

Babcock Power Inc.



One Source

Many Solutions

One Purpose

WPCA Scrubber Seminar

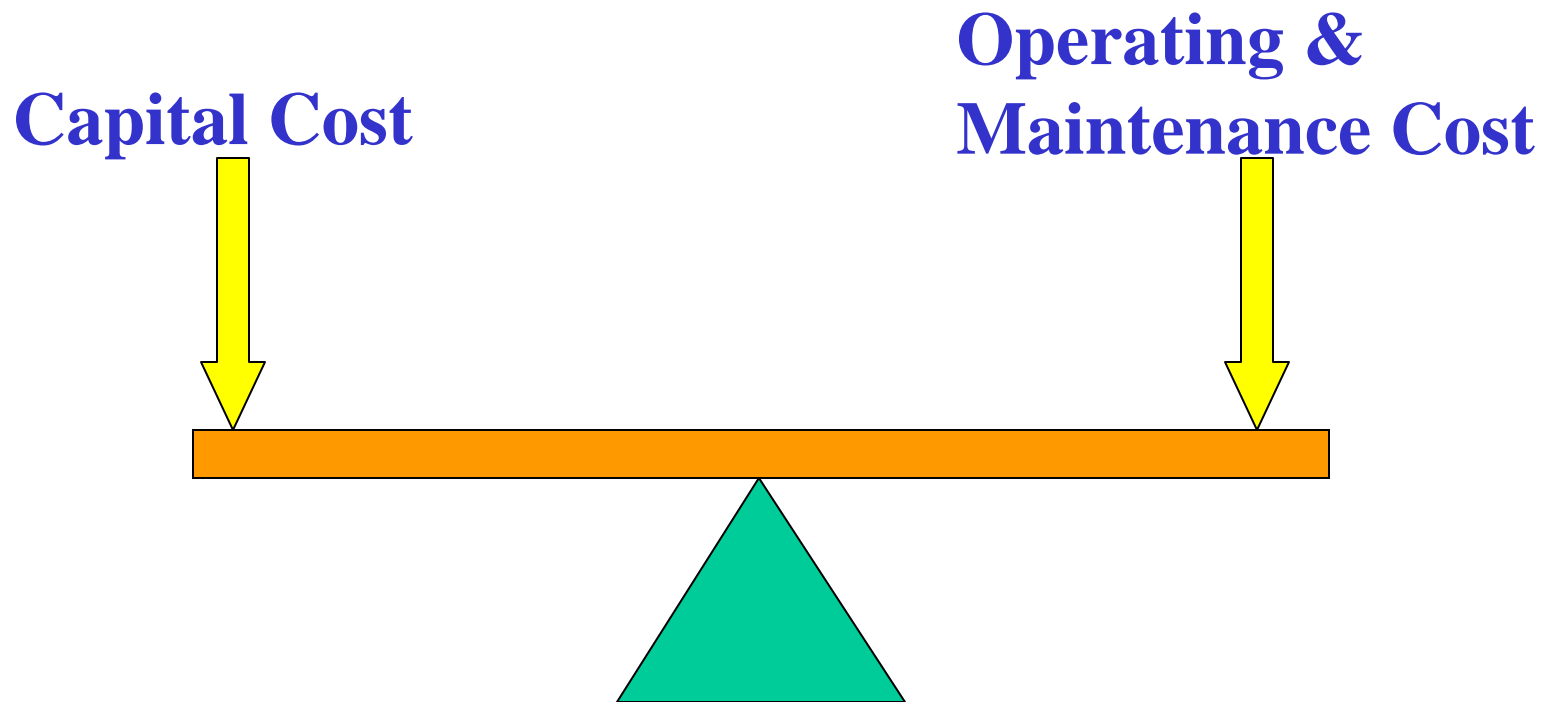
WFGD Maintenance

Tony Licata

Babcock Power Environmental Inc.



Total Cost



Wet Scrubbing Challenges

- Liquid to Gas Ratio
- Oxidation
- Chloride Concentration (Blowdown)
- Gypsum
- O&M
- Turndown

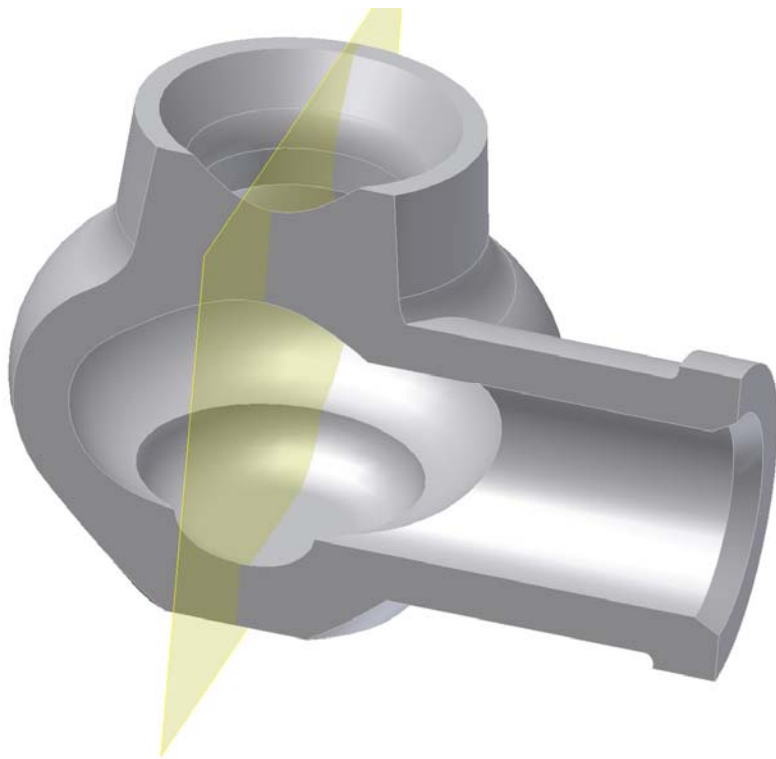


FGD Maintenance Challenges

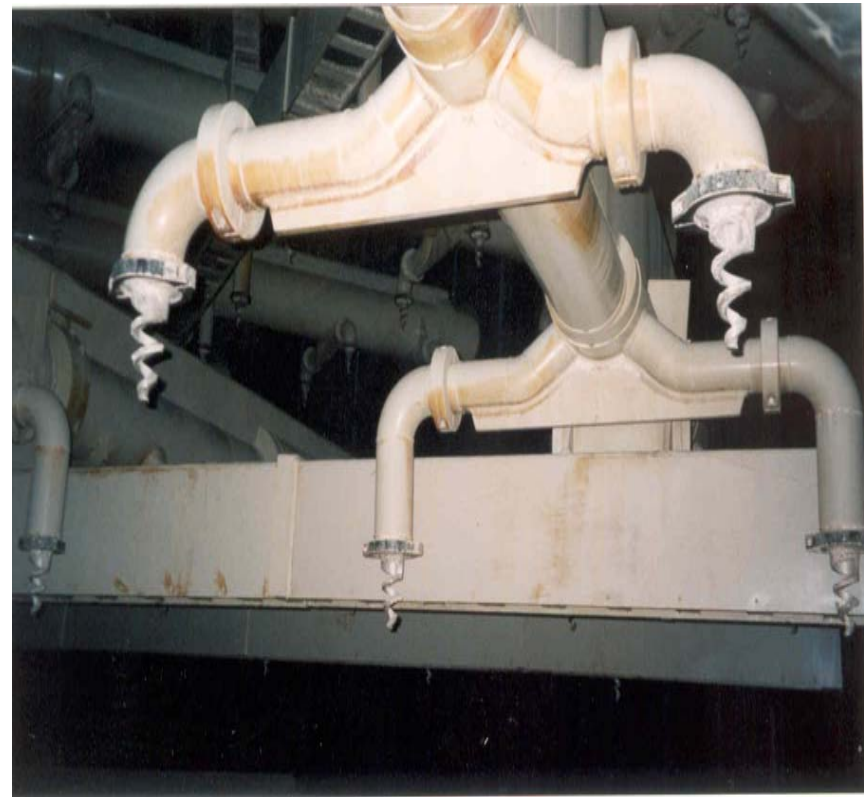
- Mist Eliminator Washing
- Plugged Nozzles/Lines
- Filtering Process
- Limestone/lime Storage-prep
- Cleaning/Safety
- Availability
 - Outage schedule
- Compliance



**New nozzles tend
not to plug**



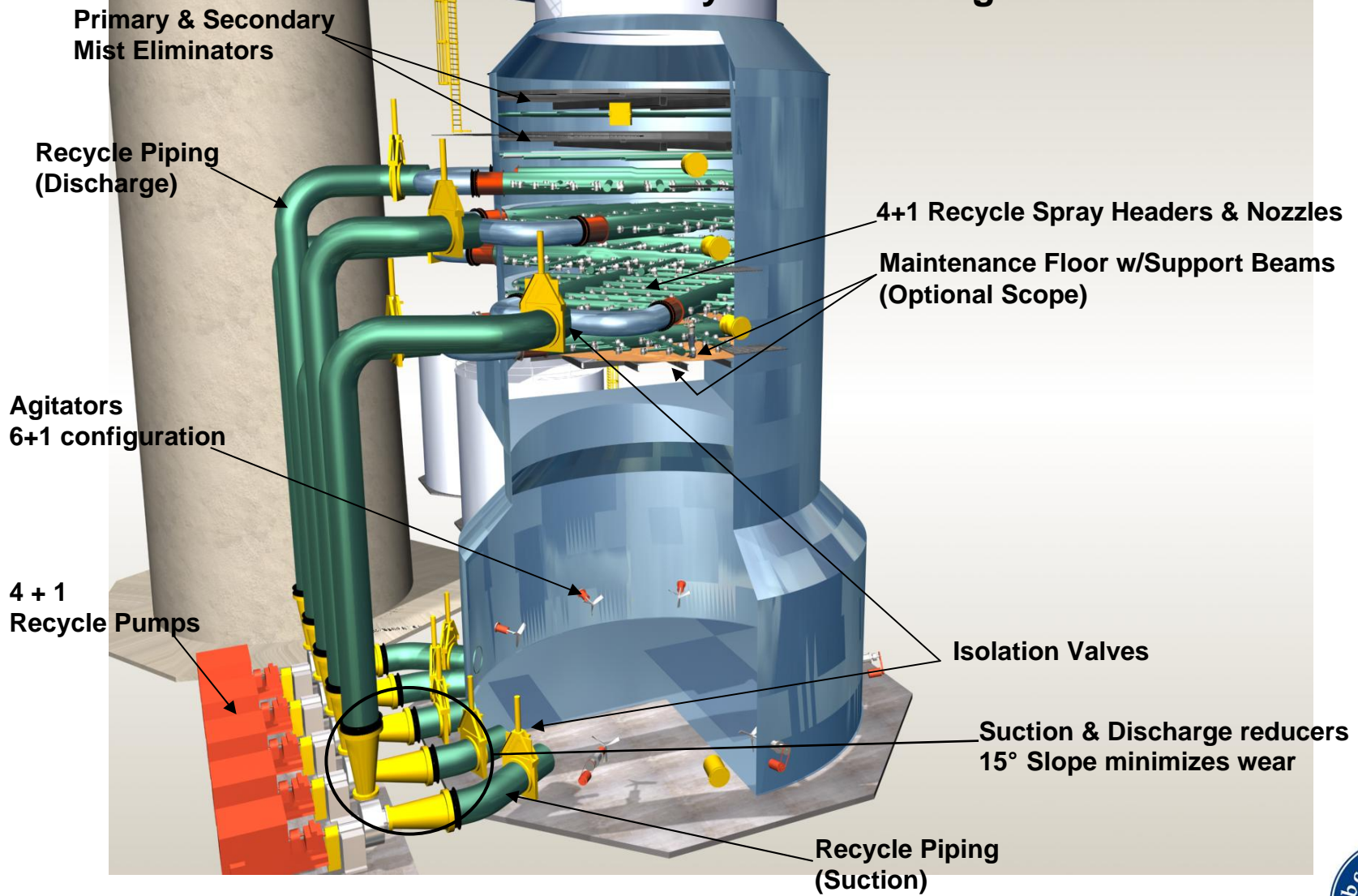
**Old nozzle design –
plugging problems**



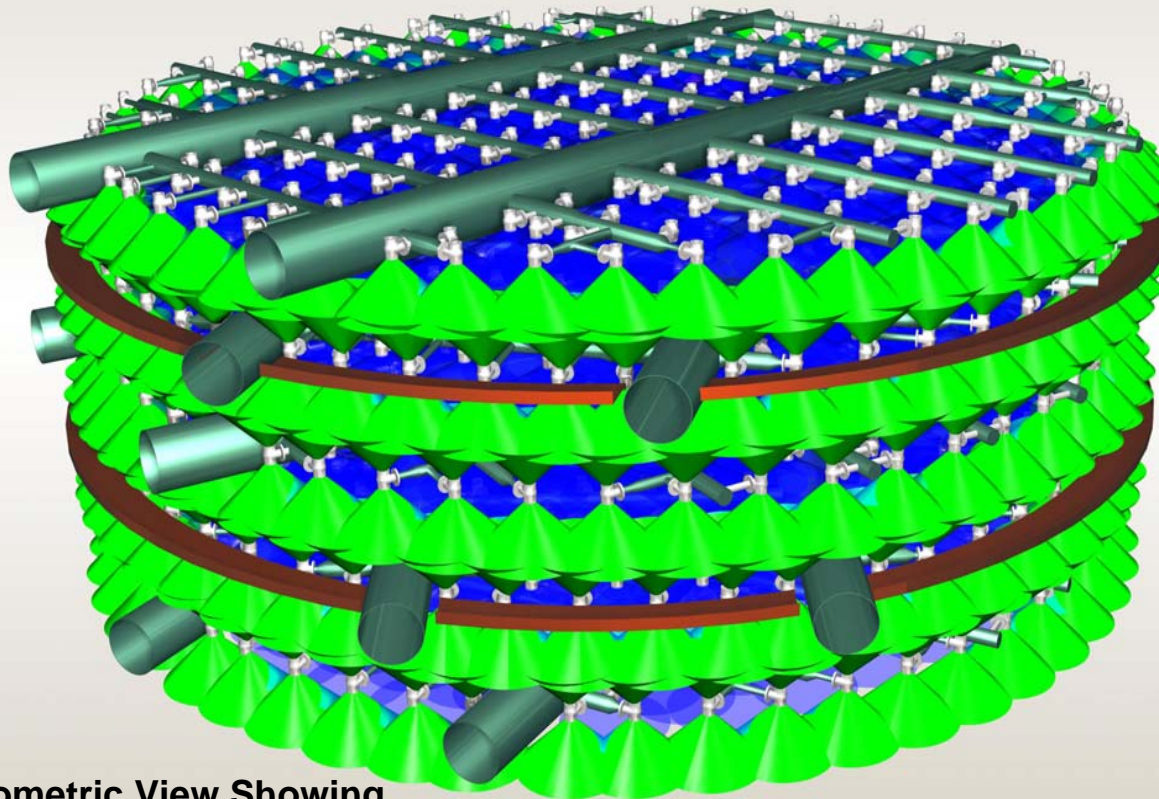
Absorber Internals



Absorber Island Cutaway View Showing Absorber Internals

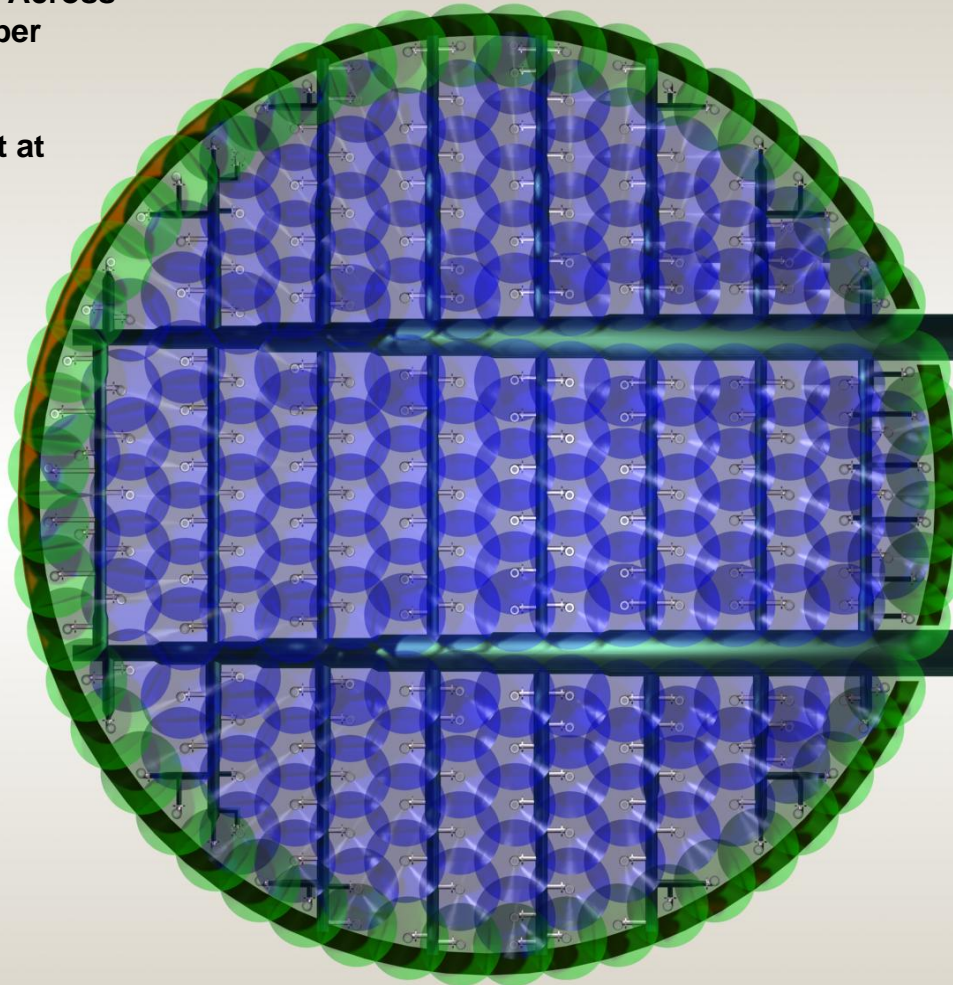


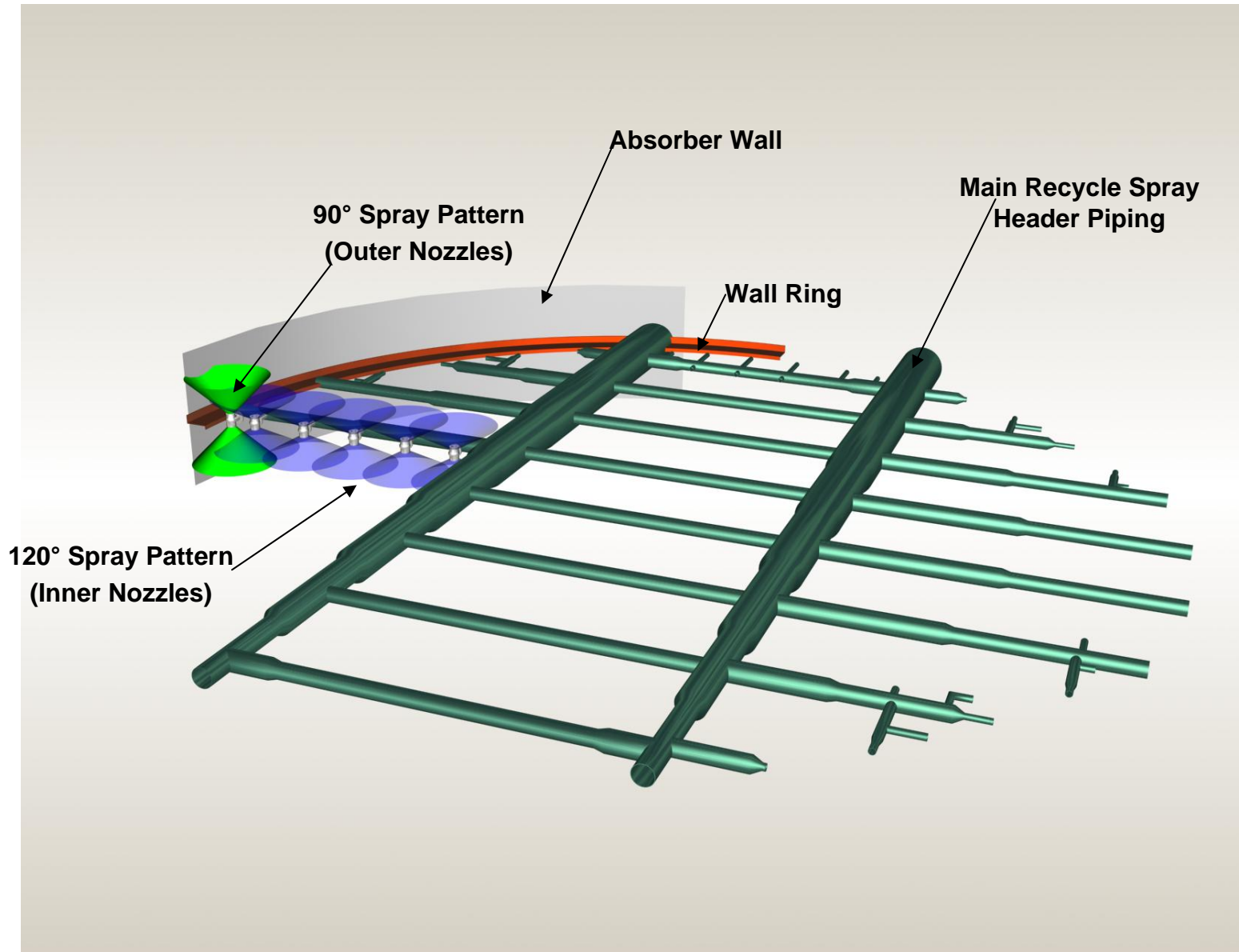
**Note: All Elevations Spray In 2
Directions Except the Top Spray Level
To Avoid Clogging of Mist Eliminators**



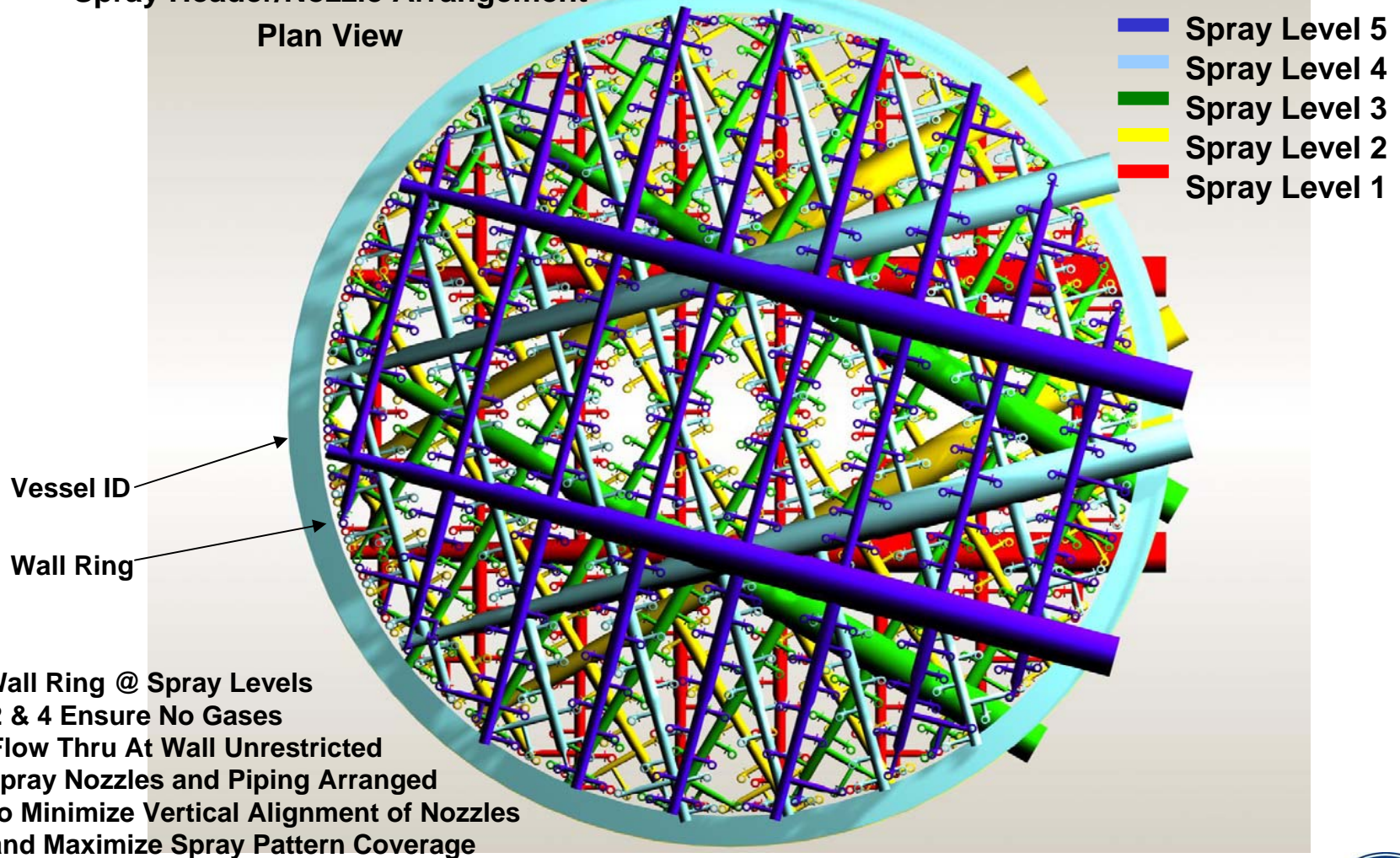
**Isometric View Showing
Spray Pattern Across Five Levels**

- **Spray Nozzles Arranged To Provide Full Coverage Across The Section of the Absorber**
- **Outer Nozzles Arranged to Ensure Maximum Coverage And Reduce Impingement at The Absorber Wall**

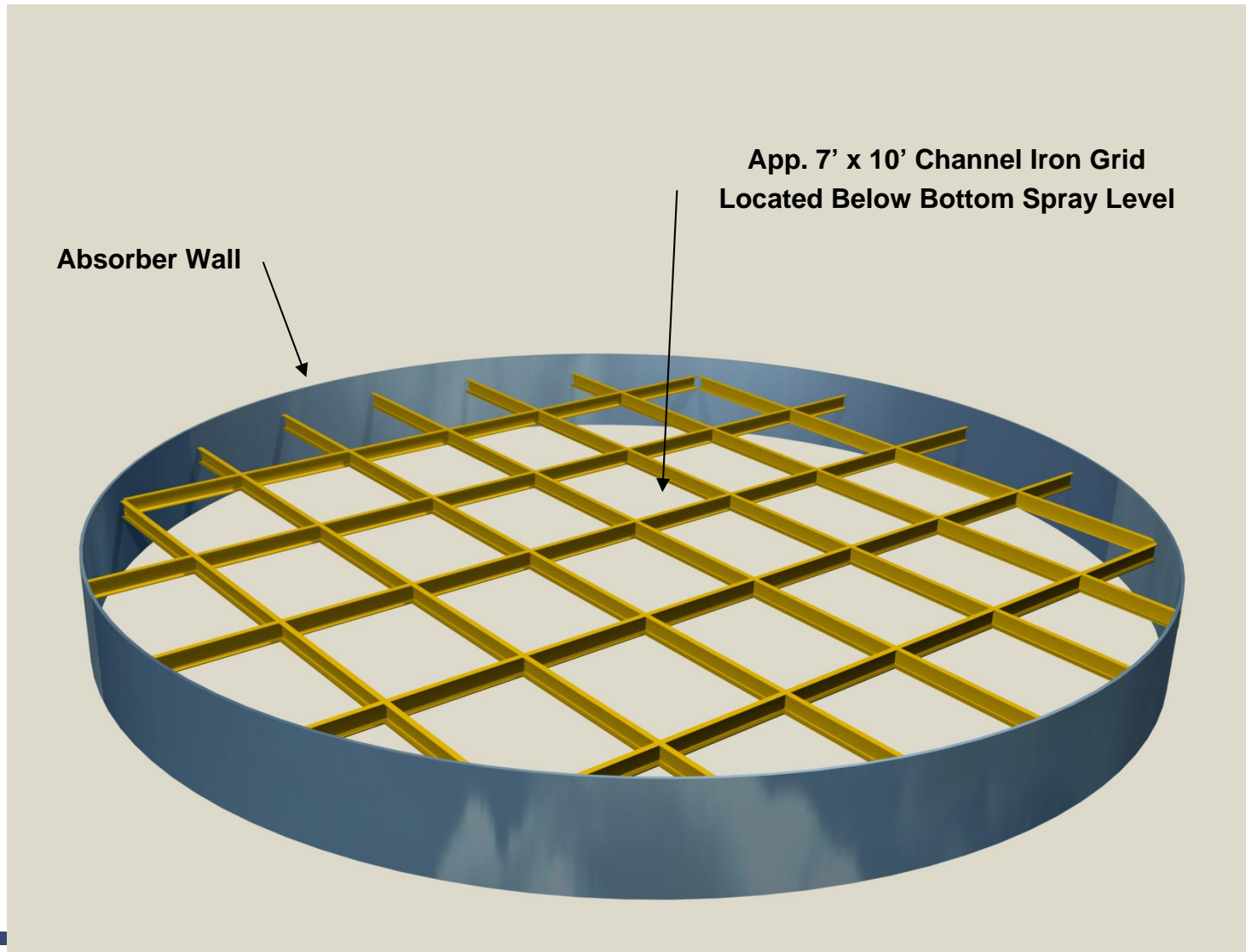




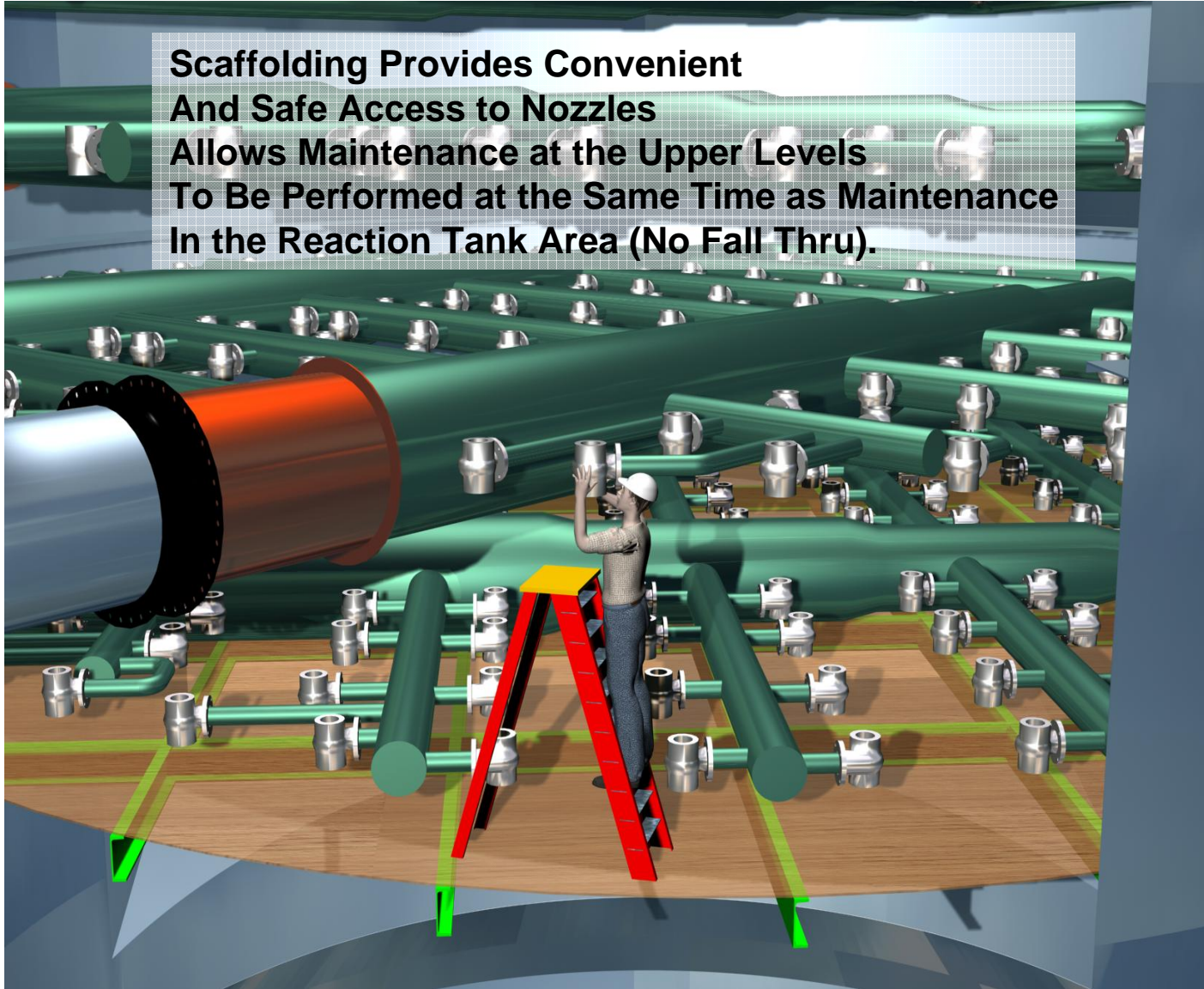
Spray Header/Nozzle Arrangement Plan View



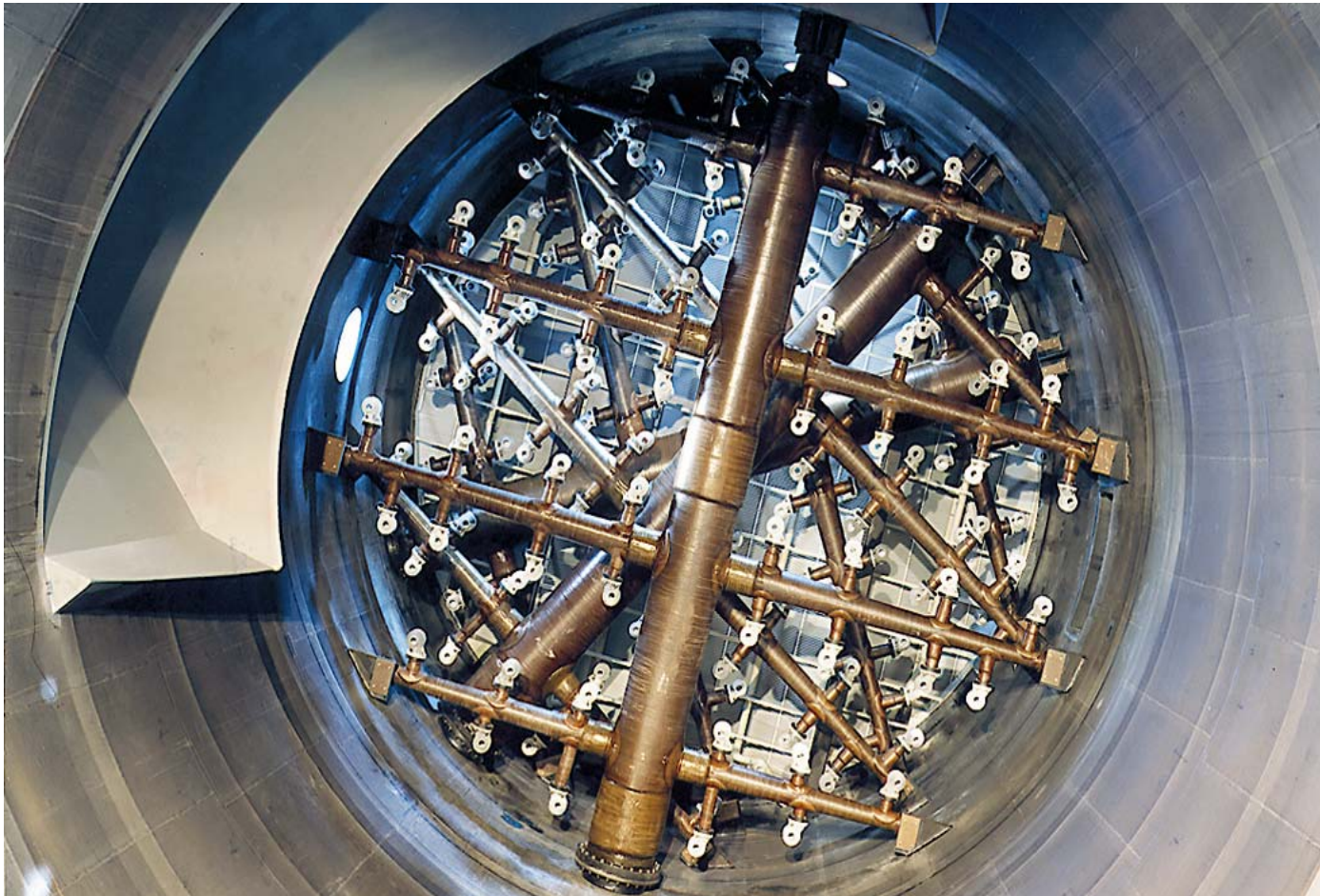
Maintenance Support Grid



**Scaffolding Provides Convenient
And Safe Access to Nozzles
Allows Maintenance at the Upper Levels
To Be Performed at the Same Time as Maintenance
In the Reaction Tank Area (No Fall Thru).**



FGD Absorber Internals



Weather Protected Limestone Storage and Feeding



Enclosed Ball Mill for Sound Protection and Maintenance in Cold Climate



**Outdoor Ball Mill
Warm Climate**

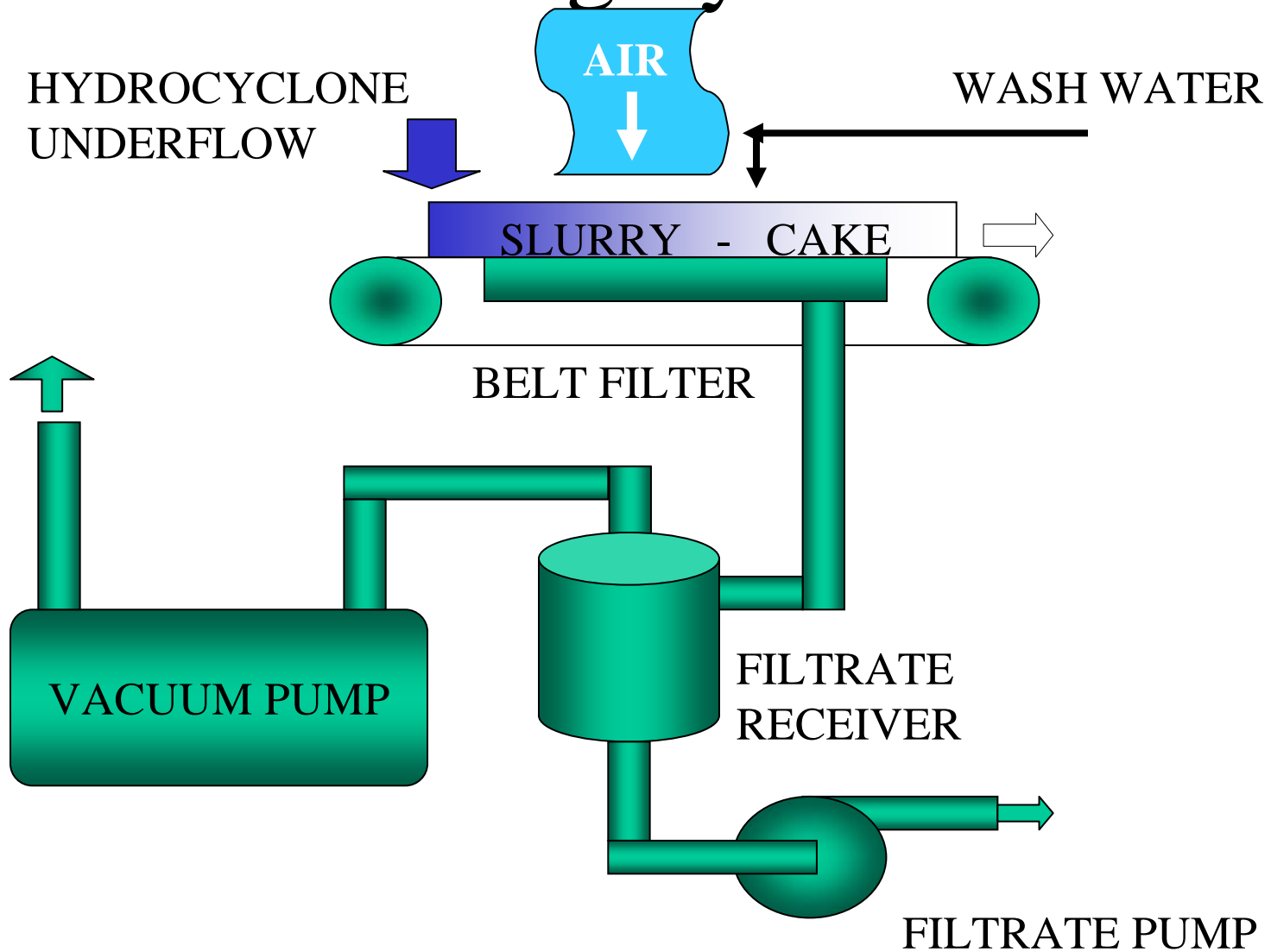
Maintenance Crane



Oxidation Air Blowers in Sound Enclosure

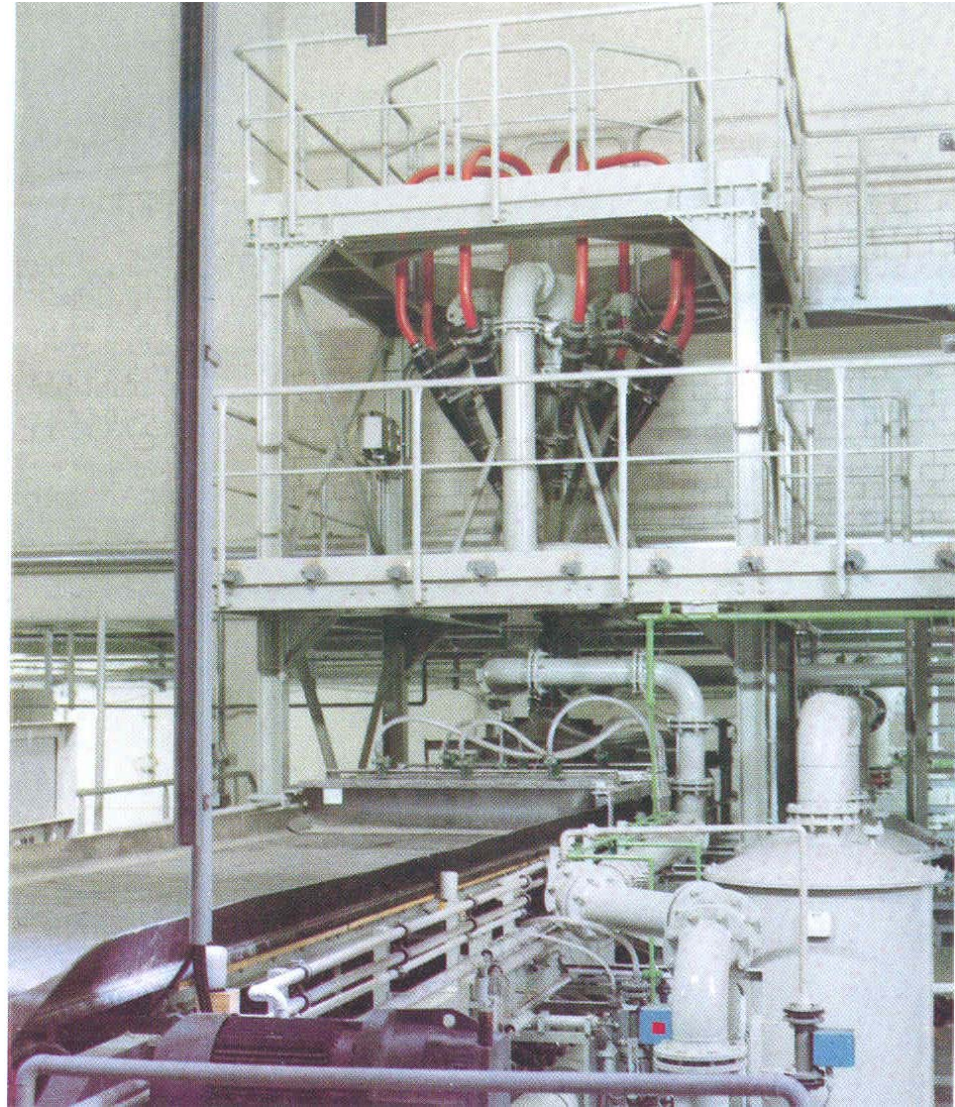


Dewatering System



Gypsum Dewatering

Hydrocyclone & Belt Filter Arrangement









Power Optimization

Design Influence

- **Recycle Pumps**
- **Fans – Gas Side DP**
- **Oxidation Air Blowers**
- **Limestone Grinding Mills**

Operational Influence

- **On-line Optimization**
- **Automatic and in Real Time**



Power Optimization Oxidation & Agitation

- **Tank Sizing**
 - **Limestone Dissolution**
 - **Oxidation**
 - **Mixing**
 - **Residence Time**
 - **Reaction Completion**
 - **De-supersaturation**
 - **Gypsum Crystal Growth**
 - **Size**
 - **Shape**
- **On-line Monitoring**



Power vs. SO₂ Removal

750 MW East. Bituminous Coal

Wet FGD Power Usage

		SO ₂ Removal		
		<u>95%</u>	<u>97%</u>	<u>99%</u>
Booster Fan	kW	4,253	4,593	5,303
Recycle Pumps	kW	4,160	4,593	6,961
Oxidation Air Blowers	kW	2,315	2,556	3,500
Ball Mills	kW	1,614	1,648	1,682
Others	kW	2,660	2,710	2,772
total	kW	<u>14,572</u>	<u>16,100</u>	<u>20,218</u>



Operation and Maintenance



Operational History - Inspection



Operational History - Inspection



Layout Impacts Number of Operating Personnel



Limestone unloading & Storage

Gypsum storage silos

Ball mills and recycle pumps

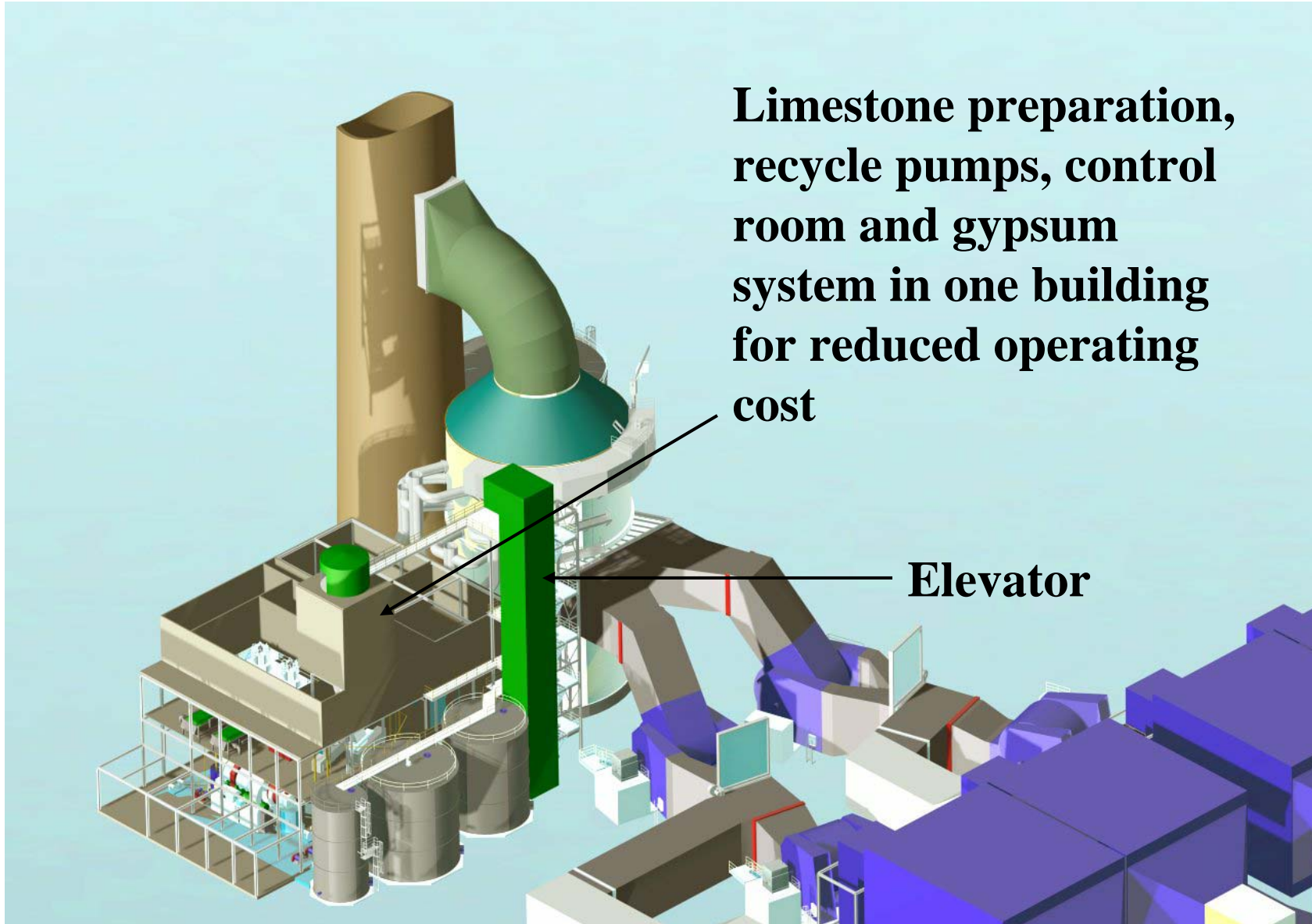
Gypsum loading barge



O & M Criteria

- **Safety**
- Balance between initial capital cost vs. long-term operating cost
- Plant availability/redundancy
- Operating economics
 - Elevators vs. stairs
 - Weather encloses
- Wash down/Cleaning
 - Drains/pits/pumps
- All in one building





**Limestone preparation,
recycle pumps, control
room and gypsum
system in one building
for reduced operating
cost**

Elevator



Isolation Valves for Pump Maintenance



All pumps in straight line/overhead cranes



**Note wide
maintenance
aisles**

Floor drains



Overhead crane for maintenance

Room between pumps for forklift



Overhead cranes



Recycle pump screens to prevent pump wear and nozzle plugging



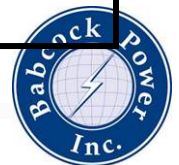
Operational WFGD Testing Requirements

Test Description	Test Method
pH	EPRI – C1
Density	EPRI – D2
Wt % of Solids	EPRI – F3
Chemical Composition – Sulfate	EPRI – L2
Chemical Composition – Sulfite	EPRI – M1
Chemical Composition – Carbonate	EPRI – N3
Particle Size	EPRI – G1
Crystal Water	ASTM C471M
Residual Moisture	ASTM C471M
Chloride	EPRI– I3



Operational WFGD Testing Requirements

	Frequency of Sampling	pH	Density	Wt% of Solids	Chemical Composition of Solids SO ₄ SO ₃ CO ₃ Inert	Particle Size Distribution	Cl-Content
Slurry Recycle	1x per day	X	X	X	X	X (2/week)	X
Gypsum Slurry	1x per week		X	X	X	X	--
Gypsum	1x per week				X	X	X
Limestone Slurry	1x per week	X	X	X	X	X	X
Limestone	Weekly composite				X		
Ball Mill Hydrocyclones						X	
Make Up Water	1x per week	X					X
Waste Water	1x per week	x		X			X



Operational WGFD Testing Manpower

- Man-hours per absorber 14.5 hours / week
- Man-hours plant common systems
 - Reagent system 15.5 hours / week
 - Water system 4.5 hours / week
 - Gypsum byproduct 4 hours / week
- Man-hour estimate 2 absorbers and common systems 53 hours
- Man-hour estimate 2 absorbers and common systems 2756 hours



Periodic Mechanical Inspection

- Pumps – Check
 - Oil level
 - Seal leakage
 - High vibration
 - Belt tension
 - Bearing temperature
 - Alignment
- Agitators – Check
 - Oil level
 - High vibration
 - Gland seal water leakage
- Strainers
 - Differential pressure each shift, clean if high



Periodic Electrical Inspection

- Motors – Check
 - Bearing temperature
 - Insulation resistance
 - Bearing vibration
 - Brush wear
 - Slip ring roughness
 - Motor heater current
 - Clean parts of carbon dust
- Electrical
 - Annual inspection or per manufactures instructions
- Relays
 - Differential pressure each shift, clean if high
- Instrumentation
 - Per manufactures instructions



Periodic Maintenance Manpower

- Man-hours per absorber 20 hours / week
- Man-hours plant common systems
 - Reagent system 20 hours / week
 - Assist with Operational Testing 20 hours / week
- Man-hour estimate 2 absorbers and common systems 80 hours
- Man-hour estimate 2 absorbers and common systems 4160 hours



Operation and Maintenance Manpower

- WFGD Operator, current control room operator from each unit will monitor and control
- Assistant WFGD Operator, one required for plant, perform WFGD operational testing
- Maintenance Mechanic, two required for plant, perform periodic maintenance and assist with testing



Scheduled Outage Inspection

- Absorber Tank
 - Inspect for corrosion, scale and deposits
 - Remove loose material
 - Map location of deposits
 - Repair lining as needed
- Spray Headers and Nozzles
 - Check spray nozzles for plugging and map
 - Clean or replace nozzles as necessary
 - Check headers for erosion
- Mist Eliminators
 - Check for damage or deposits
 - Check wash system for valve function and coverage
- Reagent Preparation
 - Inspect and repair in accordance with manufactures' instructions



Outage and Maintenance Costs

- Estimated outage (3 yr) cost \$250,000 / absorber including
 - Absorber scaffolding
 - Sump cleaning
 - Absorber vessel and header repairs
- Estimated yearly maintenance cost \$150,000 / absorber including
 - Agitator parts
 - Recycle pump rebuilds
 - Misc. pump rebuilds



Owners Decisions

- Redundancy
 - Pumps
 - Ball Mills – 3 x 50% or 2 x 100%
 - Dewatering
 - Spares
- Organic Acids
- Waste Water
- Gypsum Markets/landfilling



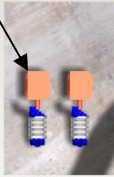
Absorber Access

- **Safety First**
 - Confined Space
 - Fall Protection
 - Personal Safety Equipment
 - Working Conditions: Lighting, GFIs, Tools, Noise, Welding. Flash Protection, etc.
- Maintenance
 - Minimize outage time
 - Simple PM programs
 - Easy access for service and cleaning

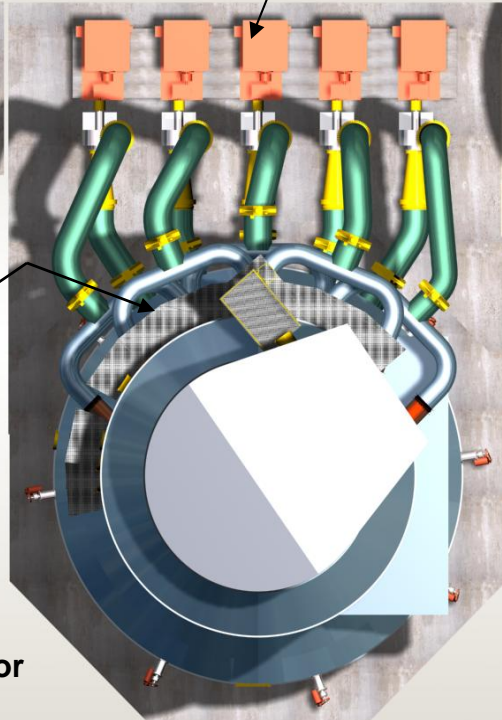


**Ghent Station Unit 3 Absorber Island
Plan View**

Oxidation Air Compressors



Recycle Pumps



2nd Stage Mist Eliminator Access Platform

- Wrap Around Design Provides Access To Spray Header Valves
- A Lay Down Area for Demister Modules



Existing Unit 1
FGD Stack

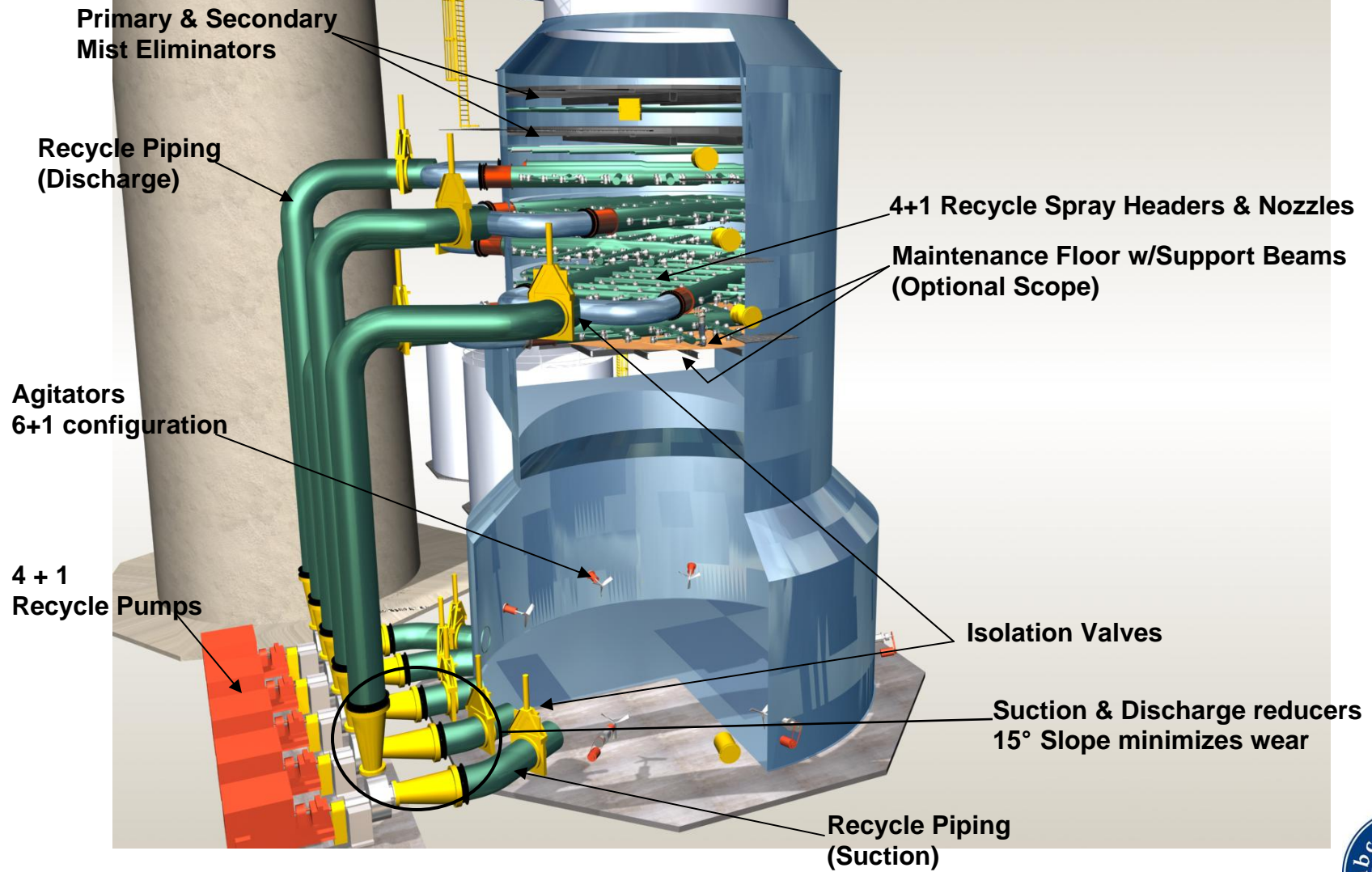
2 – Gypsum Transfer Tanks ea.207,000 gal.
- Carbon Steel (Rubber Lined)
- Return from 3 Recycle Pumps
- Each With Agitators



1- Process Water Tank 85,500 gal.
- Carbon Steel
- 2 Redundant Mist Eliminator Wash Pumps



Ghent Station Unit 3 Absorber Island Cutaway View Showing Absorber Internals

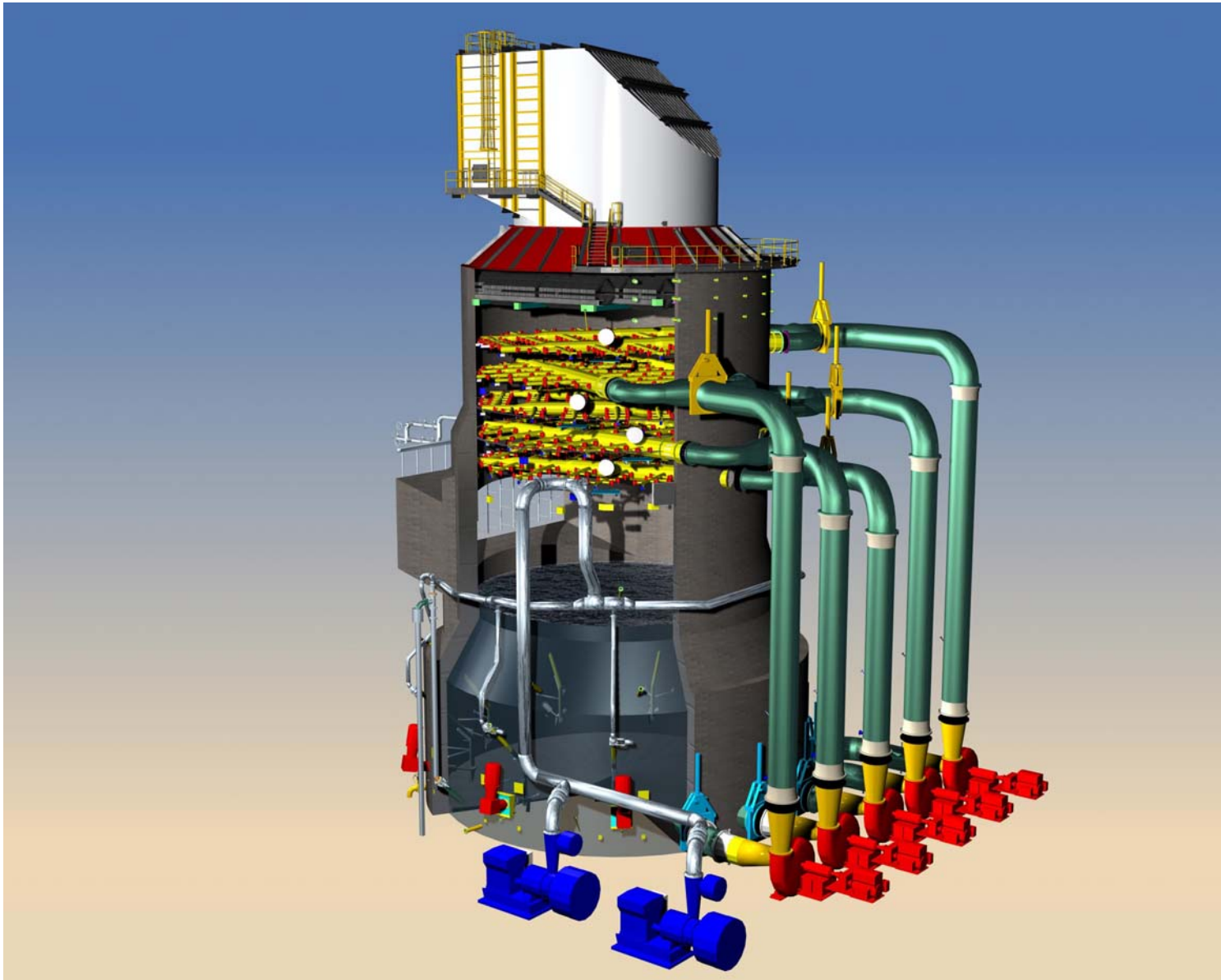


Equipment Delivery

In Weeks

Commodity	2003	2008
Structural Shapes	8-12	20-24
Recycle Pumps	26-30	56
Ball Mills	26-30	75
ID Fans	72	64
SCR Catalyst	46-48	52-54





Typical Maintenance Issues

- Mist Eliminator Plugging
- Scaling and Buildup of Solids
- Low SO₂ Removal
- Gypsum Quality
- Reagent Usage



**Many Common Issues or Conditions Impact
Maintenance and Operations**



Mist Eliminator Plugging

- Water quality
- Broken/missing/plugged nozzles
- High gas velocity



Scaling and Buildup of Solids

- Wet Dry interface
- Chemistry
- Oxidation air system
- Limestone quality or sizing



Low SO₂ Removal

- Sorbent preparation/sizing/quality
 - Feed rate
- Blinding
 - Sulfite or aluminum fluoride
- Plugged nozzles
- pH monitor



Gypsum Quality

- Reagent preparation & utilization
 - Sizing/quality
- Oxidation air
- Belt filter and hydrocyclones
- Wash water



Reagent Usage

- pH monitor
- Sorbent quality and grind size
- Blinding
 - Sulfite or aluminum fluoride



Thank You

Questions ??

