absorber System produces approximately 60.9 tons per hour (wet weight) of calcium sulfate dihydrate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) and inert materials, commonly called gypsum. These solids are sent to the FGD Byproduct Dewatering System as slurry with 20 weight percent solids. The hydroclone clusters dewater the feed slurry to produce an underflow with an approximate 50 weight percent of solids.

4.3 Functional Constraints

To be completed during detail design.

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4.4 Redundancy

There are two each, 100 percent capacity, dewatering hydroclone feed pumps which can draw from either or both of the dewatering hydroclone feed tanks. The two tanks split the required storage volume (8 total hours of gypsum slurry storage based on total site JBR blowdown rate at the maximum continuous rate [MCR] design conditions using 4.5 lb/MMBtu SO₂ fuel).

There are two hydroclone clusters provided, each containing 25 percent spares. There are six operating and two spare hydroclones per cluster.

There are two, 100 percent capacity, submersible, sump pumps and a single agitator in each individual sump. They are used individually or in parallel depending on liquid level in the sump. The sumps alternate starts in normal operation mode to ensure even run time.

5.0 Description of Provisions for Flushing and Testing

To be completed during detail design.

6.0 Description of Provisions for Maintenance

To be completed during detail design.

7.0 Description of Hazardous Area/Materials

To be completed during detail design.

8.0 References

8.1 Flow Diagrams

Black & Veatch Drawing No.	AEP Drawing No.
141643-02ZD-M2254A	02-518005A-D
141643-02ZD-M2254B	02-518005B-D
141643-02ZD-M2254D	02-518005D-D
141643-02ZD-M2254F	02-518005F-D

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141643-02ZZ-M2266B	02-518011B-D
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8.2 General Arrangements

Later

8.3 Electrical One-Line Drawings

Later

8.4 Descriptive Articles

Later

8.5 Codes and Standards

Applicable codes and standards for the FGD Byproduct Dewatering System include the following:

- American Gear Manufacturers Association (AGMA)
- American National Standards Institute (ANSI)
- ASTM B31.3, Chapter VII – Non-Metallic Piping and Piping Lined with Nonmetals
- ASTM B31.1, Appendix III – Non-Mandatory Rules for Nonmetallic Pipe
- ASTM D2992 – Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
- American Society of Mechanical Engineers (ASME)
- American Society for Testing and Materials (ASTM)
- American Petroleum Institute (API) Standard 650, “Welded Steel Tanks for Oil Storage”
- American Welding Society (AWS)
- Hydraulic Institute (HI)
- National Electrical Manufacturers Association (NEMA)
- Institute of Electrical and Electronic Engineers (IEEE)

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8.6 Regulatory Requirements

The FGD Byproduct Dewatering System complies with all applicable state laws, local ordinances, and requirements of the Federal Occupational Safety and Health Standards, 29 CFR 1910 – General Industry and 29 CFR 1926 – Construction Industry.