Worldwide Pollution Control Association

IL Regional Technical Seminar

September 13-15,2011

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Dry FGD Operations

Reinhold Environmental LTD
WPCA Illinois Regional Technical Seminar

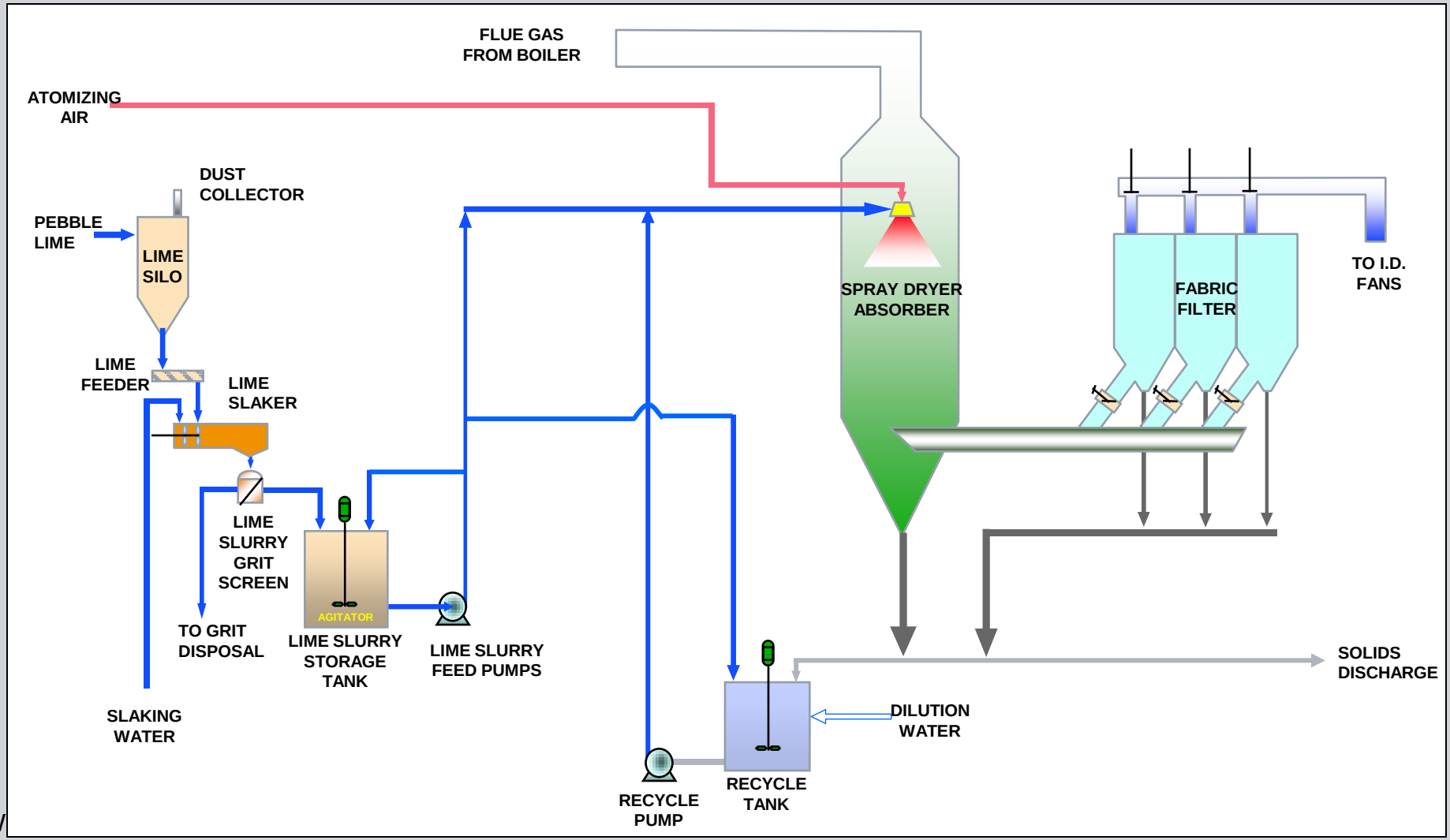
Siemens Environmental Systems
& Services

September 15, 2011

Normal, IL

Spray Dryer Absorber Dry Scrubbing Systems

SIEMENS



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EPA/MACT Proposed Emission Limits
Existing EGUs

SIEMENS

Category	Pollutants	Emissions
1. Coal Fired Unit designed for coal ≥ 8,300 Btu/lb	a. Total Particulate Matter (PM)	0.030 lb/mmBTU or 0.30 lb/MWh
	or	or
	Total non-Hg HAP metals	0.000040 lb/mmBTU 0.00040 lb/MWh
	or	or
	Individual HAP metals: Antimony (Sb) Arsenic (As) Beryllium (Be) Cadmium (Cd) Chromium (Cr) Cobalt (Co) Lead (Pb) Manganese (Mn) Nickel (Ni) Selenium (Se)	 0.60 lb/TBtu or 0.0060 lb/GWh 2.0 lb/TBtu or 0.020 lb/GWh 0.20 lb/TBtu or 0.0020 lb/GWh 0.30 lb/TBtu or 0.0030 lb/GWh 3.0 lb/TBtu or 0.030 lb/GWh 0.80 lb/TBtu or 0.0080 lb/GWh 2.0 lb/TBtu or 0.020 lb/GWh 5.0 lb/TBtu or 0.050 lb/GWh 4.0 lb/TBtu or 0.040 lb/GWh 6.0 lb/TBtu or 0.060 lb/GWh
	b. Hydrogen Chloride	0.0020 lb/TBtu or 0.020 lb/MWh
	or	or
	Sulfur Dioxide (SO2)	0.20 lb per MMBtu or 2.0 lb per MWh
	c. Mercury (Hg)	1.0 lb/TBtu or 0.008 lb/GWh

EPA/MACT Proposed Emission Limits
Existing EGUs

SIEMENS

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	b. Hydrogen Chloride	0.0020 lb/TBtu or 0.020 lb/MWh
	or	or
	Sulfur Dioxide (SO2)	0.20 lb per MMBtu or 2.0 lb per MWh
	c. Mercury (Hg)	4.0 lb/TBtu or 0.04 lb/GWh

Mercury and HAP Control w/ SDA

SIEMENS

- Particulate Collection is Downstream of FGD Scrubber
  - Fluegas is cooled to 170-180^{o}F
  - Hg / HAP condensation onto larger particulate
  - Fine aerosols/particulate collected on filter cake
- Vapor Phase SO3 is absorbed by slurry droplets
- Condensed sulfuric acid mist is collected in FF filter cake
- PAC Injection upstream of SDA
  - Vapor SO3 absorbed by SDA slurry
  - SDA provides PAC /Fluegas Mixing prior to FF

SDA & Fabric Filter Technology
Dynegy Baldwin Unit 3

SIEMENS

Dynegy
Baldwin Station
Unit 3
Baldwin, Illinois

- PRB Coal
- 627 MW (Gross)
- 2 x 50% SDAs (54 ft Diameter)
- 2 x Jet VIP PJFFs (8 Compartment)
- SO_2 Inlet: 1.0 lb/mm BTU
- SO_2 Emission: 0.08 lb/mm BTU
- FG Flow Rate: 2,496,000 @ 322^{o}F

Dynegy Baldwin Unit 3

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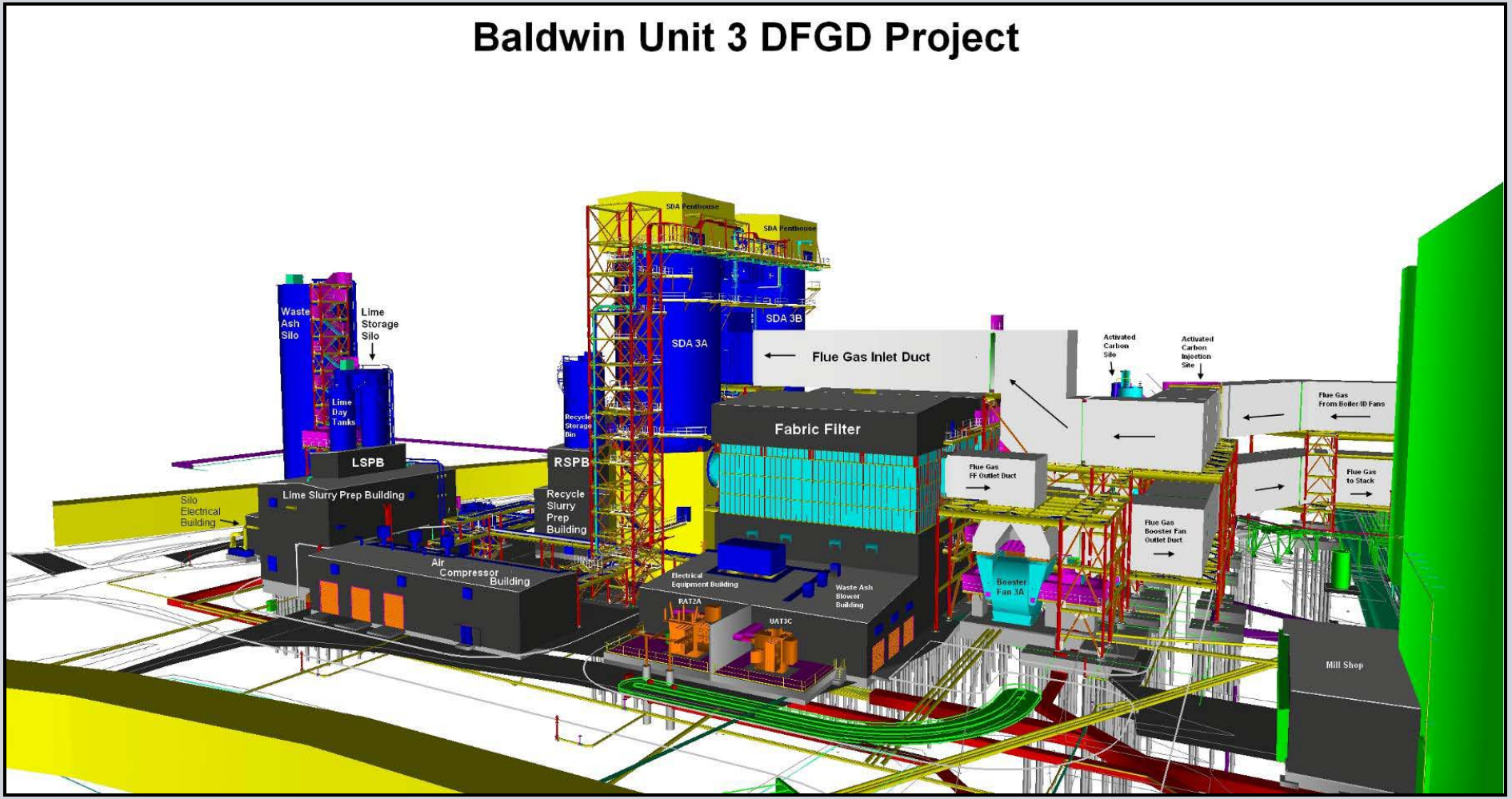
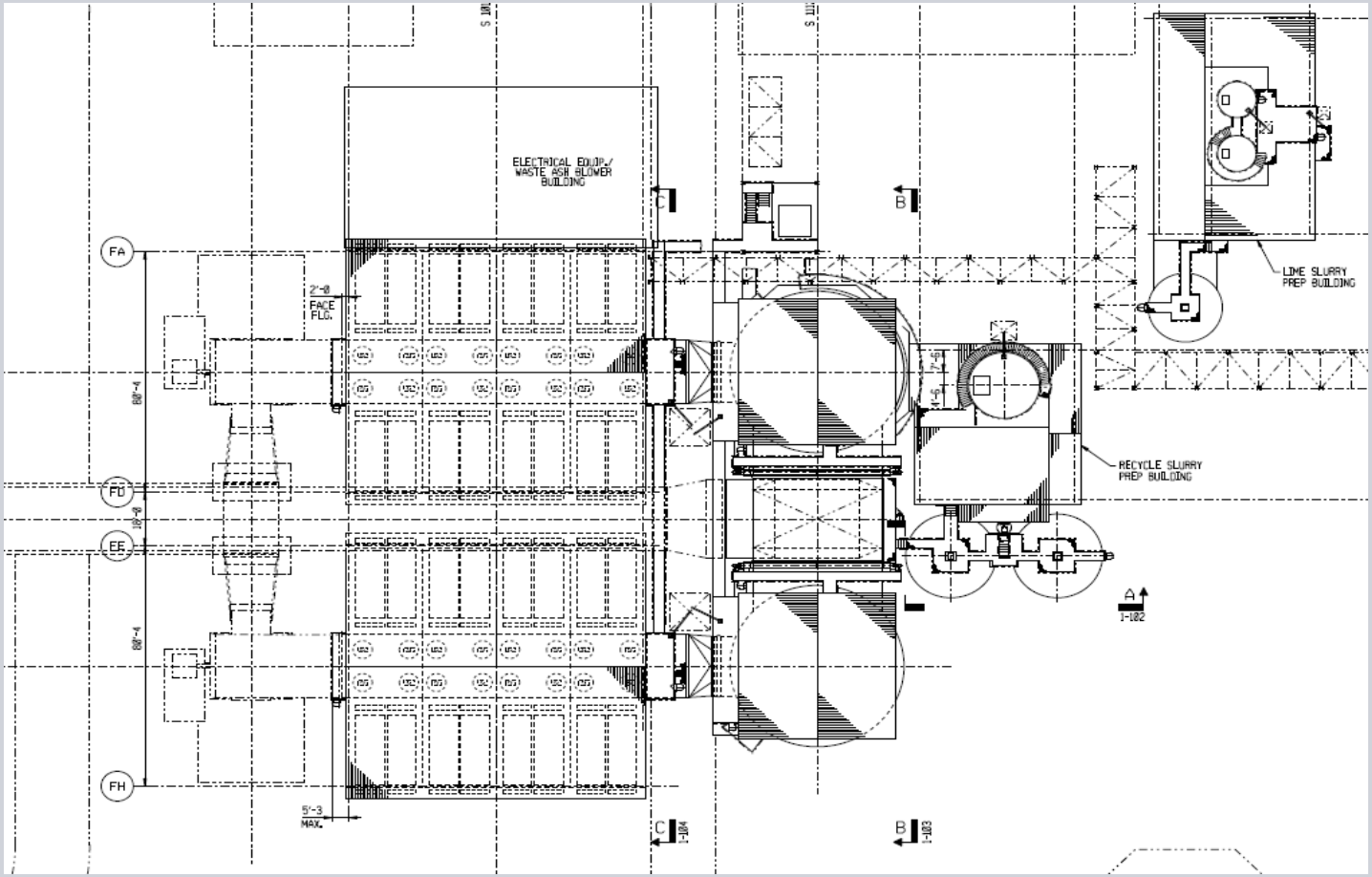


Dynegy Baldwin Unit 3 Layout



Dynegy Baldwin Design Basis

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Process Parameter	Units	Design		
Flue Gas Flow Rate		Unit 1	Unit 2	Unit 3
	Lb/hr	7,649,000		7,341,000
	ACFM	2,478,841		2,464,000
Flue Gas Temperature	ºF	285		322
Flue Gas Composition				
SO_2	Lb/hr	6,090		6,096
HCl	Lb/hr	72		144
Hg	Lb/hr	.072		0.0672
Fly Ash (ESP On)	Lb/hr	4,980		5,730
Fly Ash (ESP Off)	Lb/hr	40,000		50,000

Dynegy Baldwin Emission Requirements

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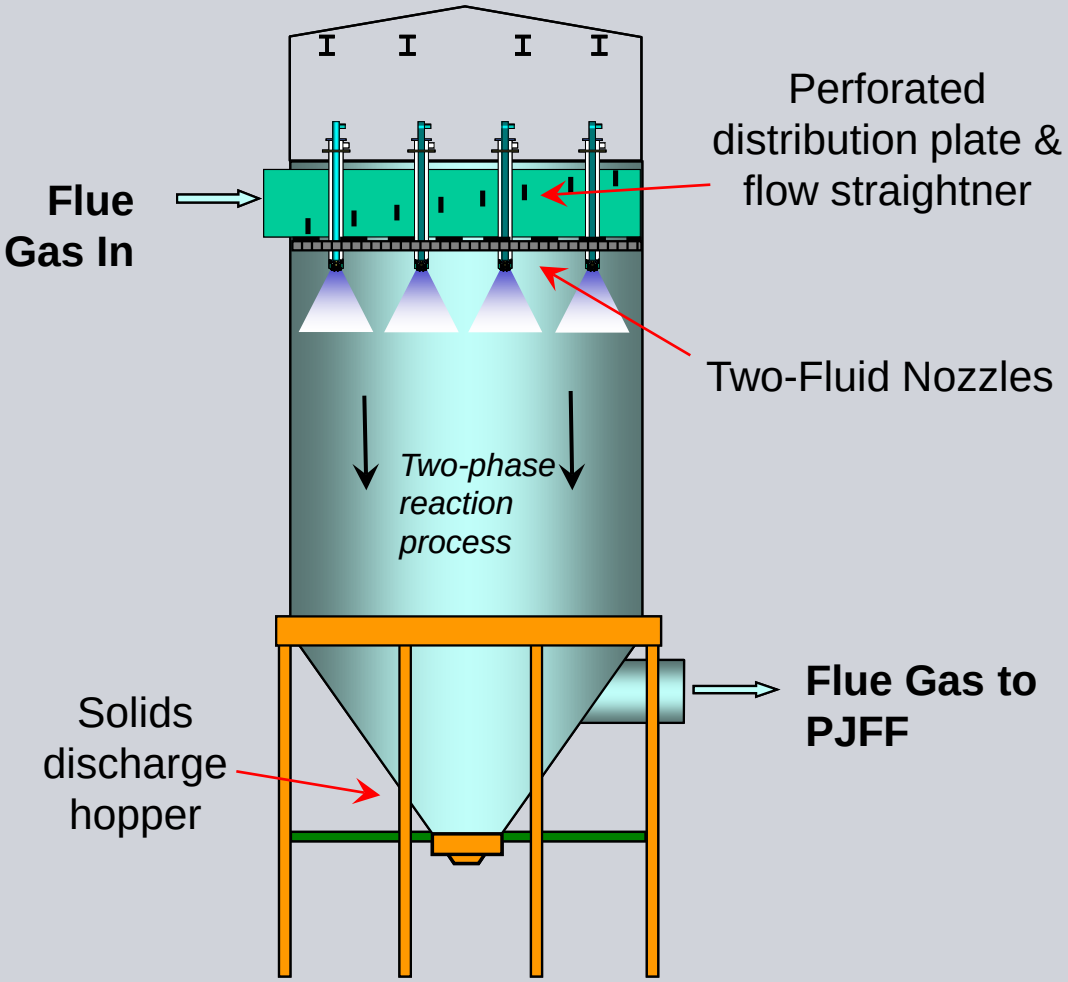
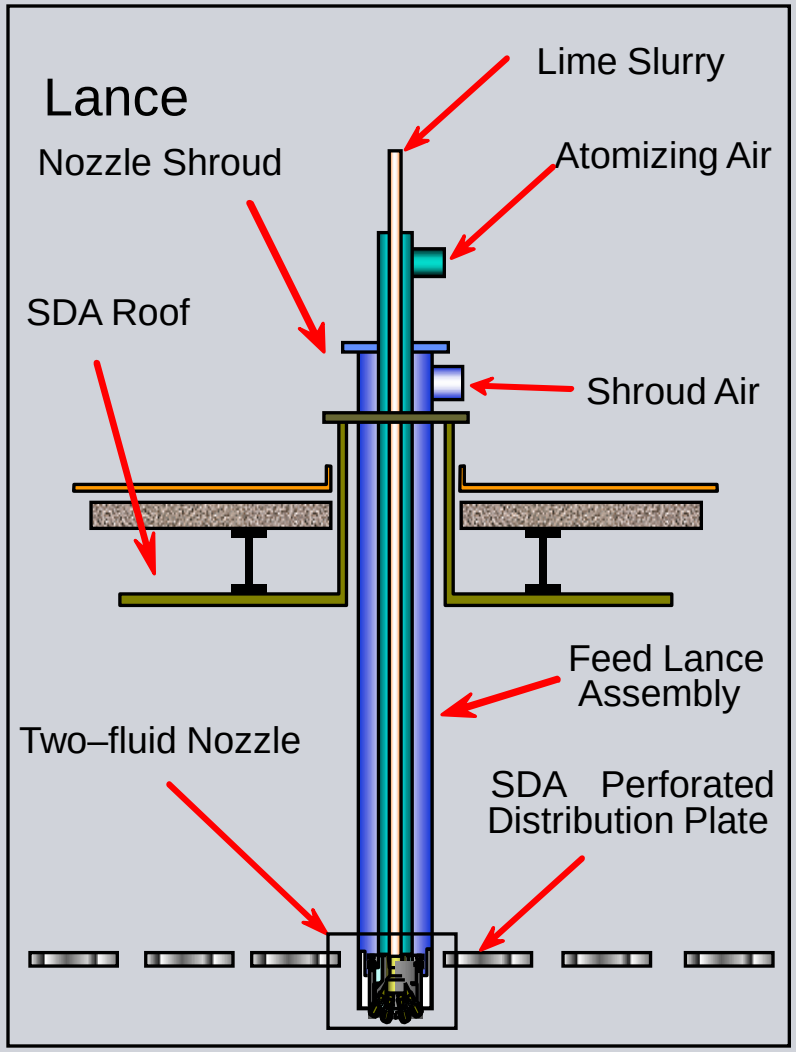
Process Parameter	Acceptance Criteria
SO_2 Removal/Emissions	0.080 lb/MMBtu (30 day average) 0.100 lb/mmBtu (1 hour average)
Solid Particulate Emissions	0.0120 lb/MMBtu (using EPA method 5)
Mercury Emissions	0.0080 lb/GWh
Opacity	less than 10%

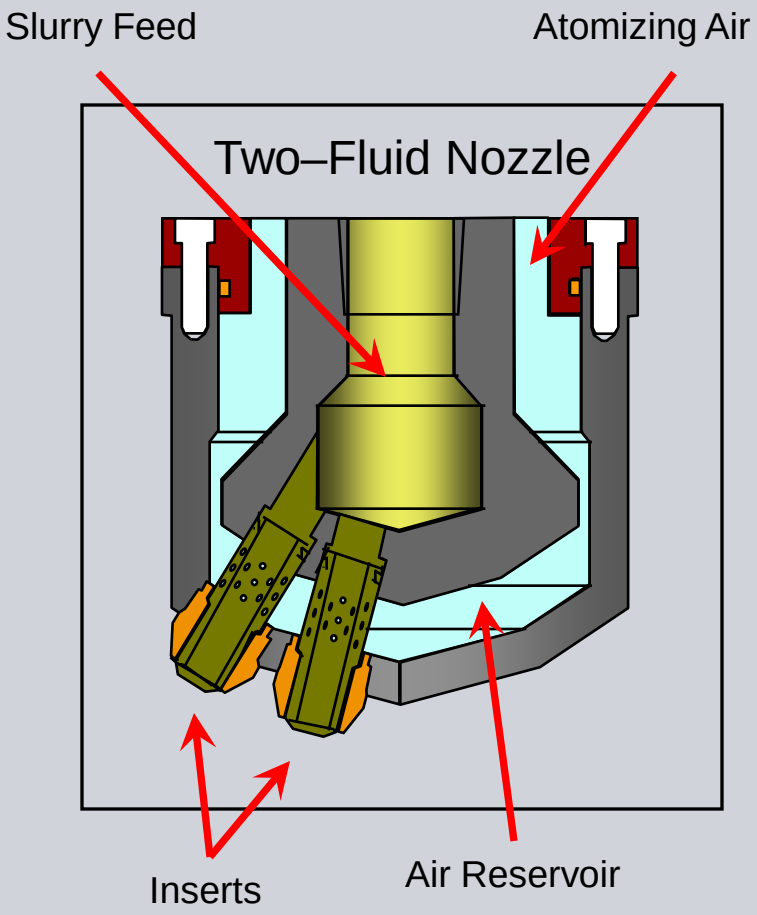
Two Fluid Nozzle Spray Dryer Absorber

SIEMENS

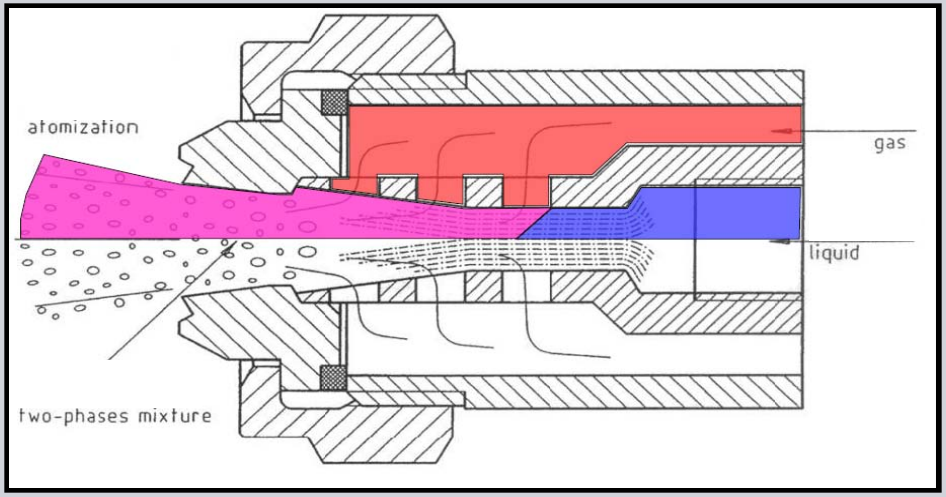


Two Fluid Nozzle/Lance Assembly





Internal Mix Two Fluid Nozzle

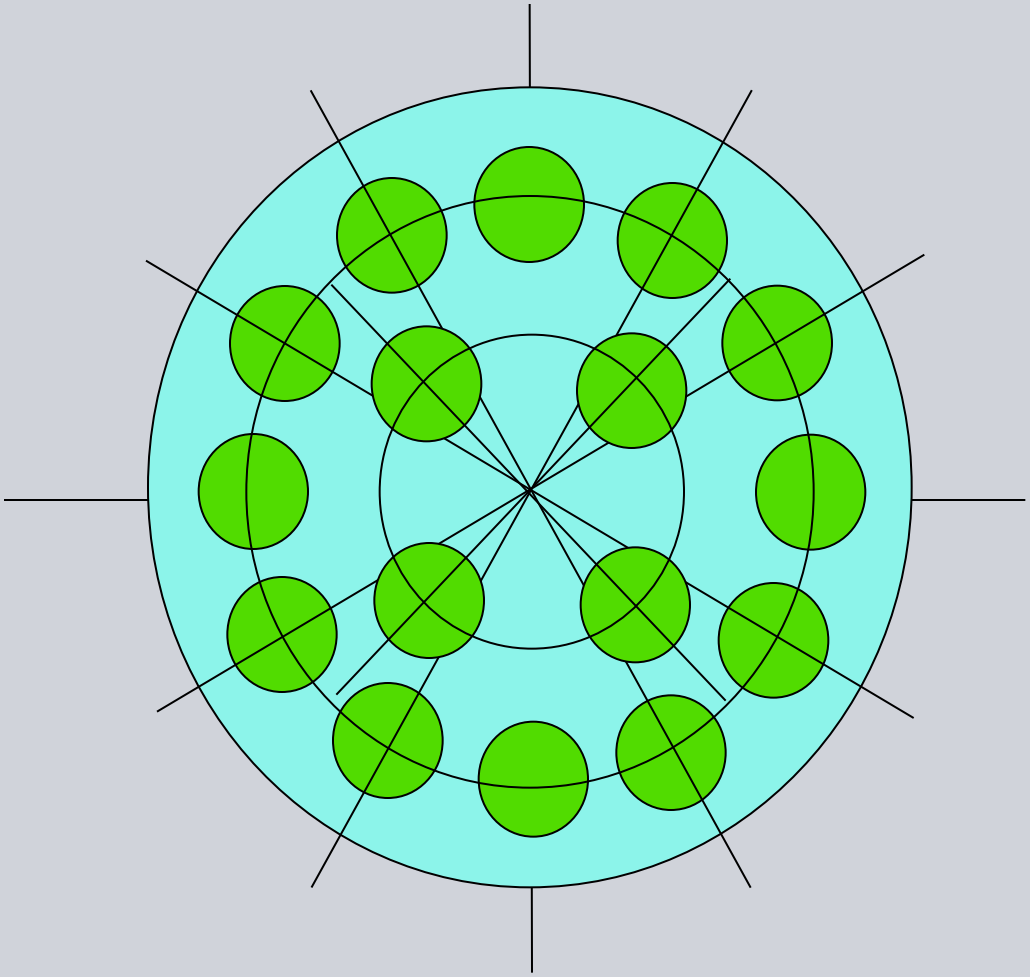


Spray Dryer Absorber Technology
Two Fluid Nozzle Operation - Video

Spray Dryer Absorber Technology
Nozzle Array

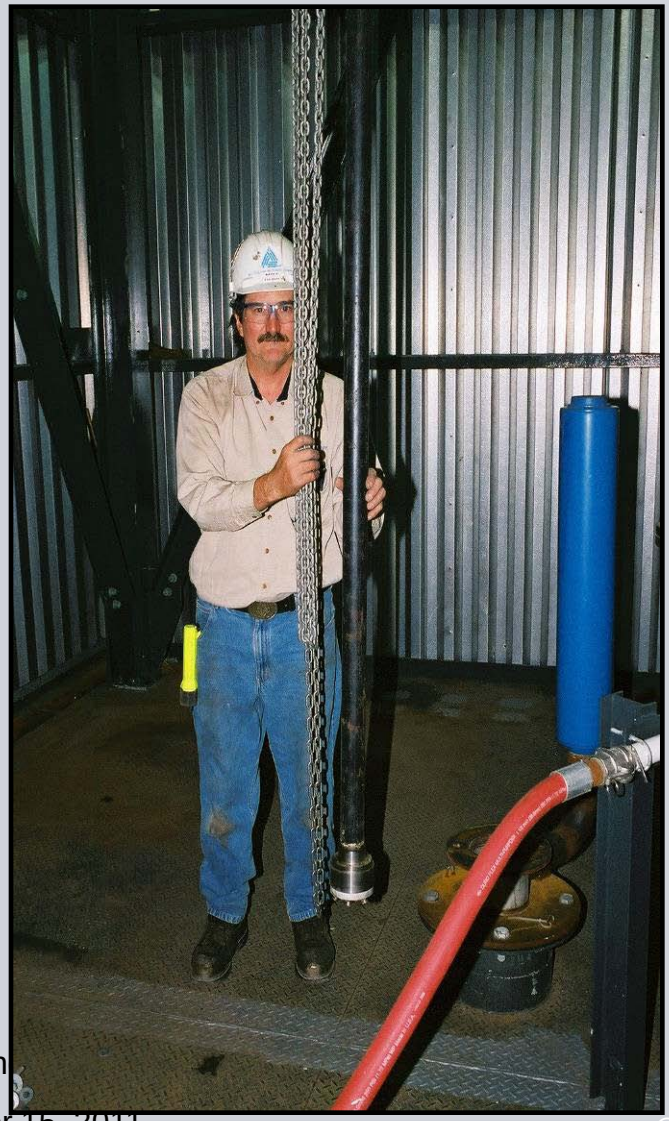
Extensive Array means:

- Flue Gas turndown in a single absorber is easily attained while maintaining performance (Typically 30%-100% load)
- Nozzle Maintenance is flexible
- Maximum Flue Gas coverage



Spray Dryer Absorber Technology

Nozzle Station



Spray Dryer Absorber Technology

Two Fluid Nozzle Lance Removal - Video

Lime Slaking Systems

- Vertical Mill vs. Detention Type
- Process Parameters
- Maintenance

Vertical Lime Slaking System

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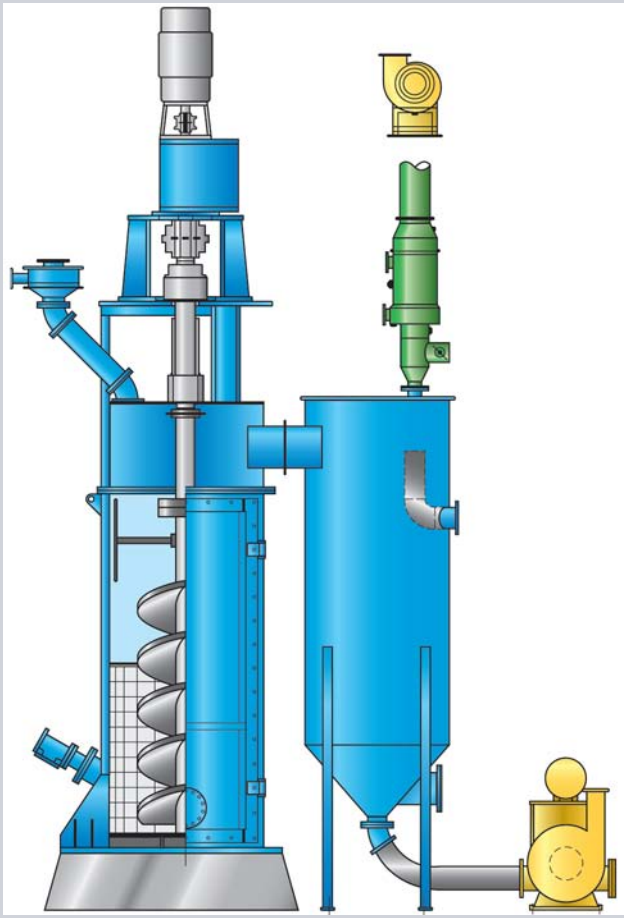
- Lime/Water enters top of Mill
- Slurry Overflows Mill to Separator Tank
- Mill Pump Circulates Slurry w/oversize material from Separator to bottom of Mill
- Smaller Particles/Slurry overflow Separator to Transfer Tank

- Larger Capacity, > 7 tph
- Grinds/Consumes Inerts
- Higher Power Consumption



Detention Type Slaking System

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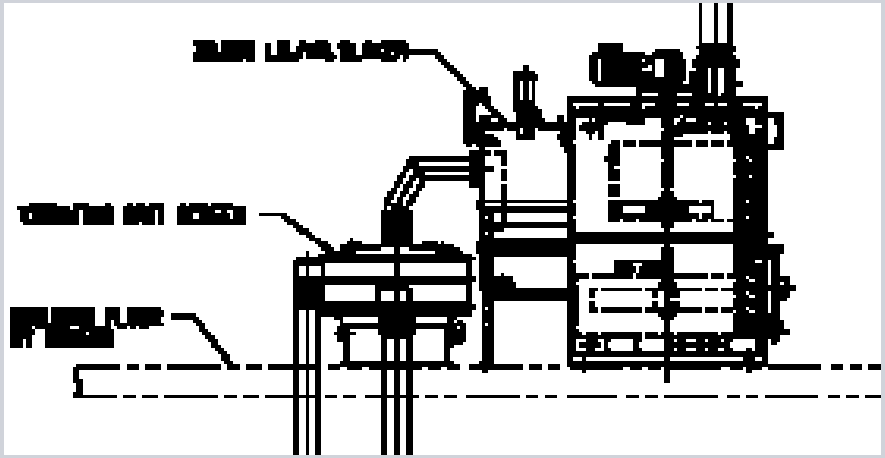
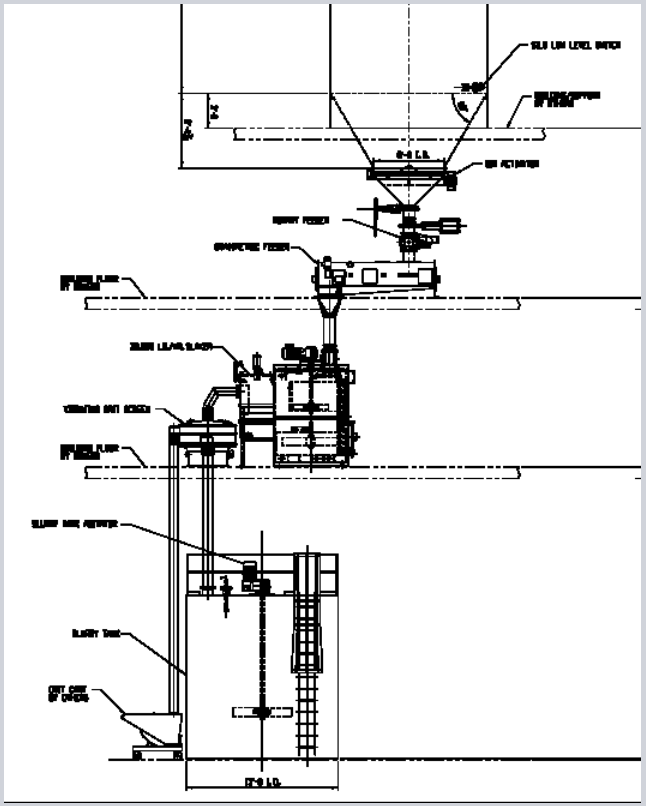
- 1 of 2 Agitated Chambers
- Water/Lime Ratio controlled
- Vibrating Grit Screen
- 20 wt% Slurry produced





Lime Slaking Systems

SIEMENS

$CaO + H_2O \rightarrow Ca(OH)_2 + Heat$

- Pebble Lime or Quick Lime
- Surface Reaction – Ca(OH)2 wash off the Pebble Lime Surface
- High Reaction Temperature (180^o-190^{o}F) Provides Smaller More Reactive Particle (5 micron)

Process Factors

- Lime Reactivity – ASTM C110-7 (Temperature Rise)
- Water Temperature
- Water Quality (< 500 ppm SO3, SO4, HSO3)
- Particle Size

Slaker Control

- Water Lime Ratio

DFGD System Process Water Requirements

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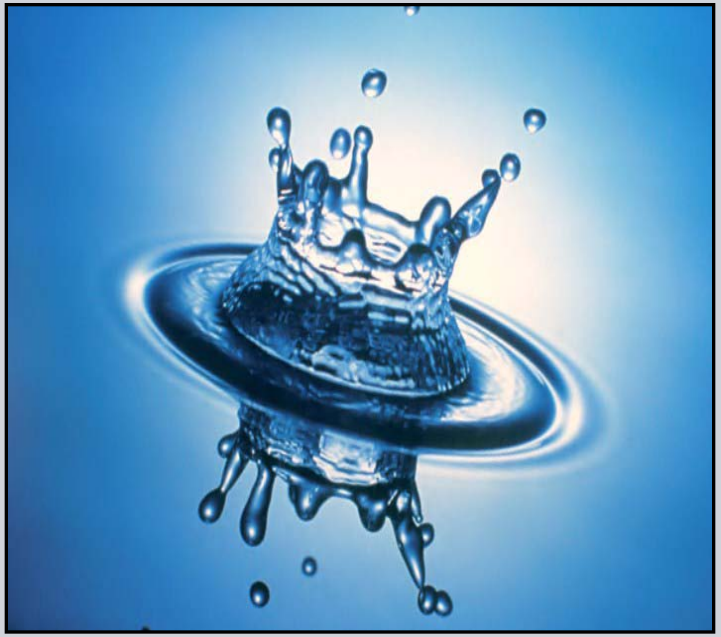
Slaking Water

Inlet Temperature:	≥ 60°F
Total Dissolved Solids:	≤ 1,000 ppm
Total Sulfate, Sulfite, Bisulfite:	≤ 500 ppm
Total Suspended Solids:	≤ 50 ppm

Seal Water

Total Suspended Solids (Hard Water):	≤ 50 ppm
Total Suspended Solids (Soft Water):	≤ 50 ppm
Maximum Particle Size:	40 µm



Dilution Water (Recycle Ash)

pH:	6 < pH < 8.5
Chlorides:	≤ 1,000 ppm

Baldwin Vertimill Lime Slaker

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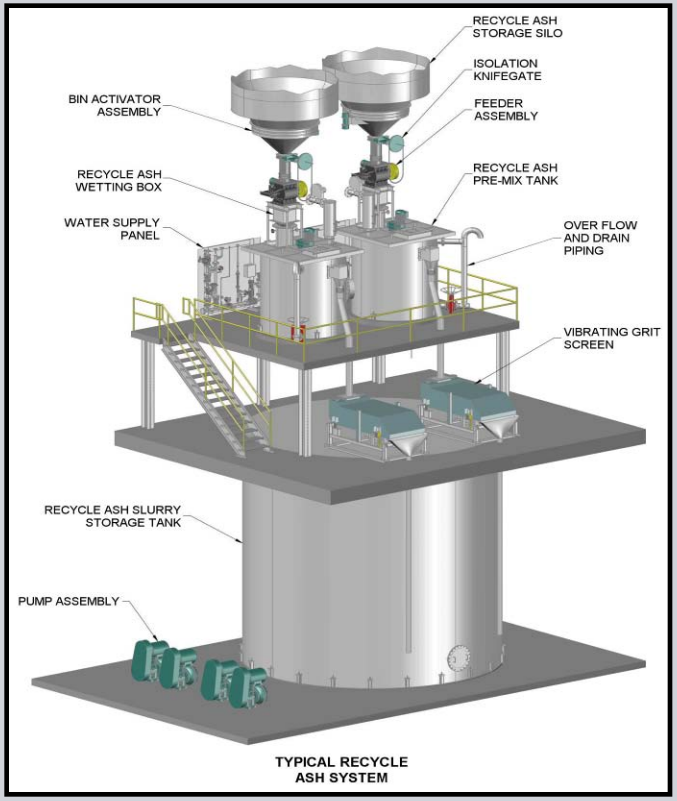
Recycle Slurry Preparation Systems

- Reaction Product Surge Bin
- Silo live bottom
- Redundant Mix Tank
- Redundant Grit Screen
- Recycle Slurry Storage Tank(s)



Recycle Slurry Agitator

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Slurry Handling

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- Centrifugal Pumps
  - Casing Liners
  - Hardened Impellers
  - Automatic flush/Drain
- Slurry Recirculation Loops
  - Maintain 4-10 fps
- Pipe material
  - Fiberglass with abrasion resistant liner
  - Heavy wall carbon steel

Slurry Pumps

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Two fluid Nozzle SDA Advantages

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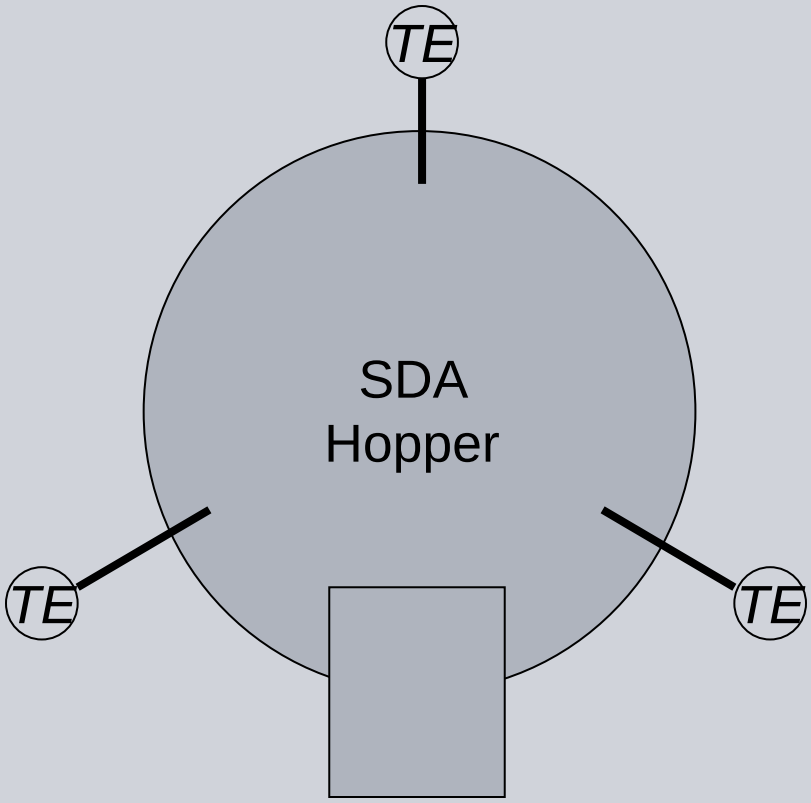
- Individual nozzles can be easily maintained while keeping the system online
- Nozzle maintenance is straightforward and does not require special tools or training
- Plug flow design ensures an even distribution of flow through the SDA vessel and allows for large single absorbers
- Overall design is simple and robust which reduces maintenance issues that can be encountered with expensive mechanical systems

Trouble Shooting: SDA

- SDA Hopper Temperature
  - SDA Hopper temperate should be close to equal to the Flue Gas Outlet temperature
  - High temperature differential indicates the presence of a dirty nozzle
- Nozzle Pressure Loss
  - Monitor pressure of clean nozzle
  - As nozzle gets dirty, pressure will increase
  - Use this to determine which nozzle is dirty



Intermediate Pressure Pulse Jet Fabric Filter

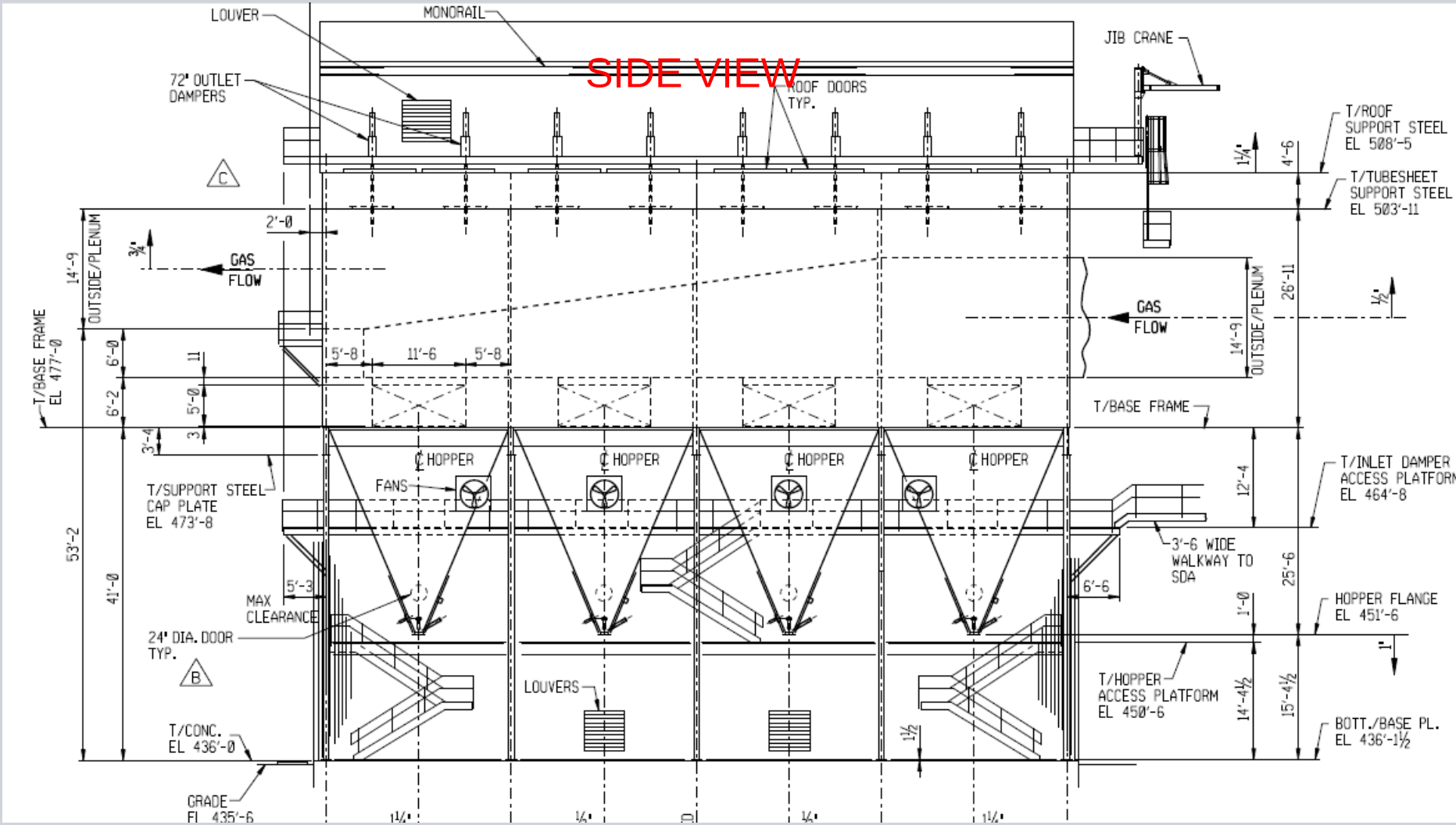
Intermediate Pulse Jet Fabric Filter

SIEMENS

- Twp 50% Capacity Casings
- 8 Compartments/Casing
  - 1,080 Bags per Compartment (18,240) total)
    - 5.25 in dia. x 315 in long PPS Felt
    - 12 vertical wire carbon steel support cages
- 3.5 fpm Filtering Velocity
- On-line Cleaning

Intermediate Pressure Pulse Jet Fabric filter

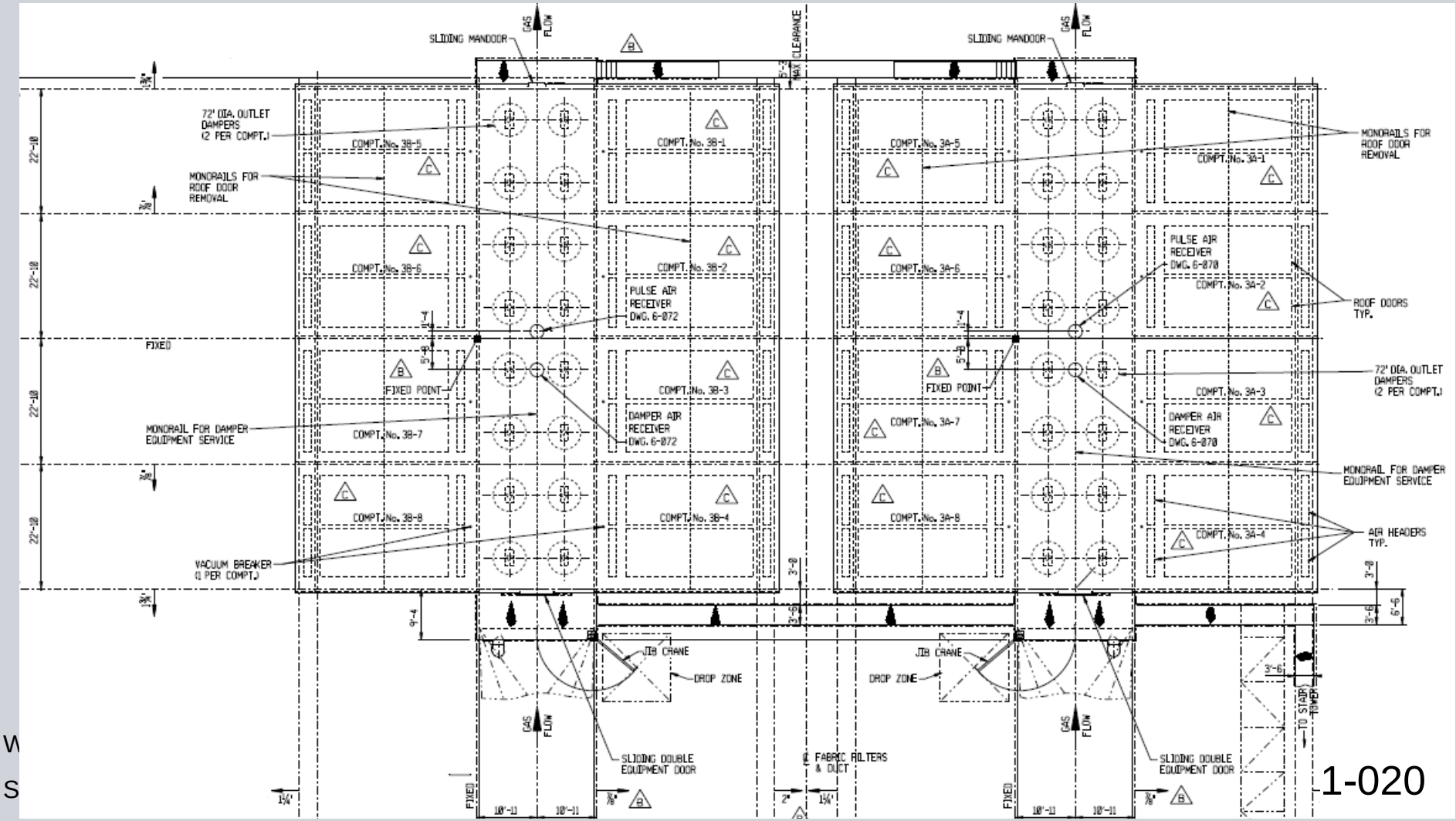
SIEMENS



PJFF Layout

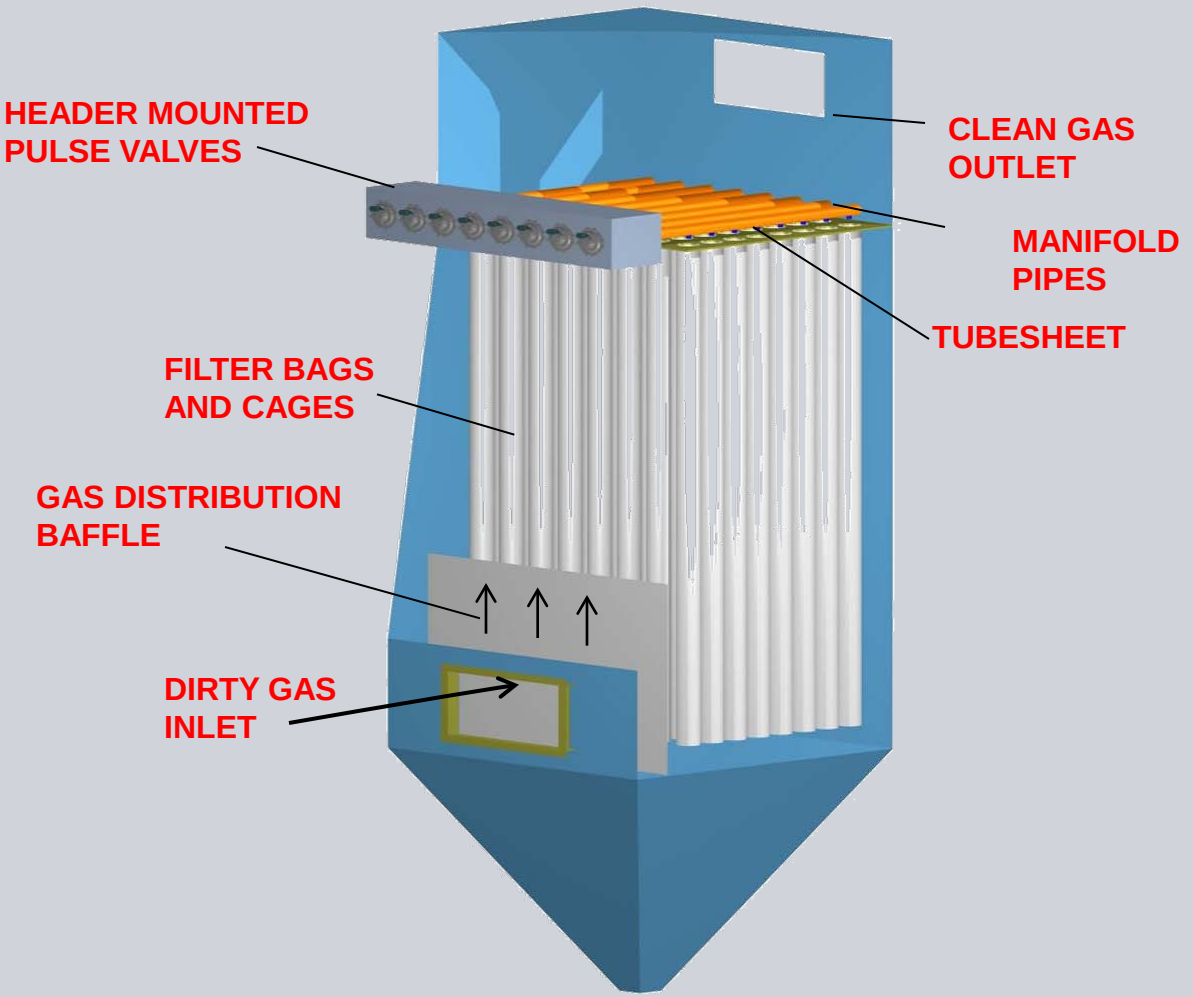
SIEMENS

TOP VIEW



Fabric Filter Technology
Jet VIP™ Pulse Systems

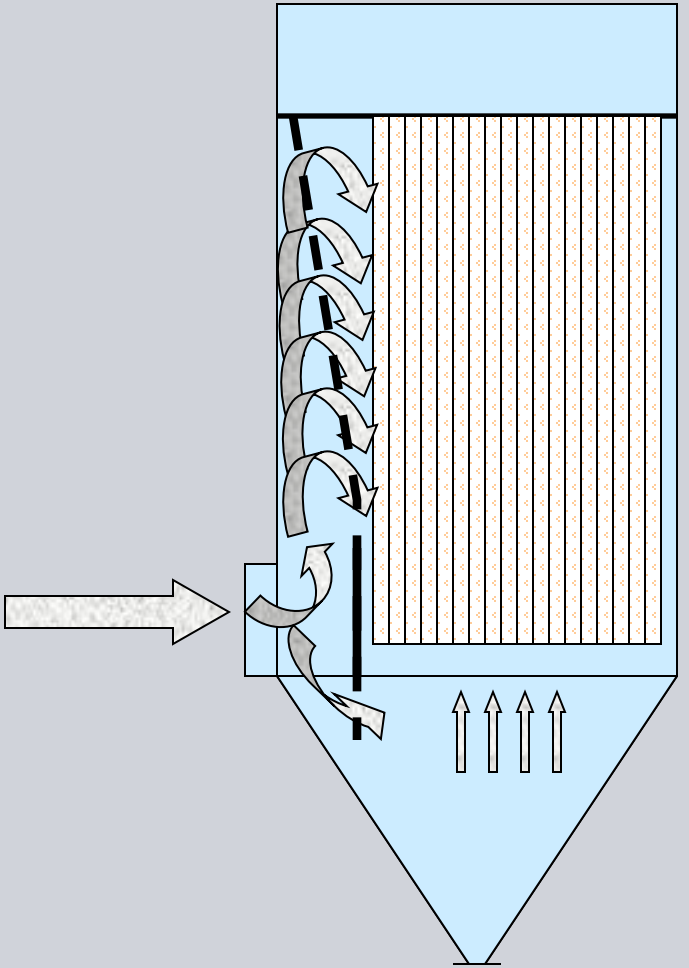
- Intermediate Pulse Pressure, 35 psig
- Designed for Long Bags (>10 m)
- On-Line cleaning
- Low Compressed Air Consumption
- Long Bag Life
- Ability to take compartments offline for maintenance



SIEMENS

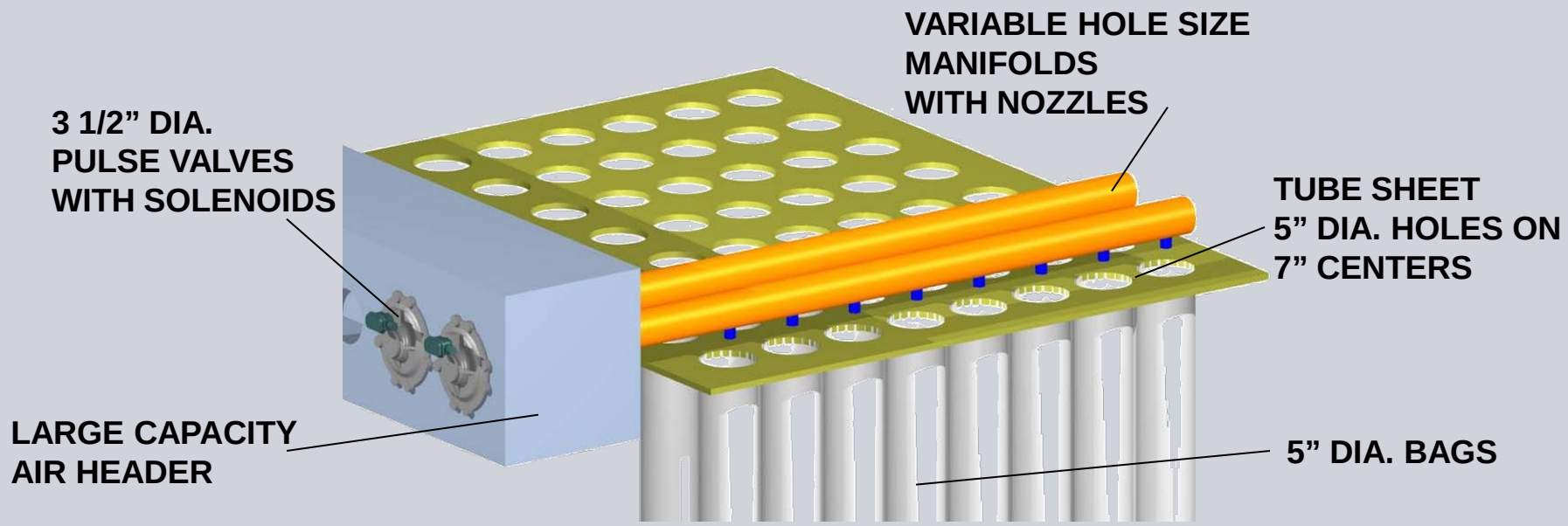
Jet VIP Gas Flow Distribution

- Split Gas Entry
- Low “Can” Velocity
- Minimizes Re-Entrainment
- On-Line Cleaning
- Low Cleaning Frequency



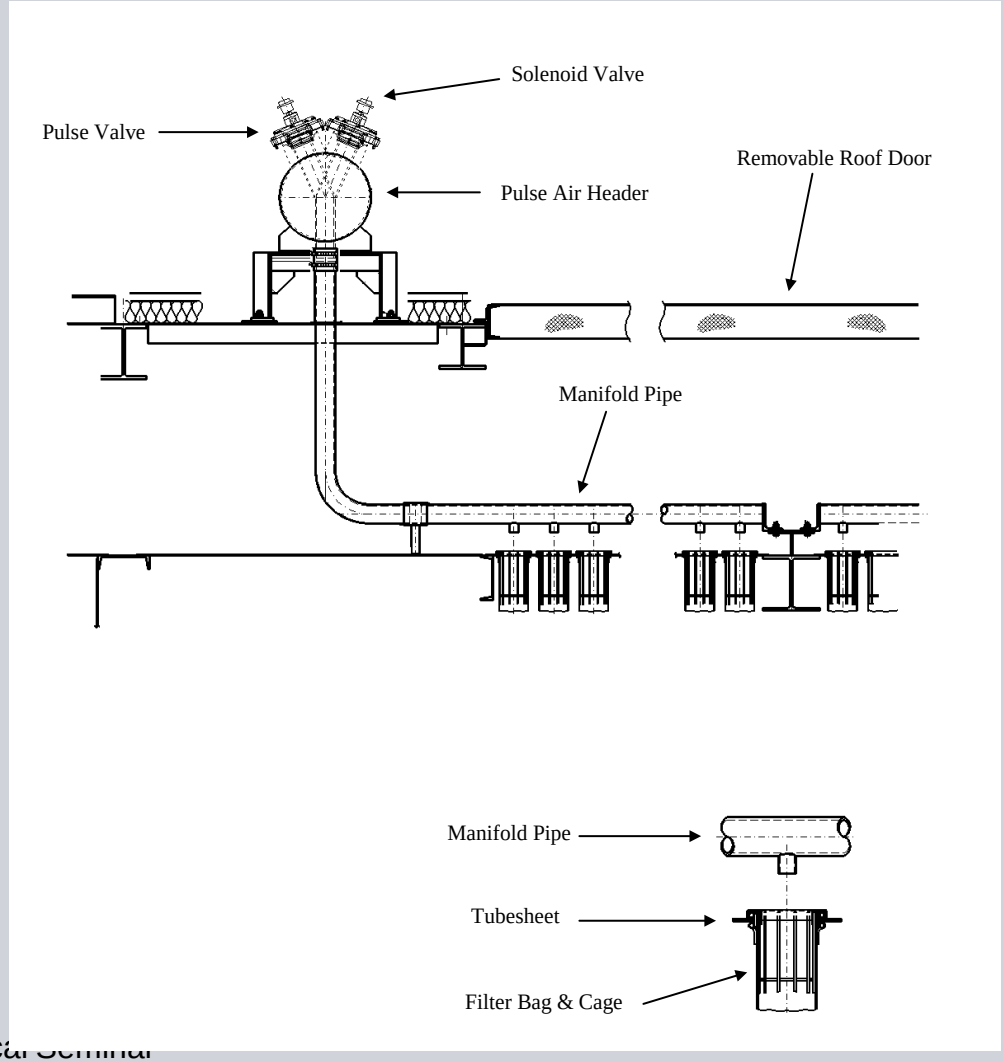
SESS Fabric Filter Design Advantages

SIEMENS



Section II: PJFF
Physical Arrangement & Details of Equipment

SIEMENS



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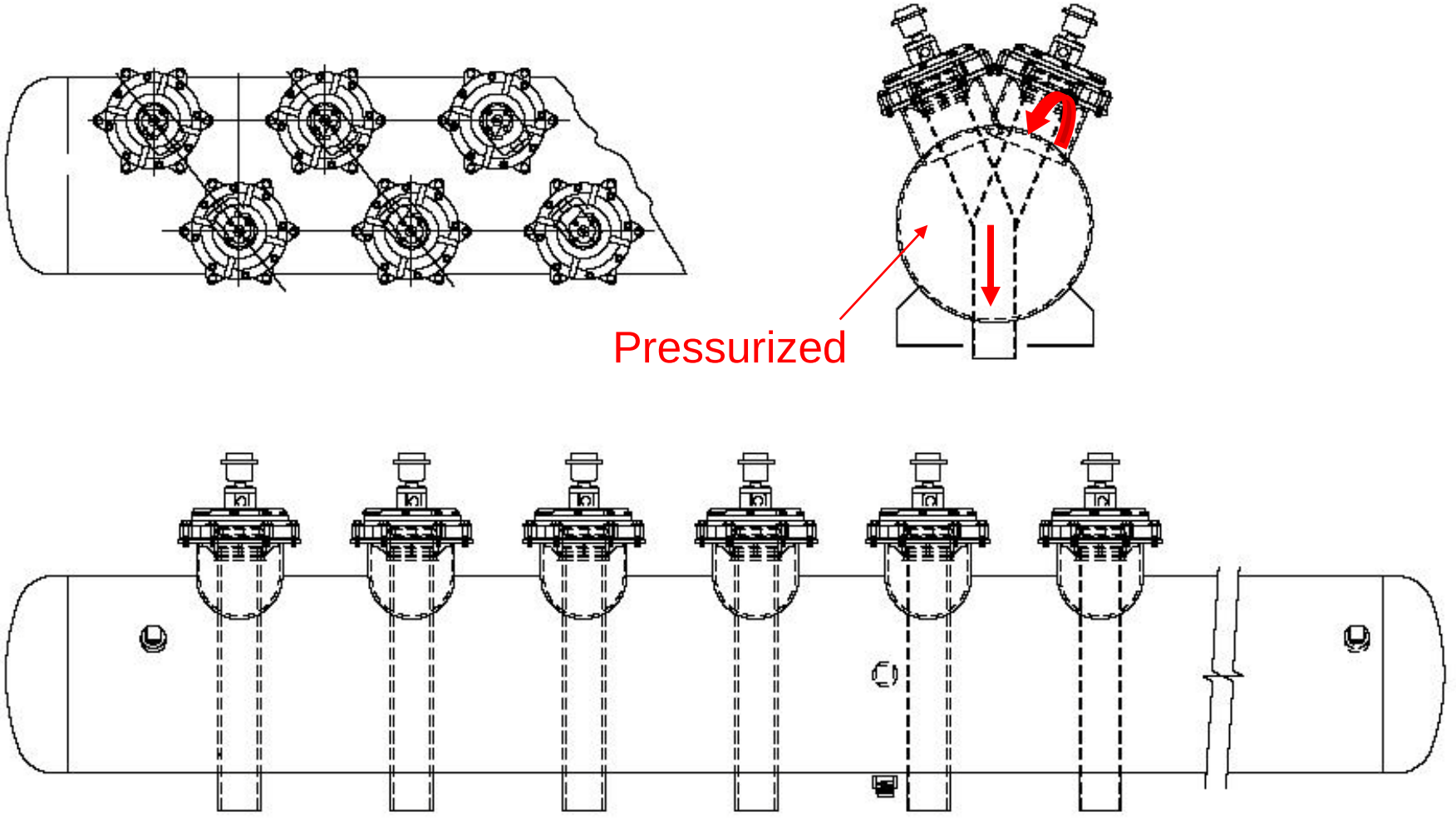
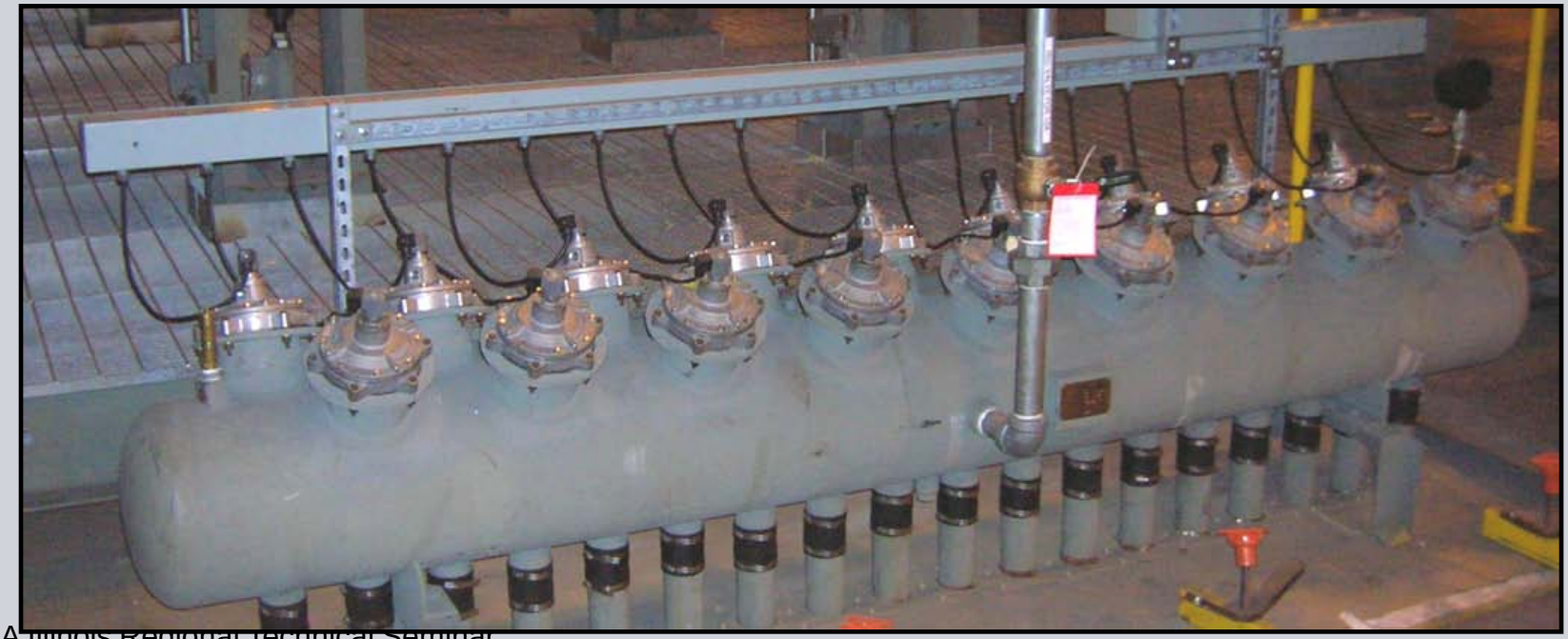


Compressed Air Header

- Multiple Headers Per Compartment (Typically 4)
- Multiple Pulse Valves Per Header
- Pressure Regulated to 35 psig
- Safety Relief Valve



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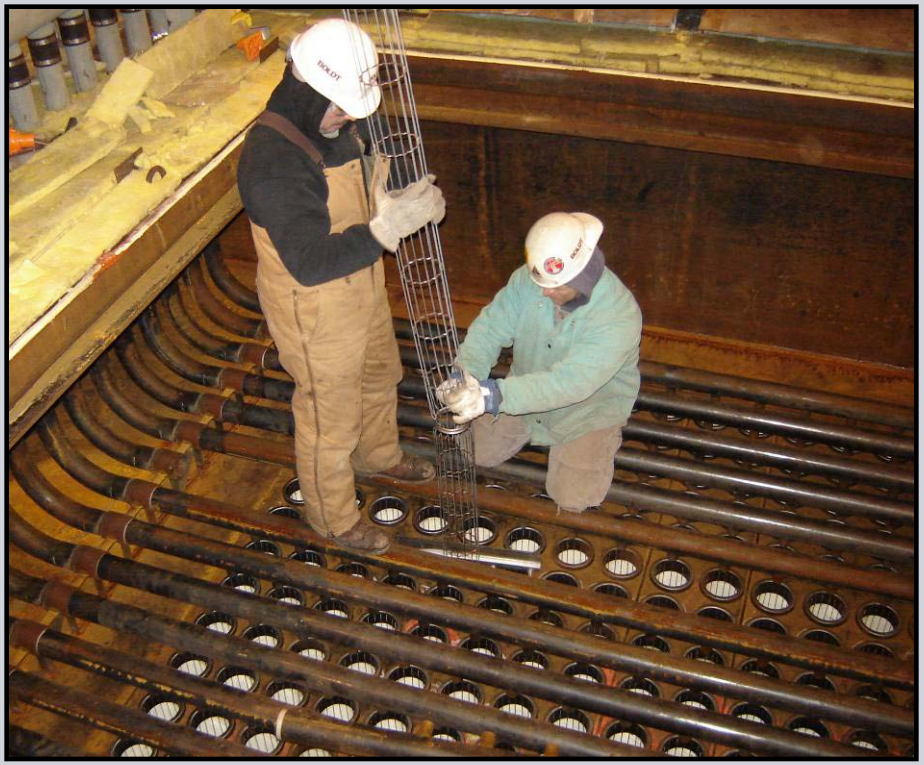
Filter Bag & Cage Installation

Positive Seal Formed By SS Snap Ring Sewn Into the Bag, Seated Against the Tubesheet.

"No-Tools" Installation



SESS Fabric Filter Design Advantages

SIEMENS

Filter Bag Material (SDA Service)

- PPS (Utility)
- Fiberglass w/ PTFE

Cages

- Two Piece
- Carbon Steel Wire
- 16 Vertical Wires

Roof Door & Penthouse Enclosure

- Roof Door Access
  - No Confined-Space Entry
  - Compartment Ventilation System Not Required
  - 2-Piece Cages
- Fully Ventilated & Lighted Enclosure
- All Roof Equipment & Access Within Enclosure

Thank You for Your Attention!