REINHOLD ENVIRONMENTAL Ltd.

2012 APC Round Table
& Expo Presentation

July 16-17, 2012, in Baltimore, MD / Hosted by Duke Energy, Entergy, FirstEnergy, Southern Company & TVA

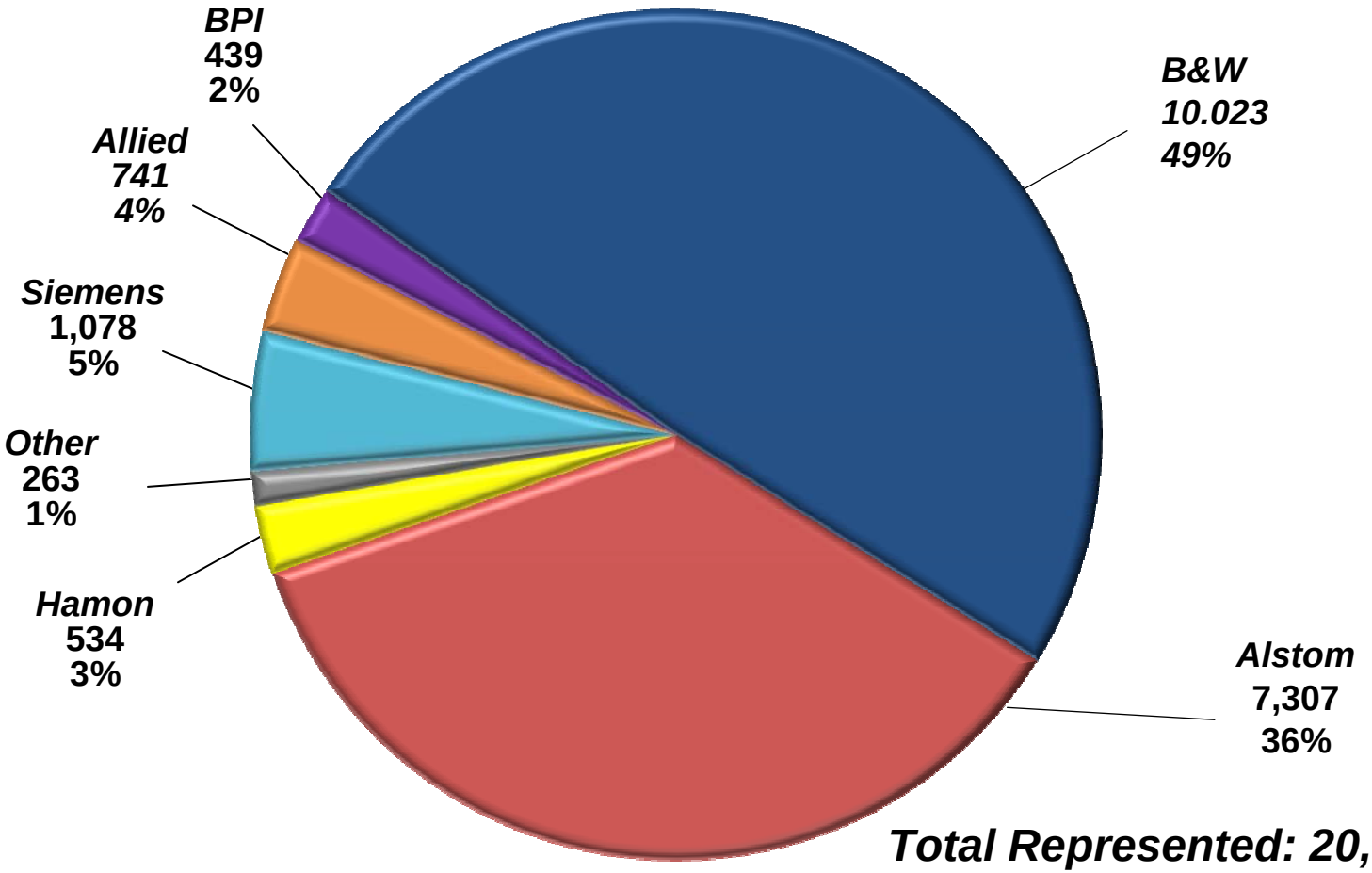
New Life for Old(er) DFGD Systems

Agenda

- DFGD System Introduction
- Spray Dryer Absorber Designs
- Reasons for Rebuilds or Upgrades
- Examples of Rebuilds and Upgrades
- Process Enhancements to Improve Operations

Dry Flue Gas Desulfurization (DFGD) Market Share

Units Entering Operation or Under Construction in U.S., 1980 to 2010, by FGD Supplier, in MWs



Total Represented: 20,385 MW

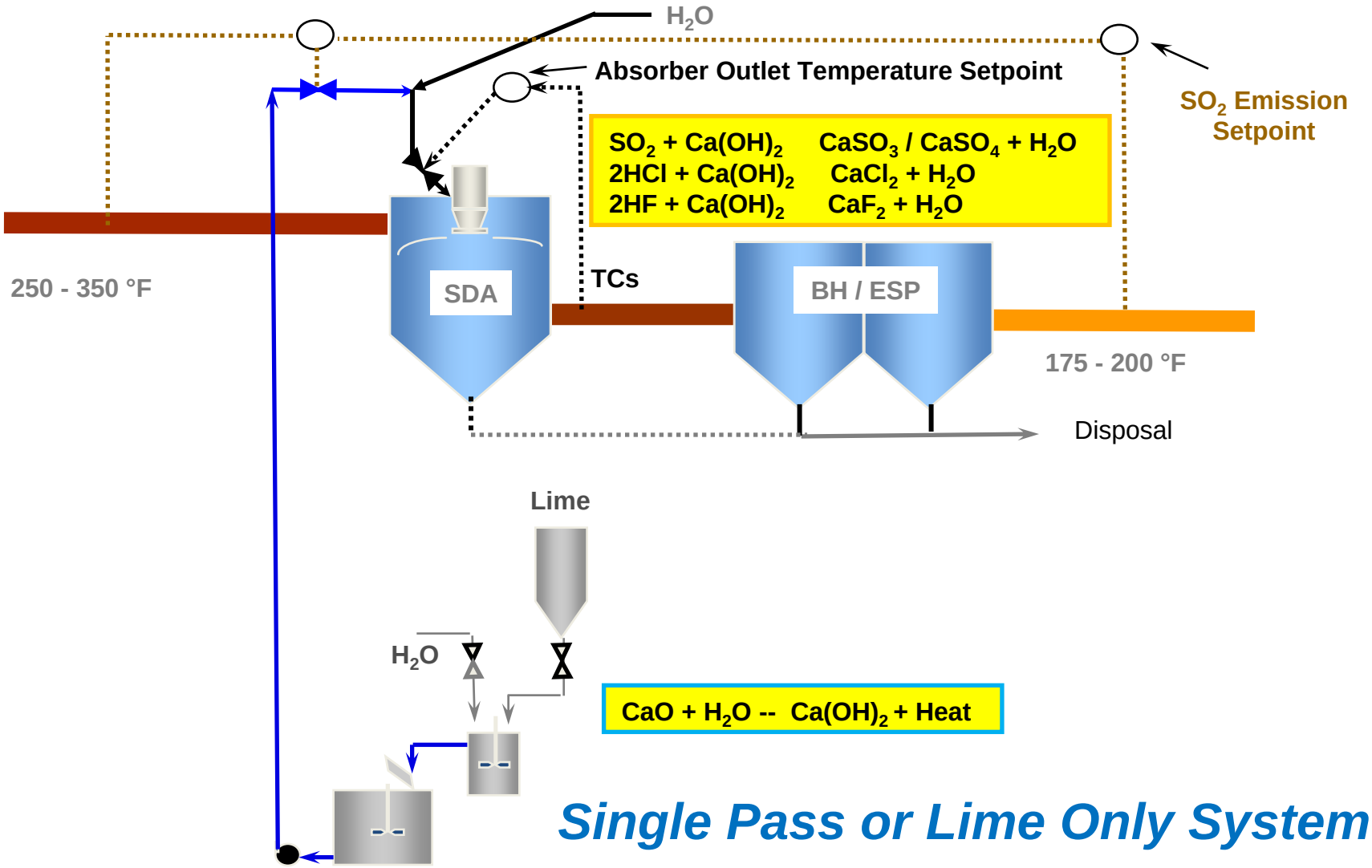
Source: Database of Utility FGD Design Trends, Carl Weilert, Burns & McDonnell, Power Engineering Magazine, August 2010

Dry FGD Slurry Atomization

Rotary Wheel

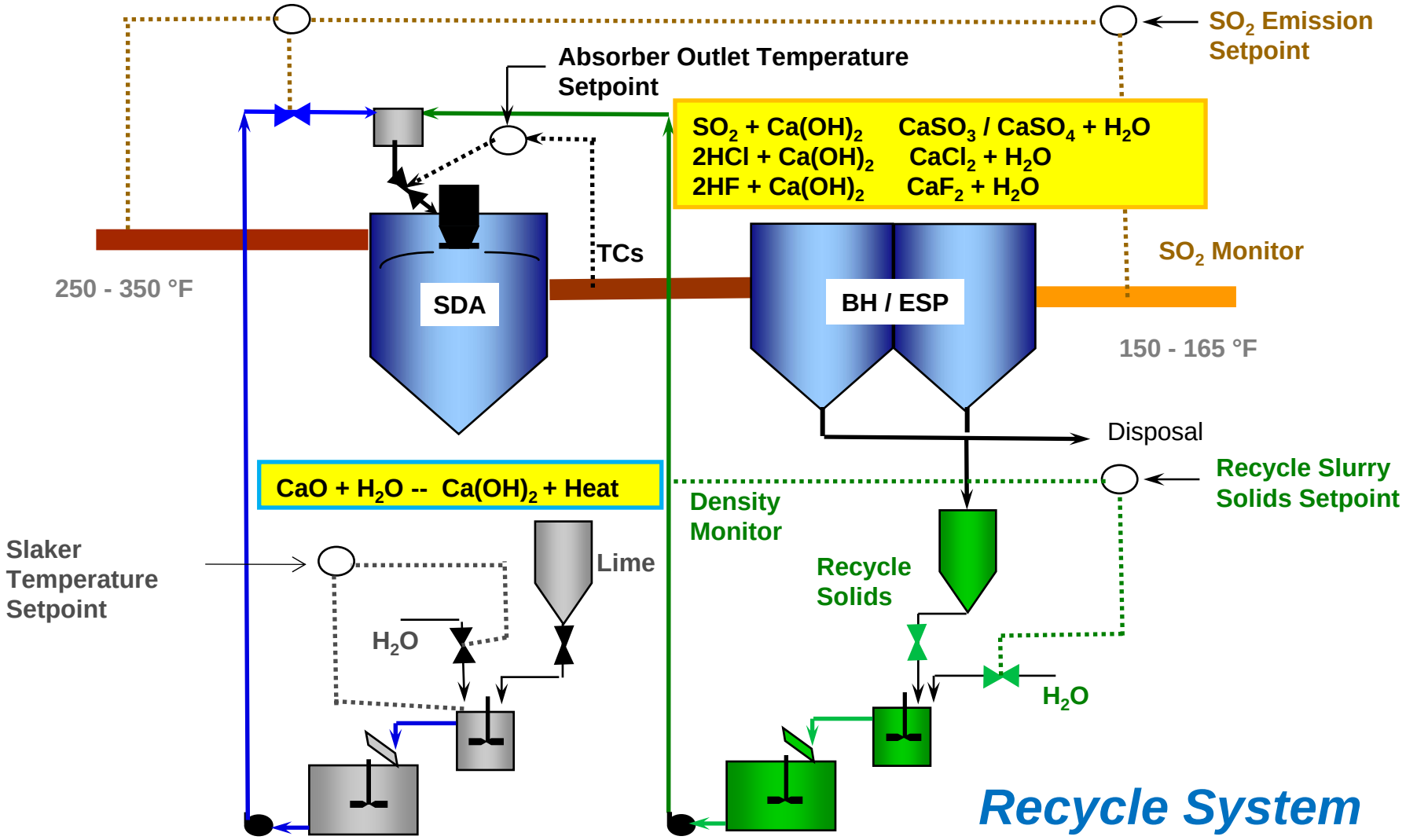
Dual Fluid

DFGD System Overview



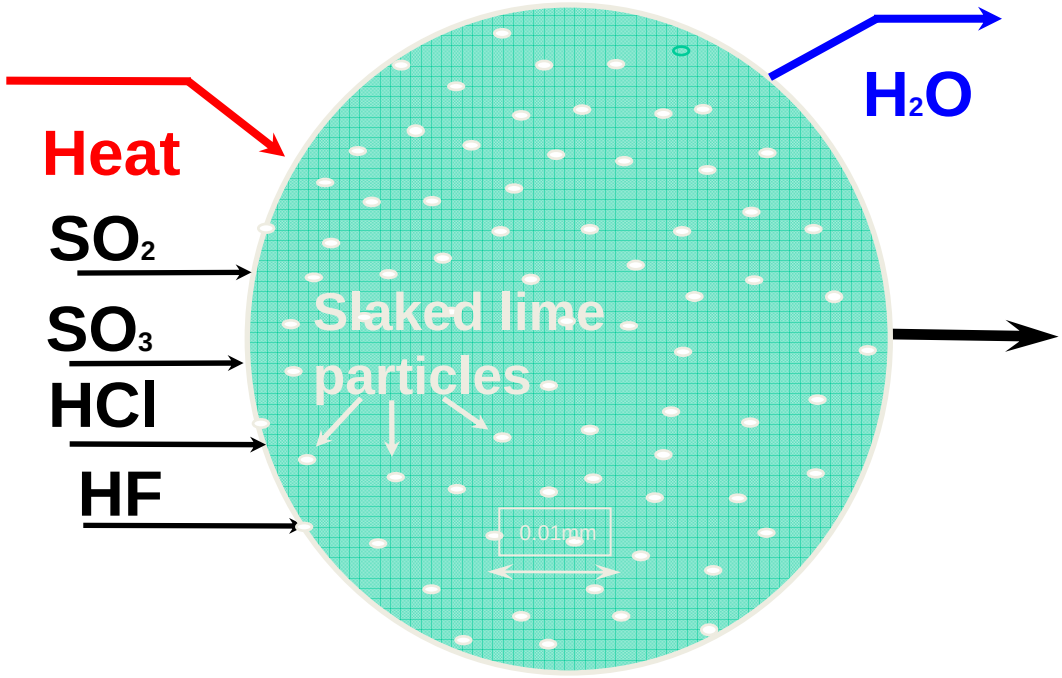
Single Pass or Lime Only System

DFGD System Overview

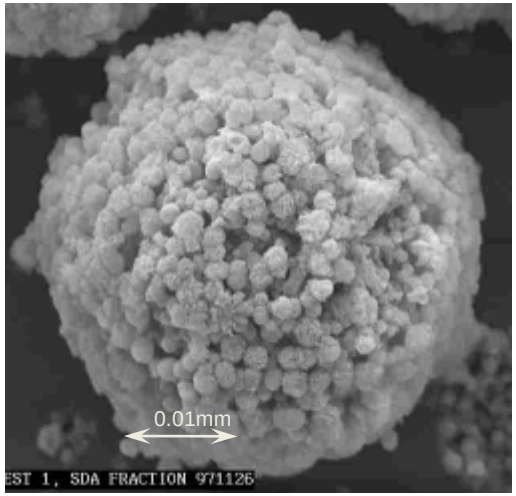


Spray Dry Absorption (SDA)

Spray droplet (0.050 - 0.065mm)



Dry reaction product



Reactions:			***Products:***
SO_2/SO_3	+	$Ca(OH)_2$	$CaSO_3 / CaSO_4 + H_2O$
$2HCl$	+	$Ca(OH)_2$	$CaCl_2 + H_2O$
$2HF$	+	$Ca(OH)_2$	$CaF_2 + H_2O$

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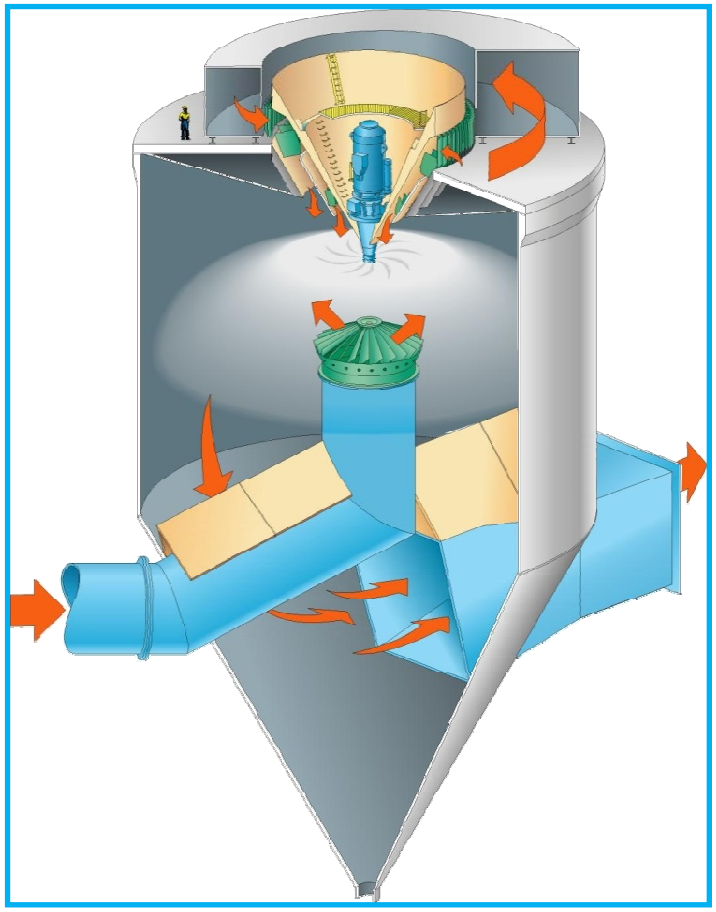
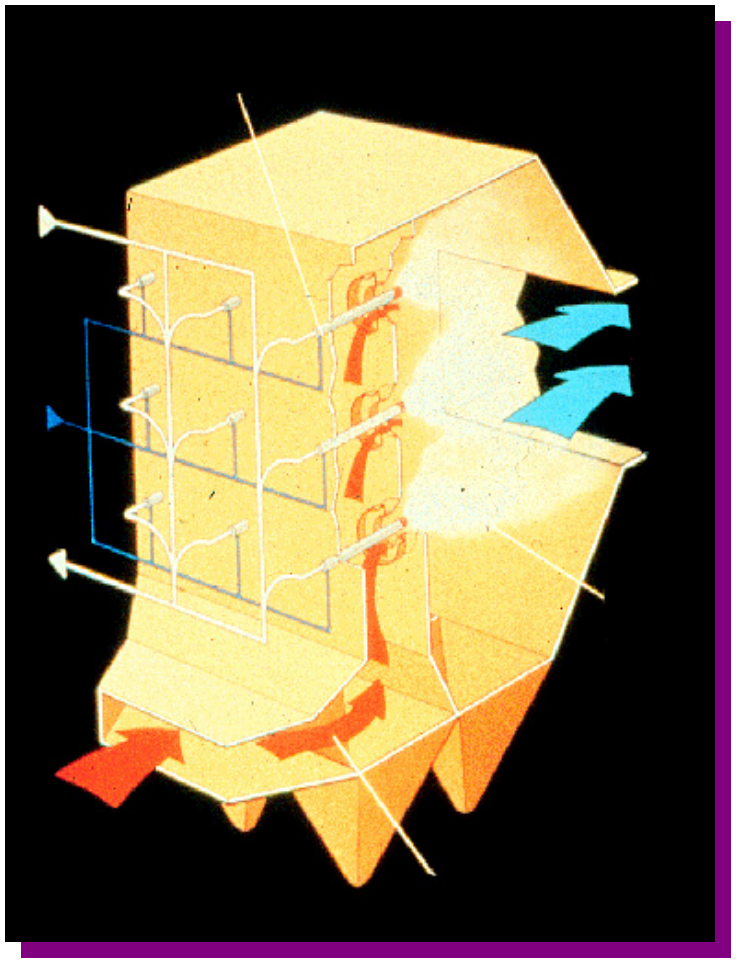
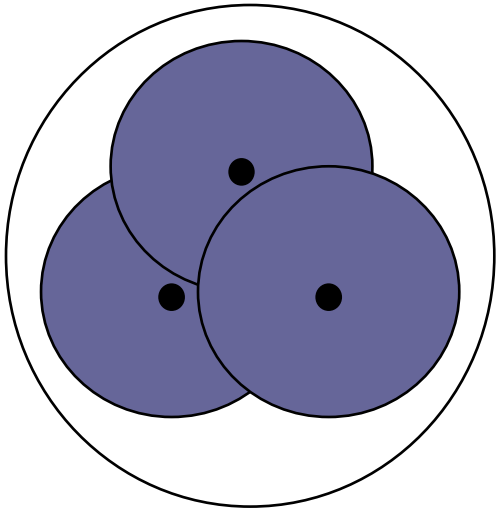
Spray Dryer Absorbers

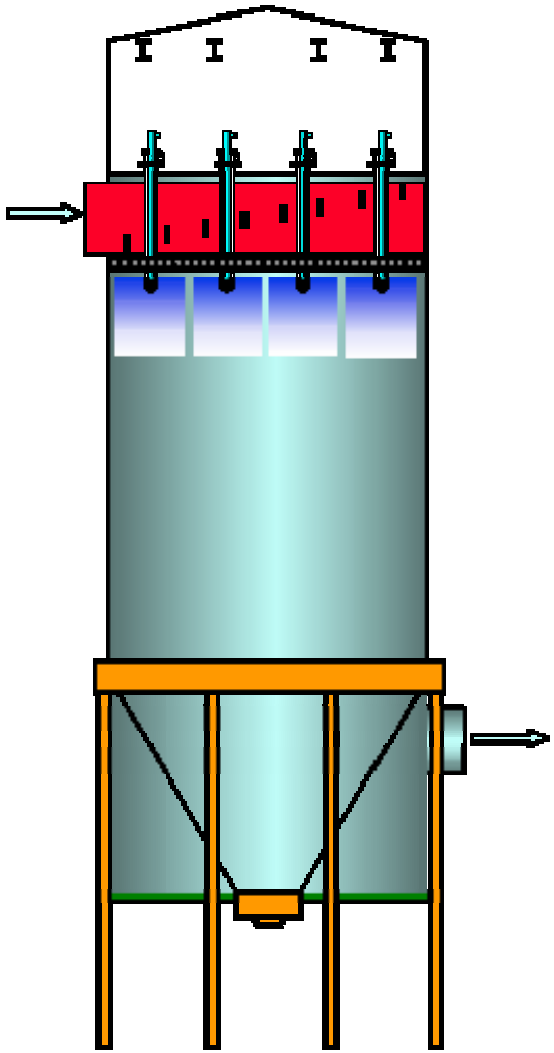


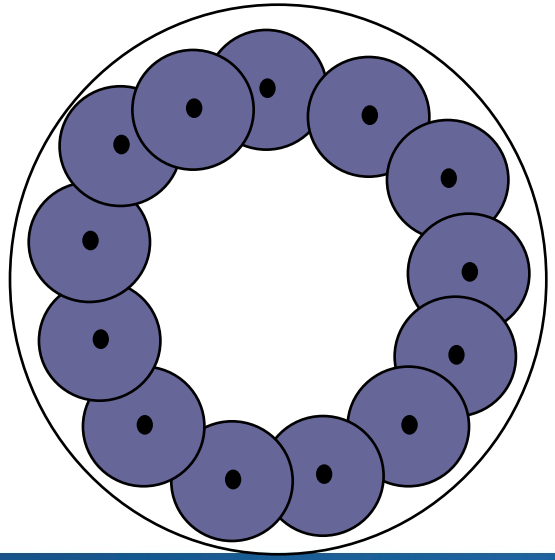


Spray Dryer Absorbers



Spray Dryer Absorbers





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Reasons for Dry FGD Rebuilds/Upgrades

- Increase SO_2 removal efficiencies to meet more stringent regulations
- SO_2 level increase in the coal supply
- Optimize lime utilization
- Improve reliability and operations
- Replacement of worn components to maintain performance

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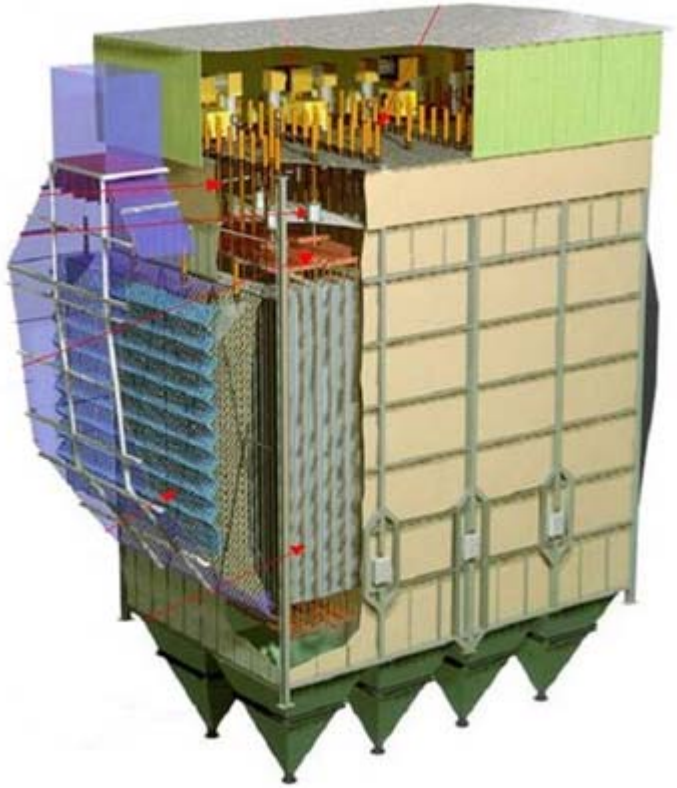
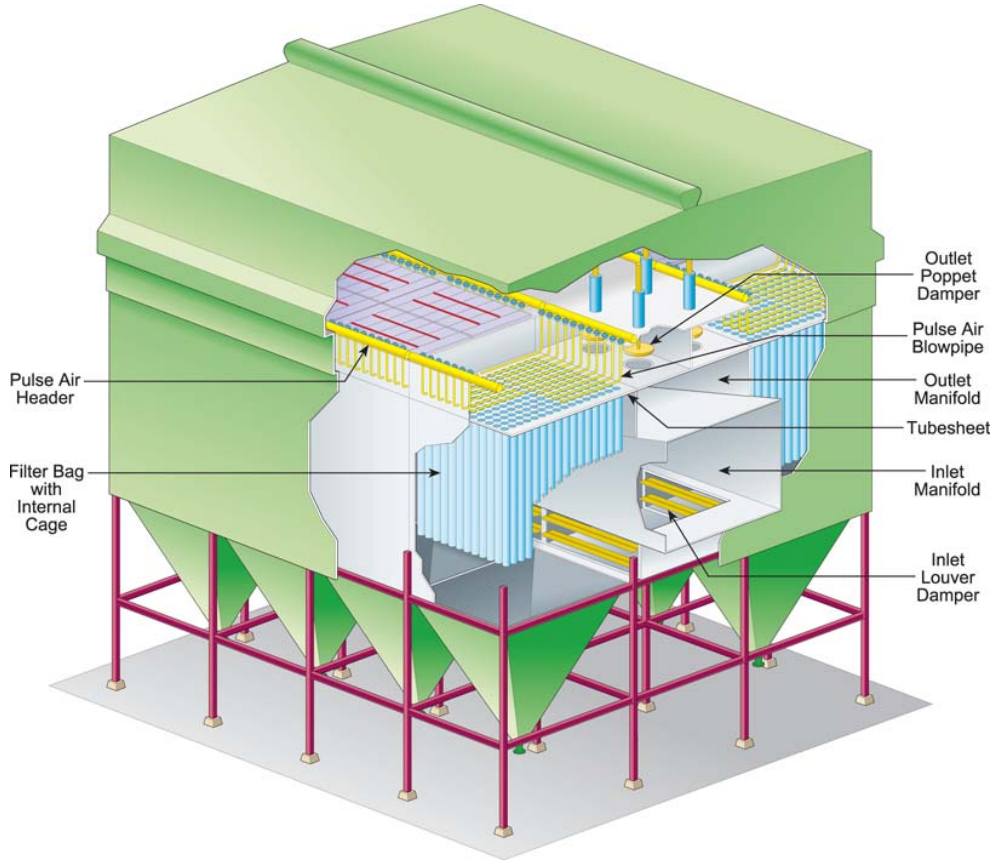
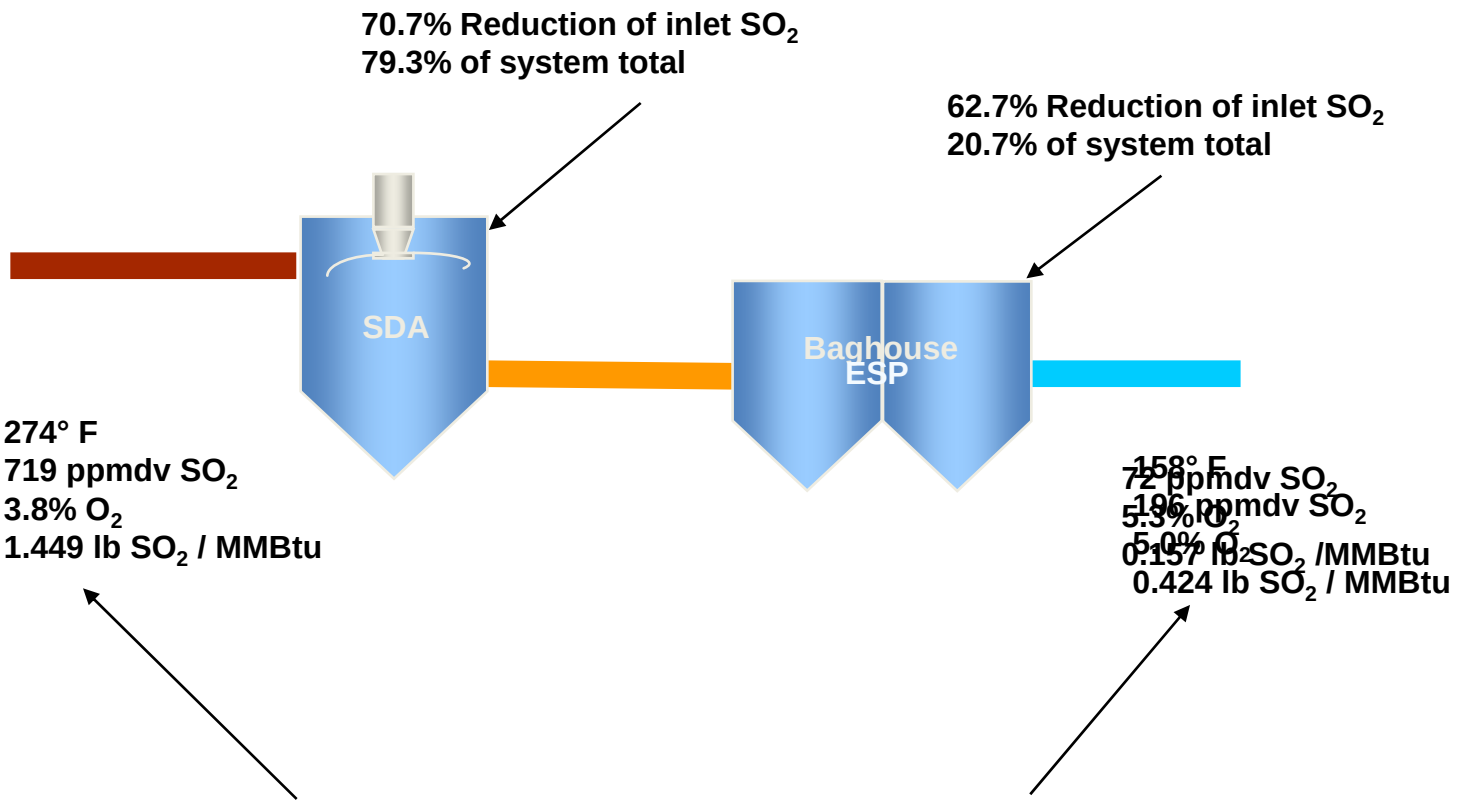
ESP to Baghouse Conversion





Significance of Baghouse on Overall SO_2 Capture

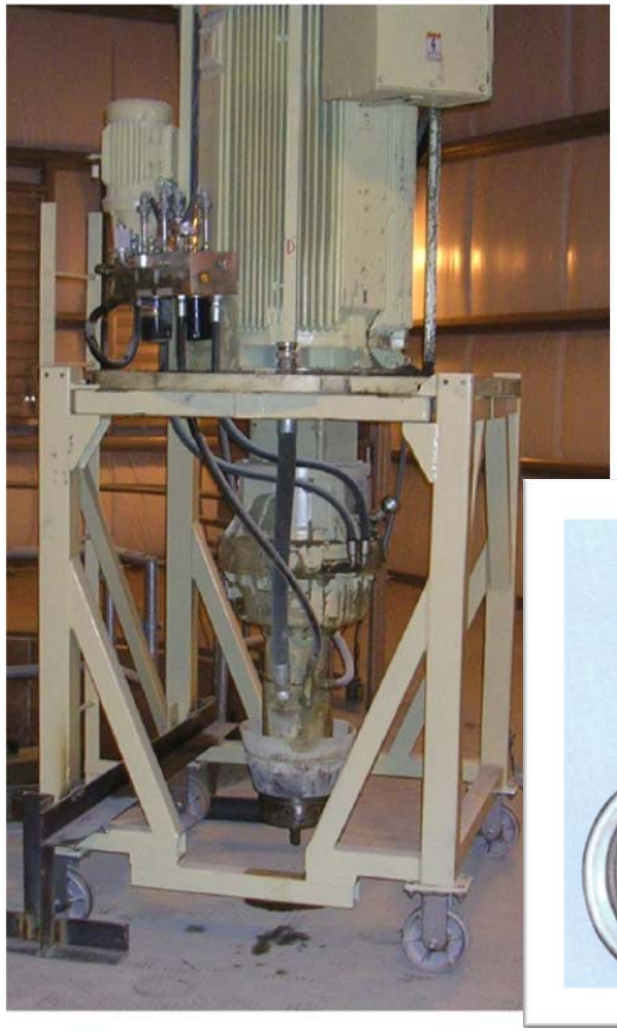


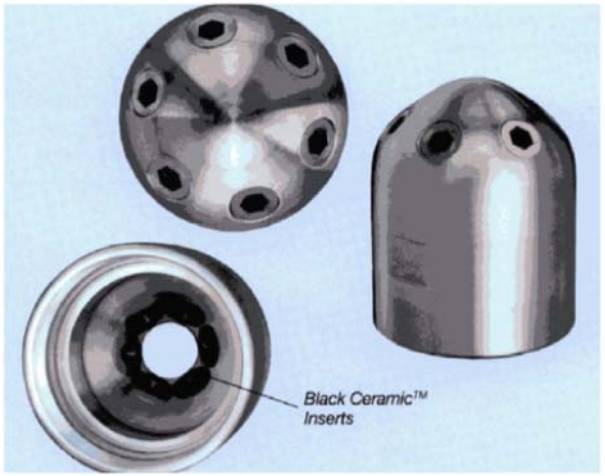
Addition of Recycle Slurry Systems

Addition of Recycle Slurry Systems

- Improves lime utilization (30 -50%)
- Achieve higher removal efficiency
- Lower approach temperature, corrosion potential
- Atomizer power increase
- Additional wear on components
- Substantial increase in ash handling equipment (6 – 10 times)

Atomizer Replacement





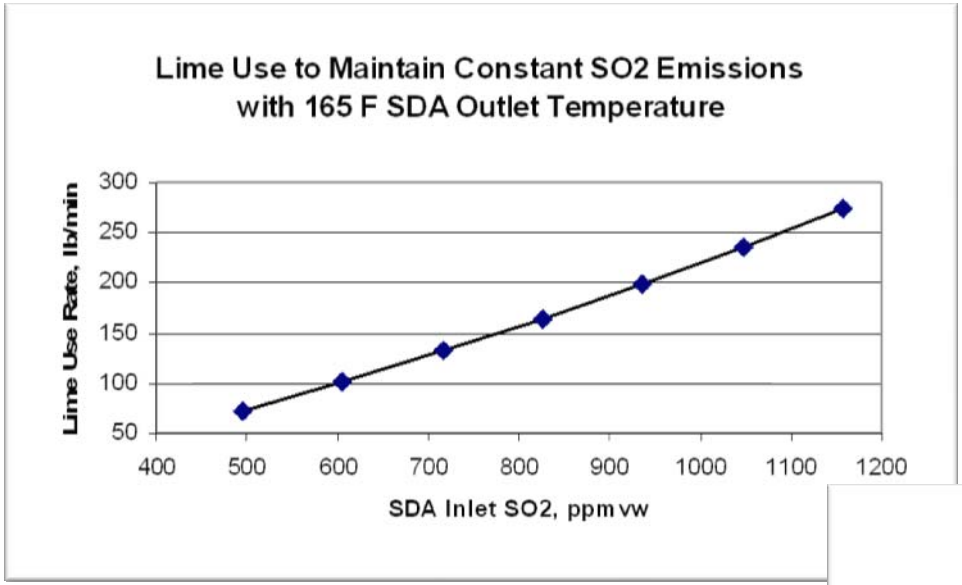
New Lime Slaking Systems

Horizontal Ball Mill

Detention Slaker

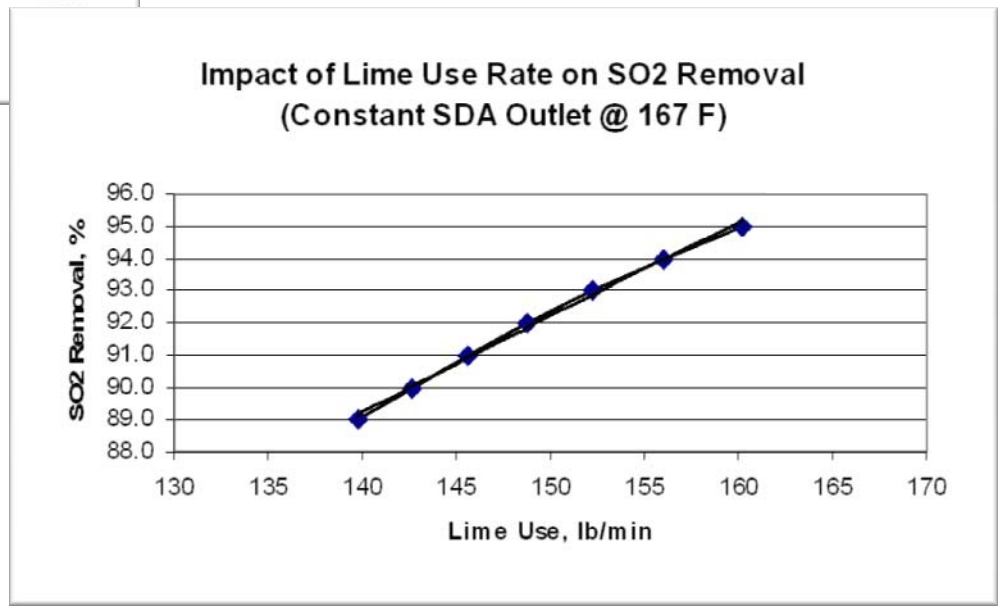
Vertical Ball Mill

Lime Usage

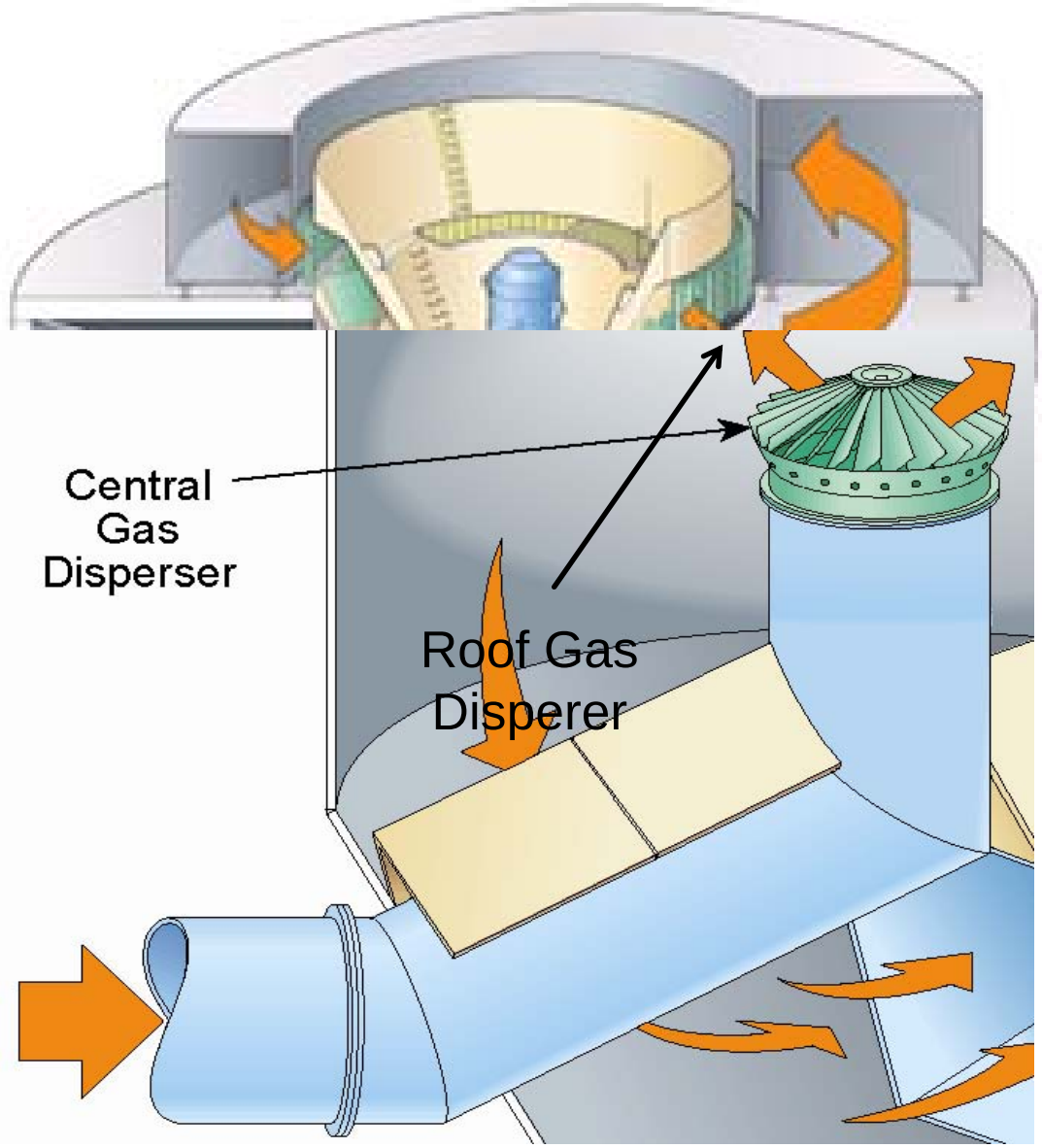


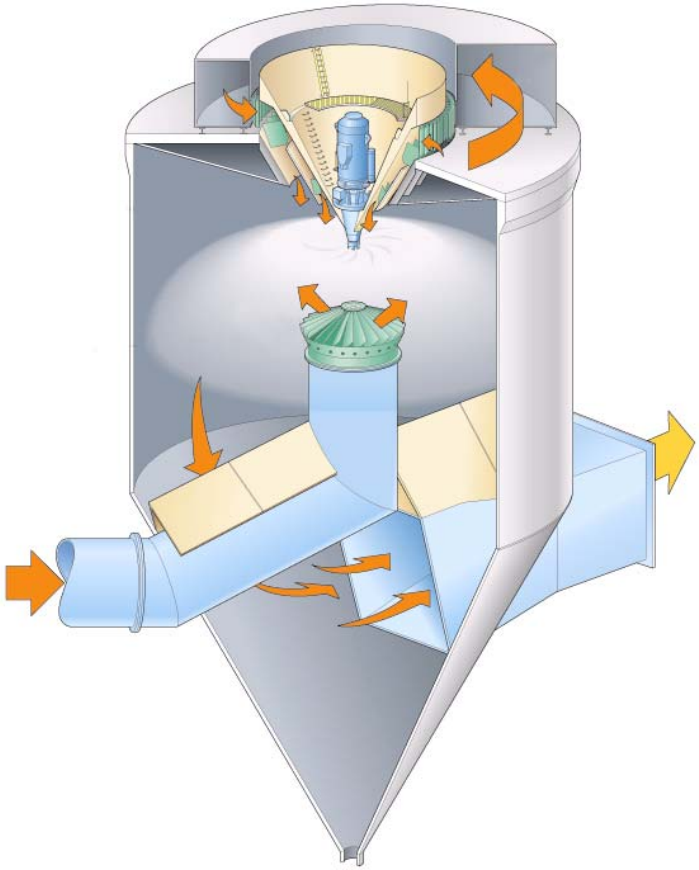
Range shown is for expected SDA inlet SO2 over coal sulfur range of 06 to 1.2%

Lime use increases by 14% to move from 89% removal to 95% at an SDA outlet temperature of 167



SDA Vessel





Roof Gas Disperser Components

Inner (Lower) Cone & Vanes

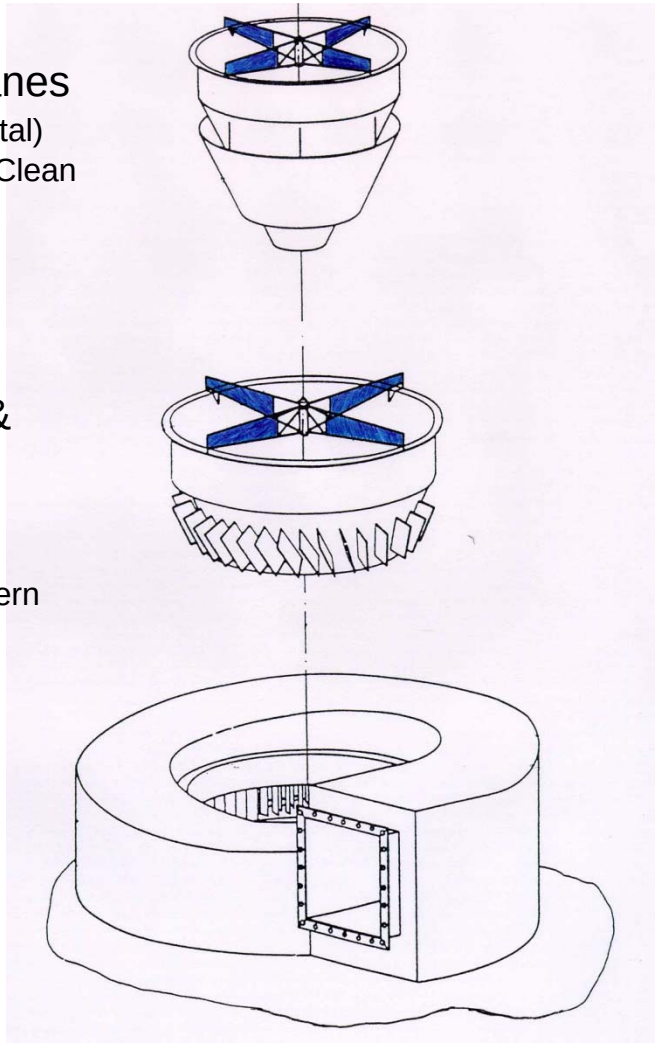
Straightens Flow (1/3 of Total)
Keeps Area Above Atomizer Clean
Vane Angle 20°

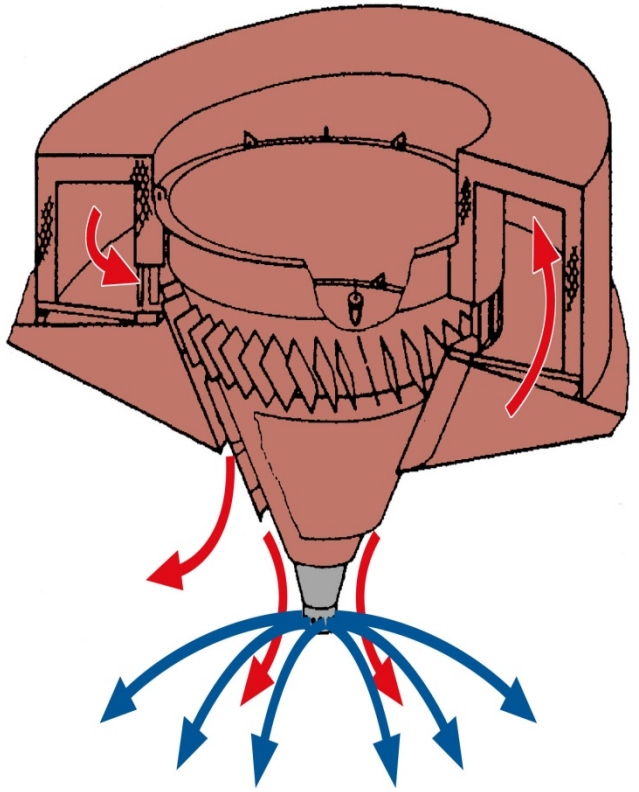
Outer (Upper) Cone & Vanes

Breaks Rotation
Bends Atomizer Cloud
Establishes SDA Flow Pattern
Vane Angle 27.5°

Scroll

Uniform Distribution
Gas Stream Rotation





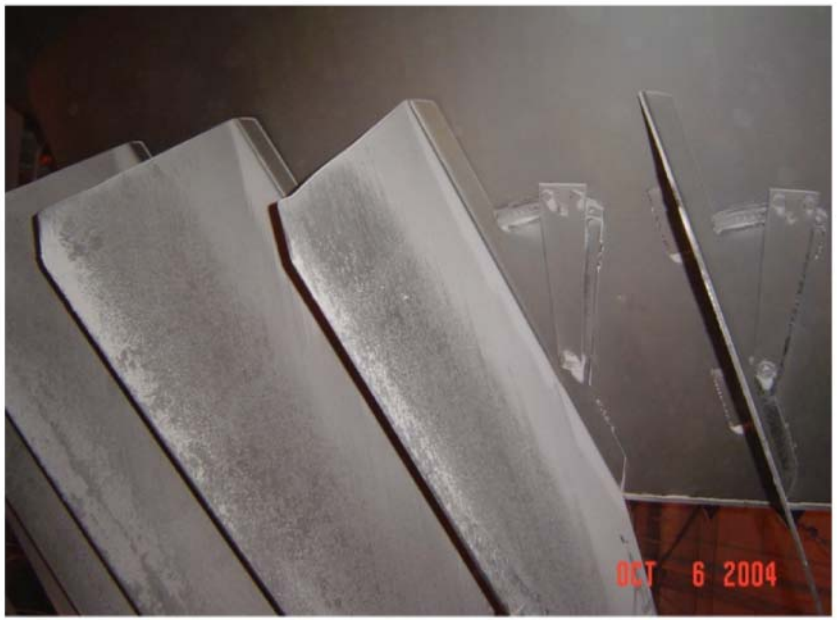
Dry FGD Rebuilds

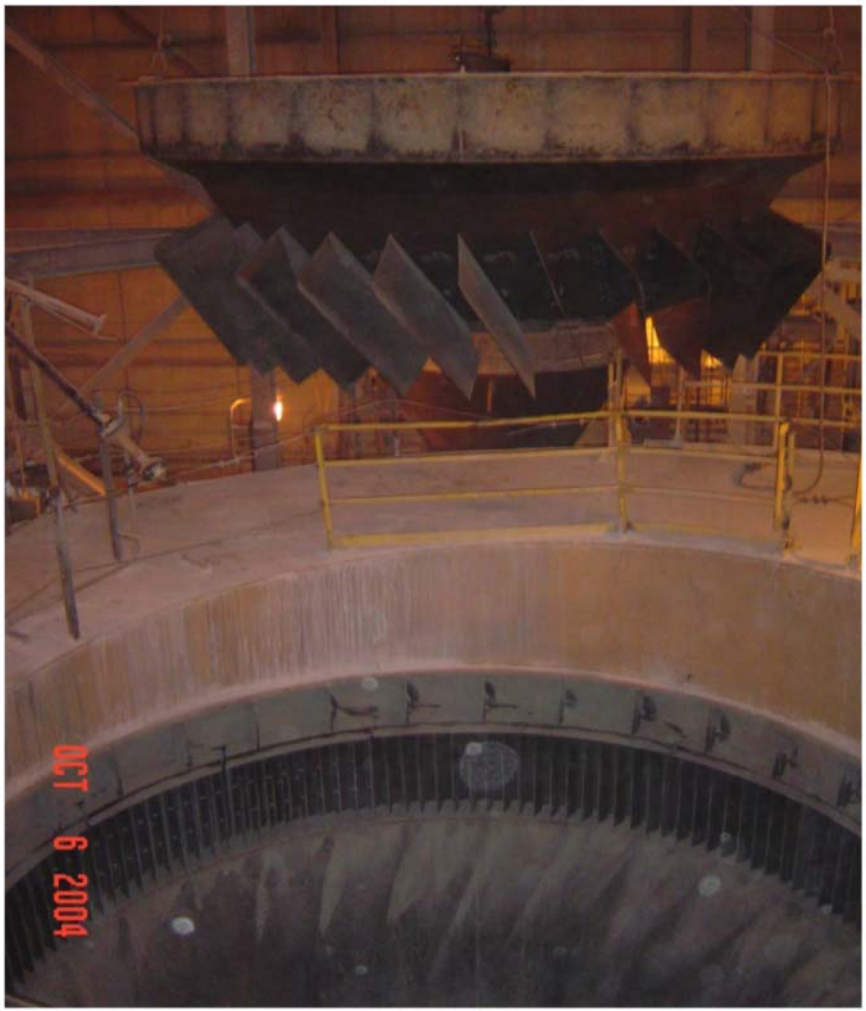
Roof Gas Disperser

Roof Gas Disperser Wear

Roof Gas Disperser

Roof Gas Disperser Wear





Replace worn components

SDA Roof Gas Disperser Scroll Vanes

Leading Edge of Turning Vane

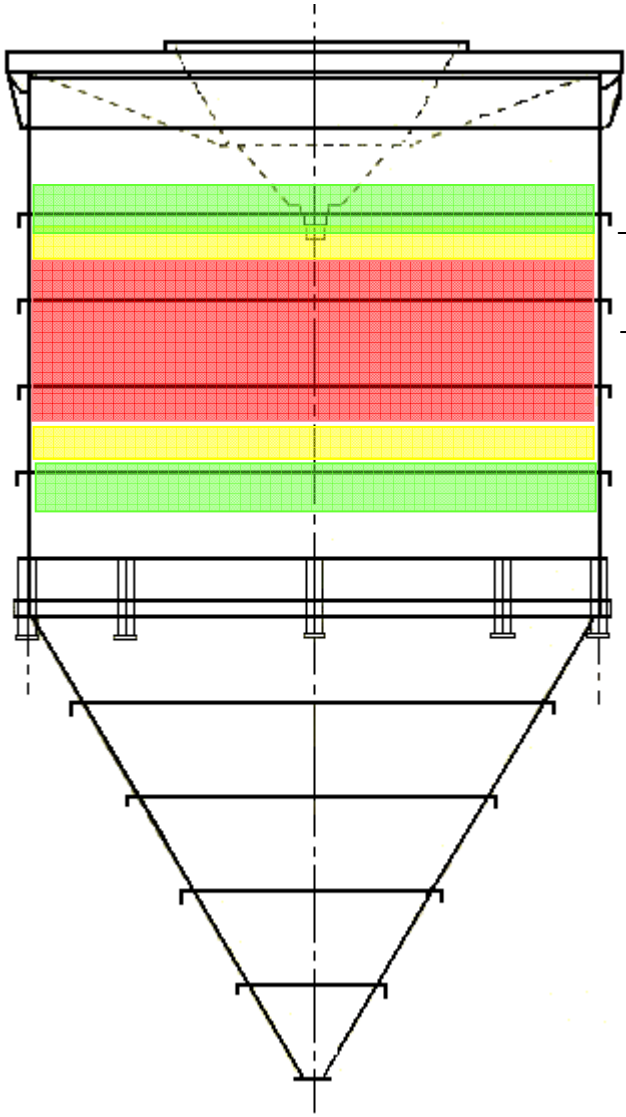
Indications of Roof Gas Disperser Wear

Wheel Outer Surface Wear

Central Gas Disperser Wear

Replacement Components

Location of Potential SDA Corrosion



Atomizer Wheel Level

Central Gas Disperser Level

Spray Zone Area

SDA Corrosion Mechanism

- ***The most severe areas of corrosion are where wall wetting and deposition occurs.***

  As deposits occur the wet interface with the metal surface and corrosion accelerators (particularly chlorides) results in localized corrosion. When the deposit is shed or cleaned the layer of corrosion is removed which exposes the surface for the cycle to repeat.

- ***The rate of metal loss is dependent on the operation of the unit.***

  Facilities that operate conservatively with minimal wall deposits probably have very little metal loss. Facilities that experience wall buildup that is shed and cleaned regularly are most likely to have appreciable metal loss.

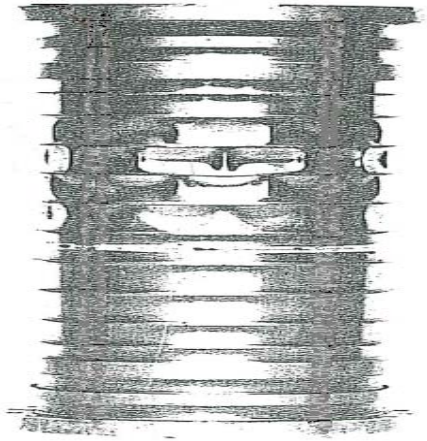
- ***Surfaces outside the area of deposits generally have minimal or no metal loss at all.***

  There can be localized areas of corrosion associated with cold spots in the vessel. Typically "Waste-to-Energy" units have experienced corrosion in the support ring near the support legs.

Results of Excessive Corrosion

Results of Excessive Corrosion

Local Axisymmetric Buckling



Asymmetrical Local Buckling

Rebuild of SDA Vessels

Removal of Penthouse, Roof Disperser and Damaged Cylindrical Section

Rebuild of SDA Vessels

Damaged Section

New Section

Repaired Vessel

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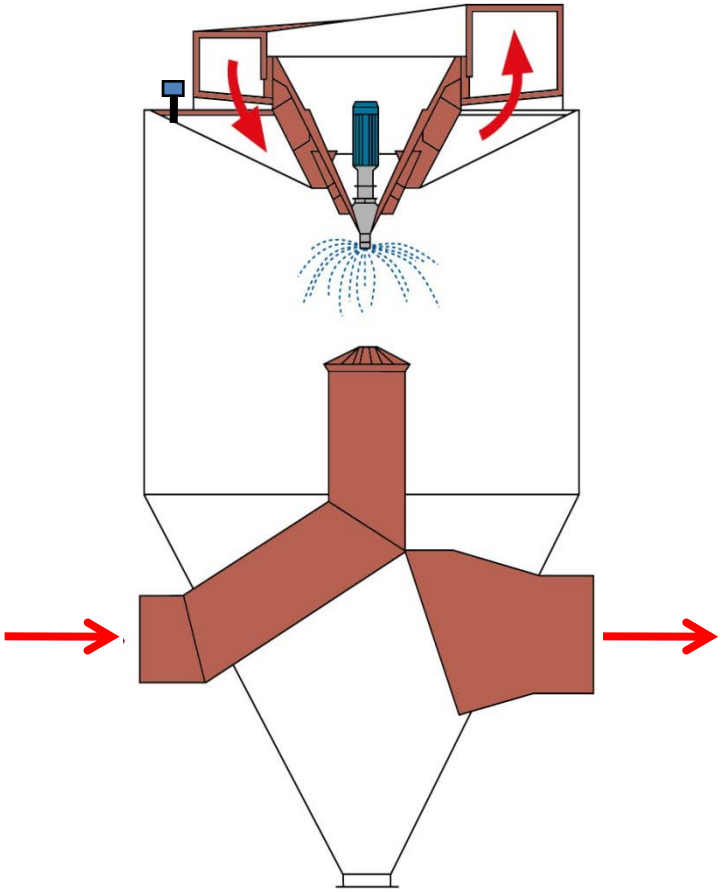
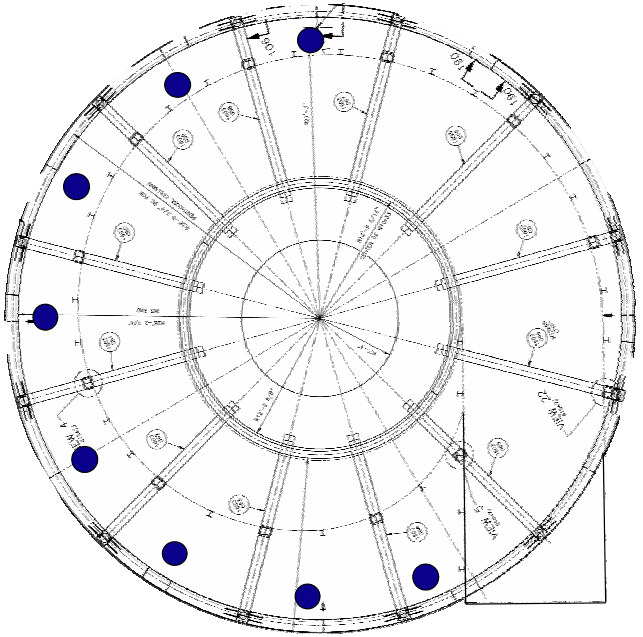
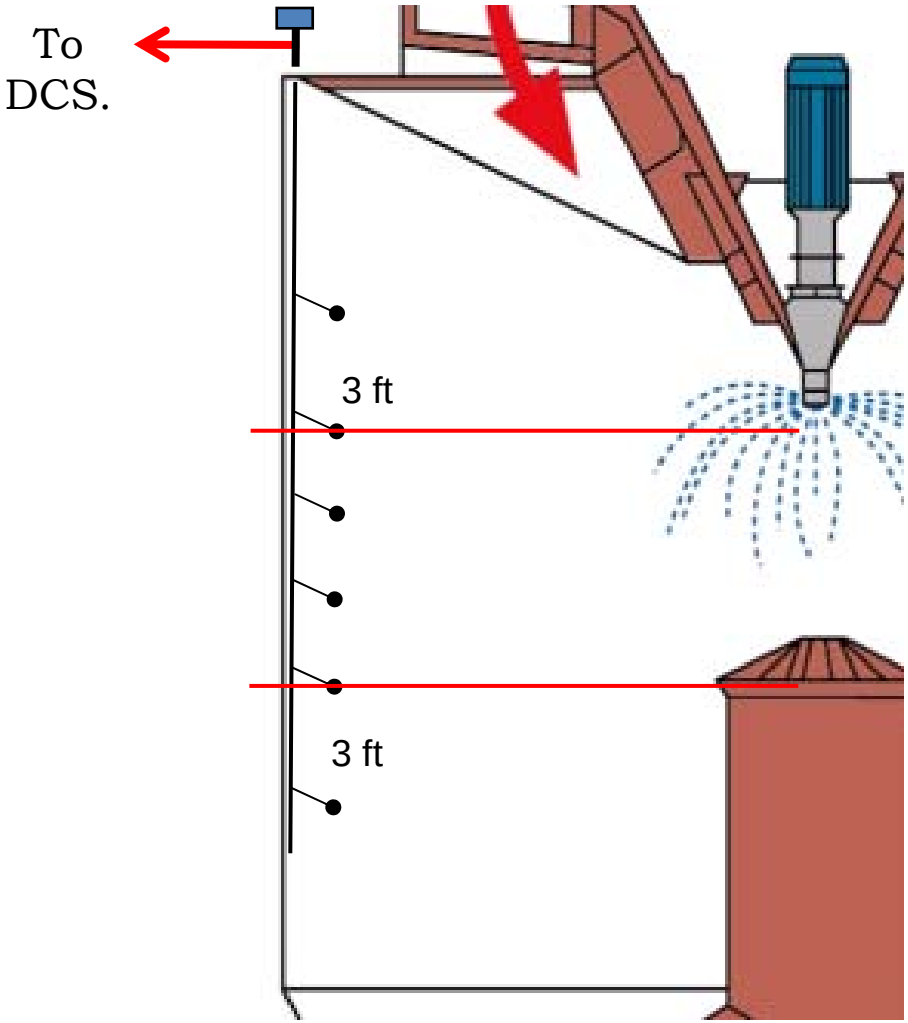
SDA Vessel Internal Temperature Mapping

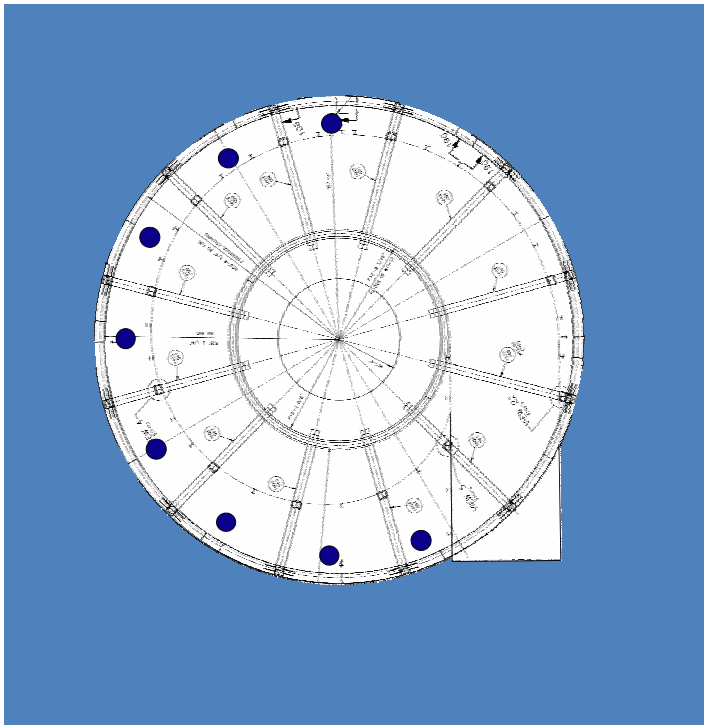


Typical SDA roof test tap locations

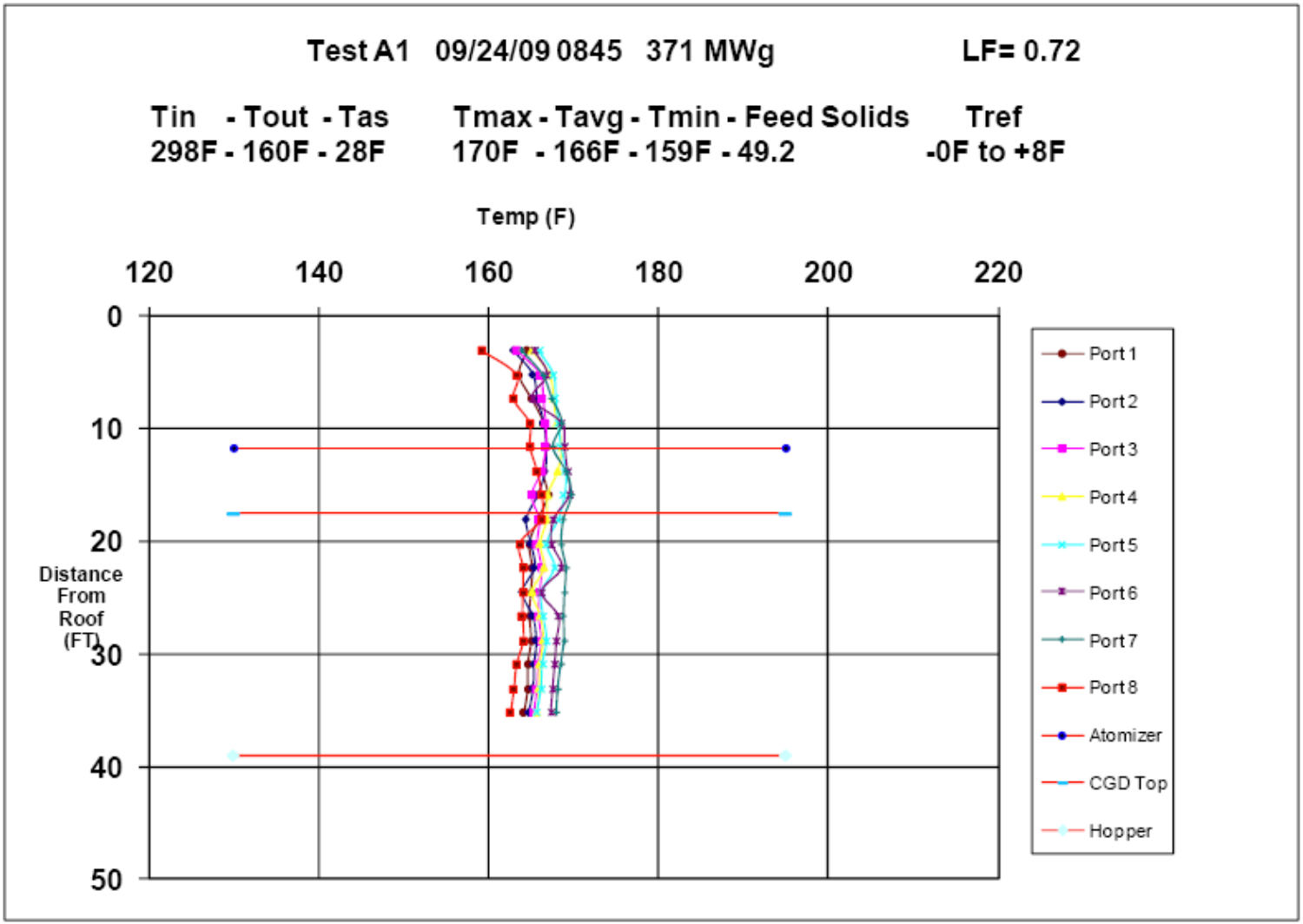


SDA Internal Wall Temperature Locations





SDA Internal Wall Temperature Locations



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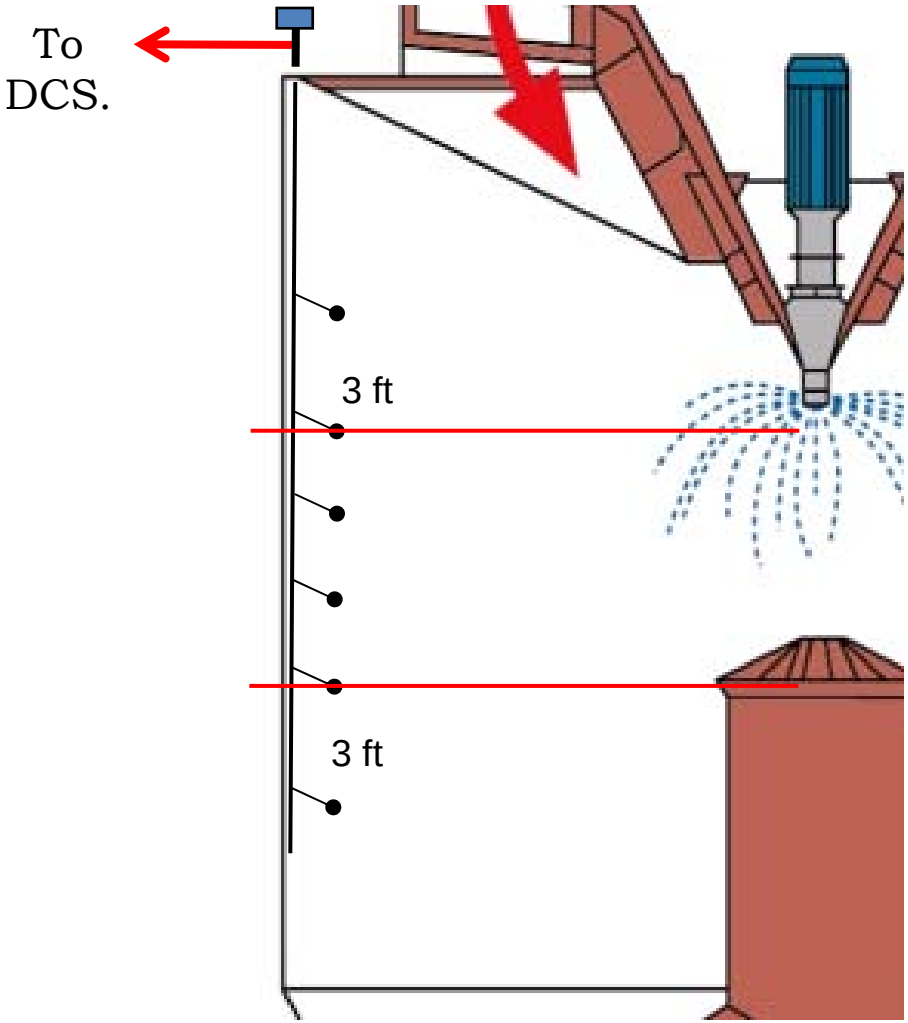
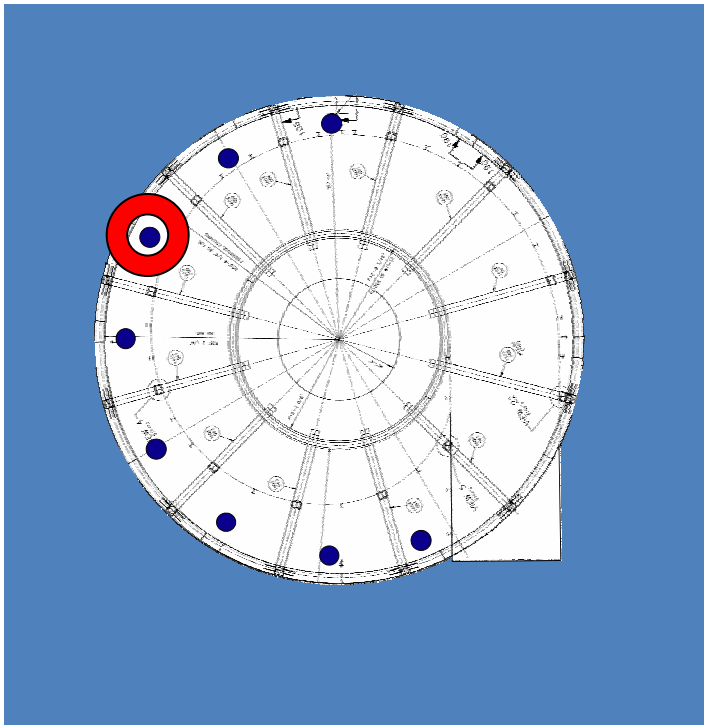




Port #3 Selected

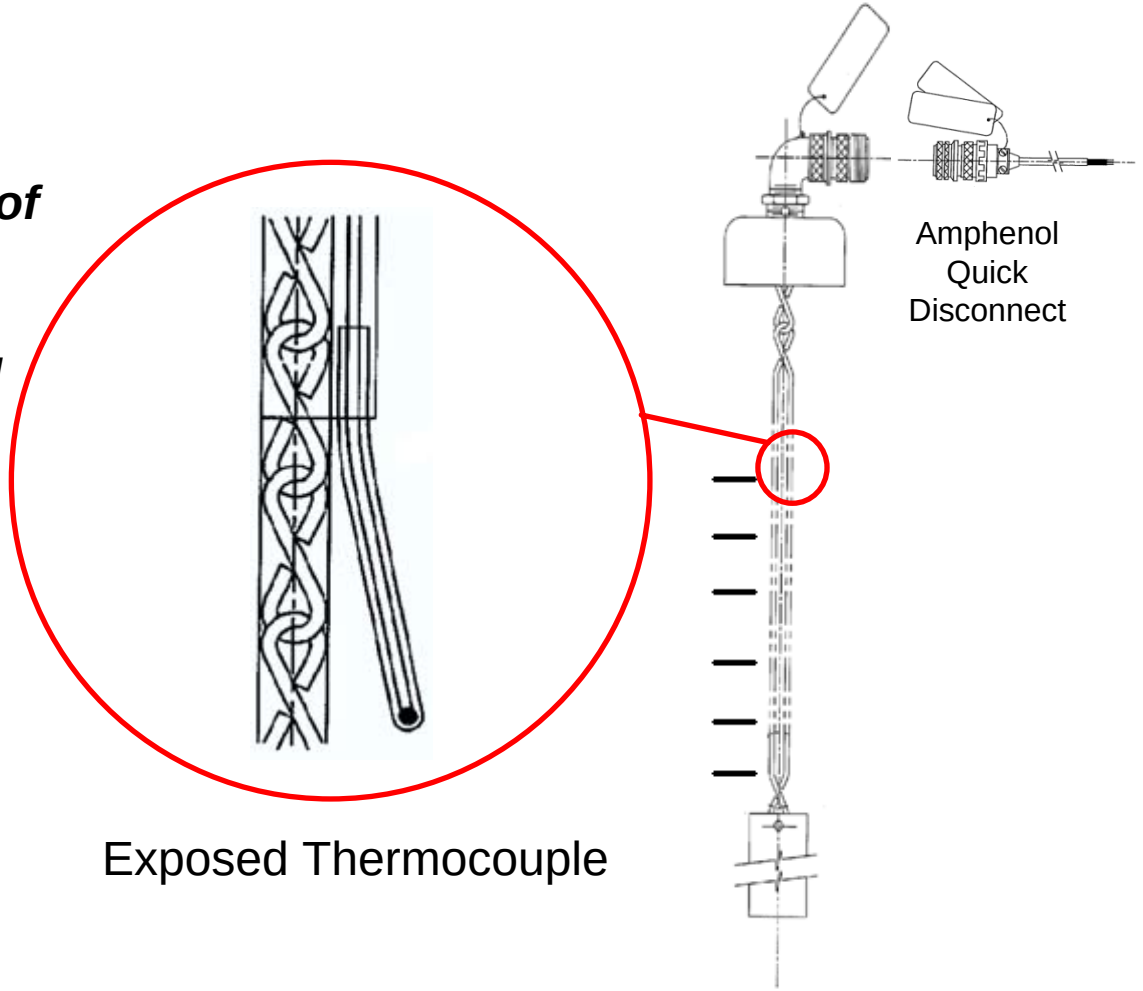
SDA Thermocouple Tree or "TC Chain"

Chain suspended near the wall of the SDA vessel

Six thermocouples are attached along the length of the chain

Hung through one of the test ports on the SDA roof

Best location (coldest spot) can be determined with minimal testing



TC Chain DCS Display

The DCS Display shows all six thermocouples

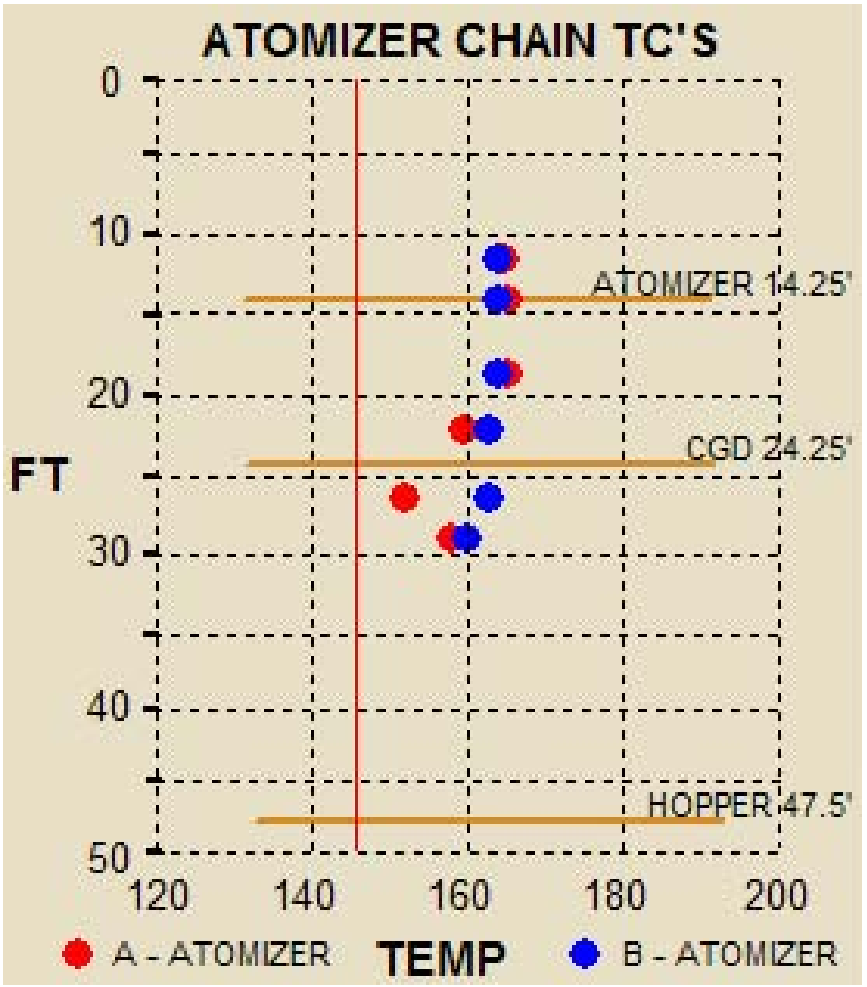
SDA Internal Wall Temps.

165F
169F
161F
163F
153F
165F

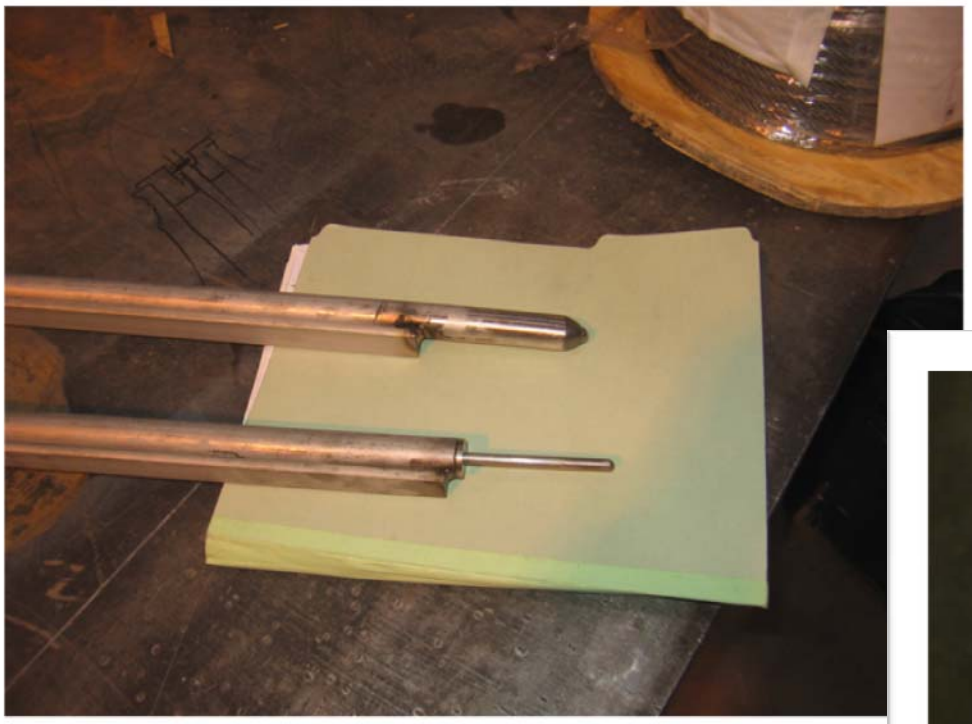
Provides a flashing alarm when any T/C temp <150F (<15F Tas) Wetbulb ~ 135°F

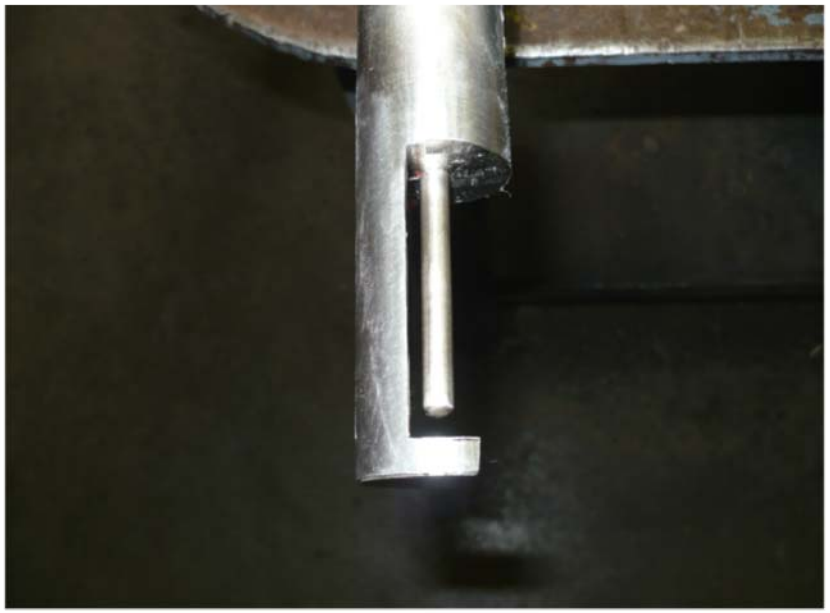
Wall Deposits

TC Chain DCS Display

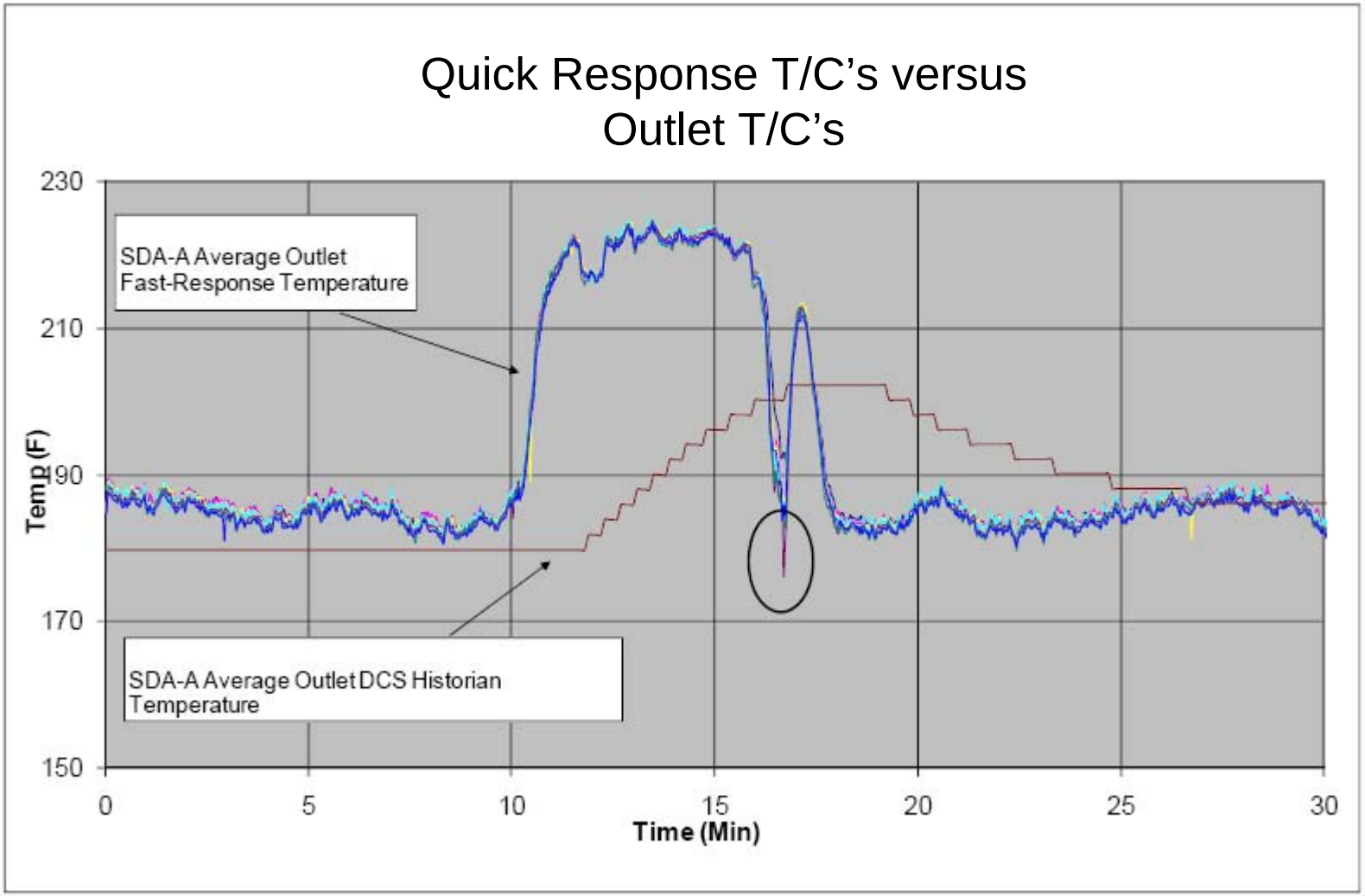


SDA Outlet Thermocouples





SDA Temperature Response



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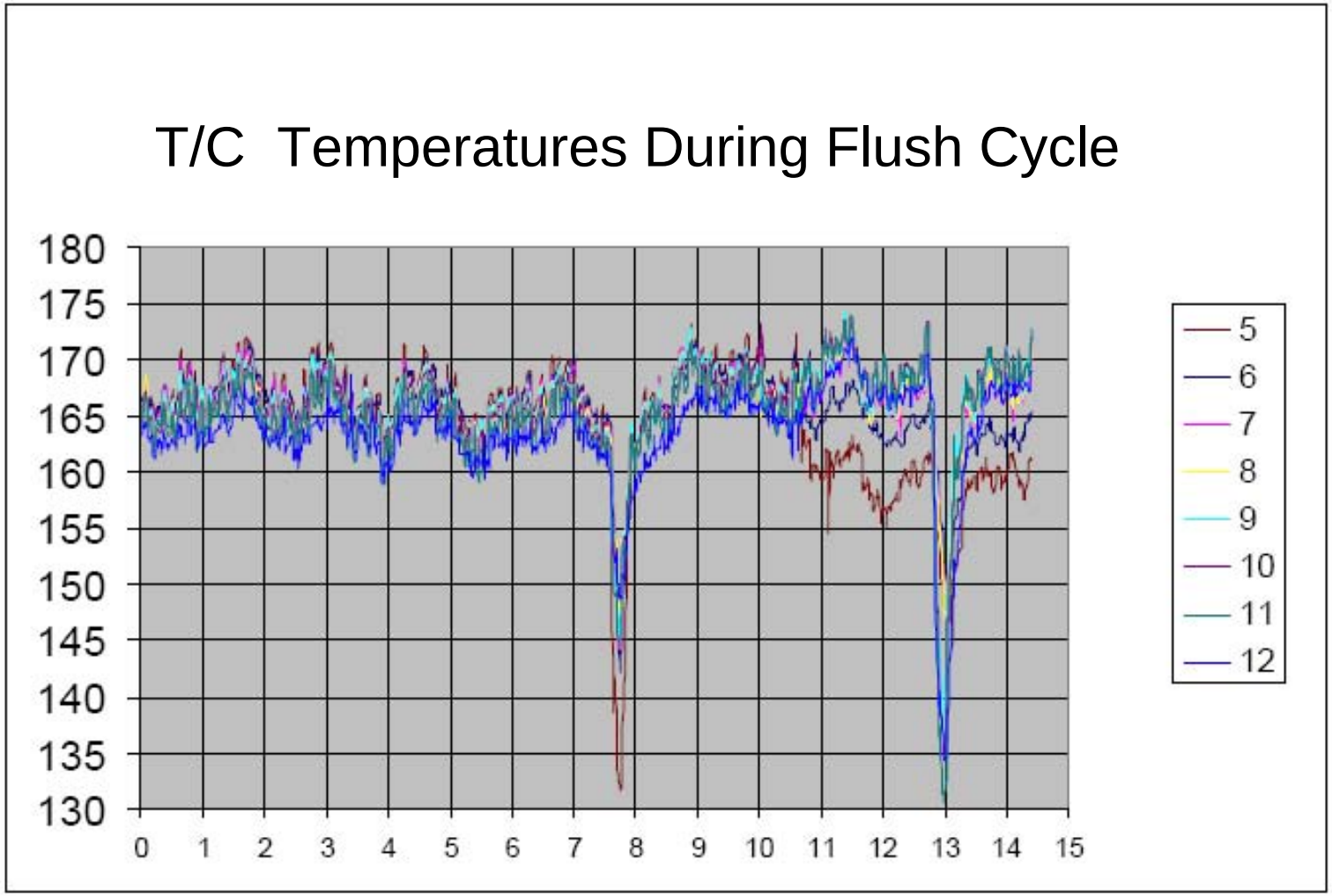
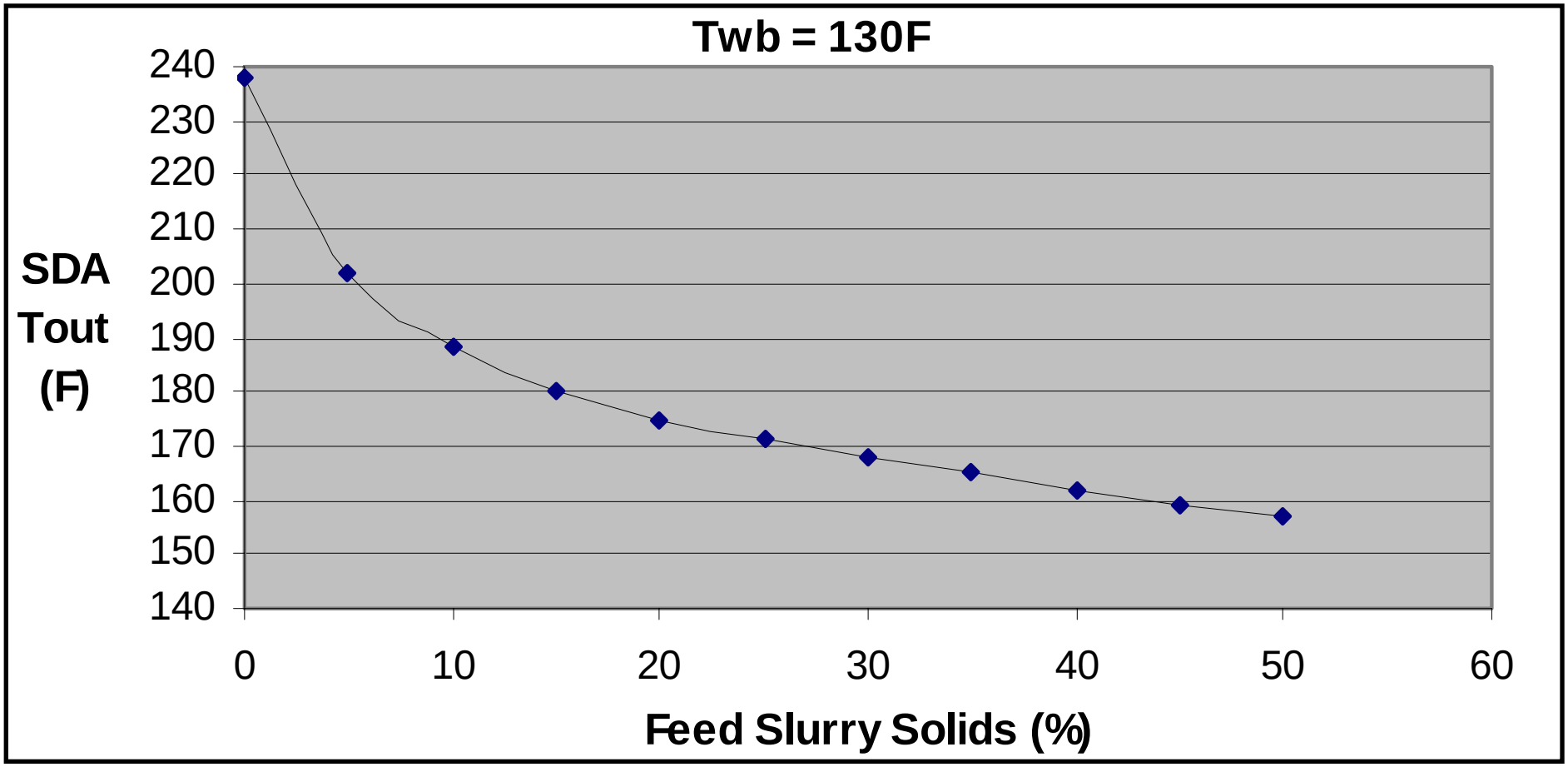
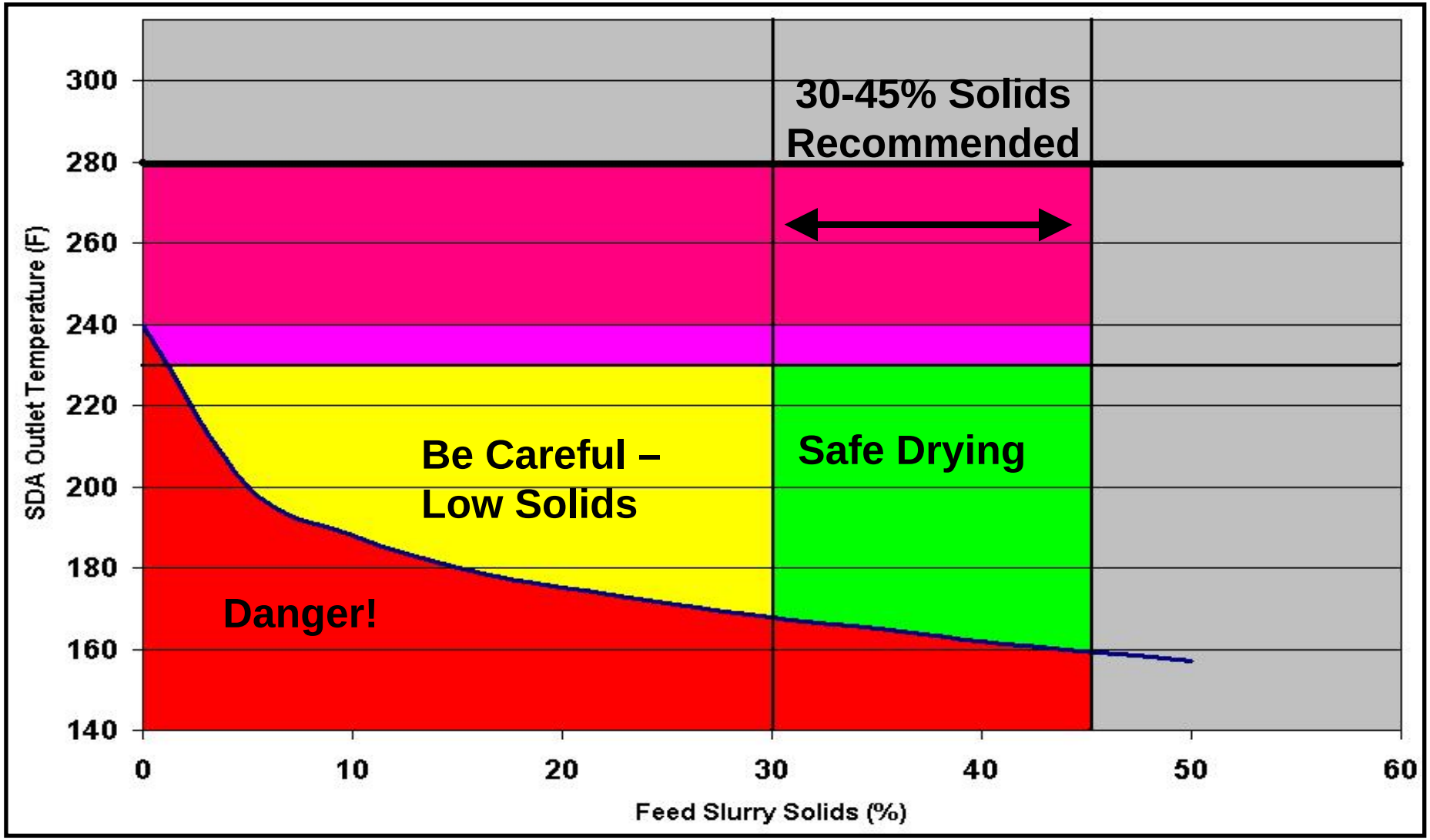


Drying Curve Example



General Operation Practices



Feed Slurry Calculations

	Lime Slurry	Recycle Slurry
% Solids	20.0	45.0
GPM	30.0	40.0

Specific Gravity	1.1224	1.3699
Slurry Mass Flow - lbs/hr	16861.72	27437.91
Slurry Solids Flow - lbs/hr	3372.34	12347.06
Slurry Water Flow - lbs/hr	13489.37	15090.85

Atomizer Feed Slurry

	lbs/hr	Average Solids Specific Gravity
Total Feed Solids Flow	15719.40	2.4356
Total Feed Water Flow	28580.23	

	lbs/hr	Specific Gravity	% Solids
Total Feed Slurry Flow	44299.63	1.2645	35.48

Base Equations:

lb/hr = gpm * (1 ft3/7.4805 gal)*(60 min/hr)*(62.43 lb/ft3)*slurry specific gravity

sp grav slurry = 1 / 1-[(wt% solids/100)*((density of solid - 1)/density of solid))]

Lime Solids Specific Gravity = 2.2

Recycle Solids Specific Gravity = 2.5

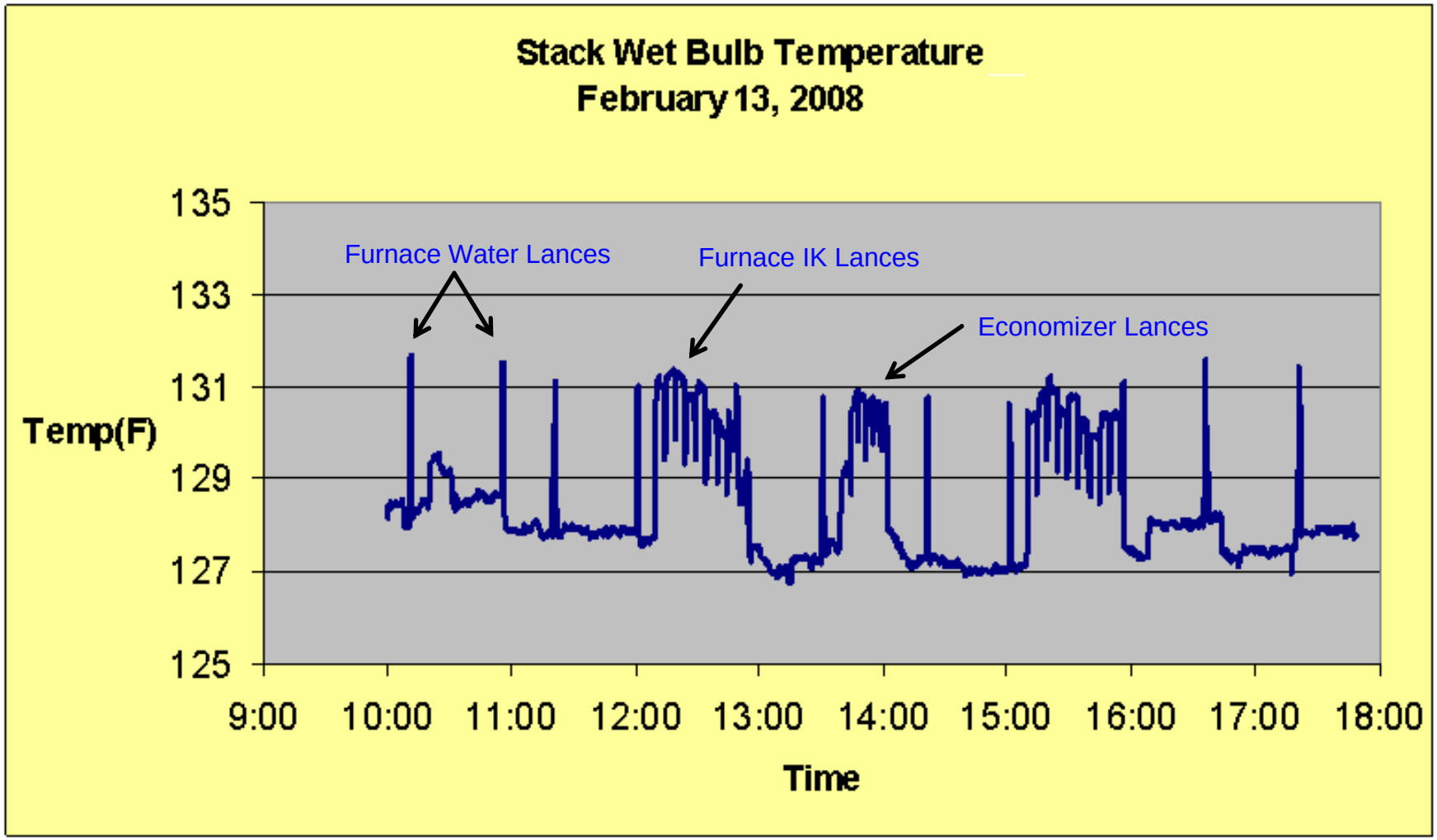
Solids Balance

Recommended Temperatures
Lime Slurry = 221°F (105°C)
Recycle Slurry = 185°F (85°C)

Humidity Monitor

Portable Monitor for measuring the Adiabatic Saturation Temperature (Adsat Temperature) or Wet-bulb temperature.

Flue Gas Adsat or Wet-BulbTemperatures



SDA Technology Advancement

Dry Sorbent Injection Integration

- ***Extends range of performance - de-couple fresh lime addition rate and reagent slurry evaporation***
- ***Enhanced unit start-up emissions control***
- ***Atomizer maintenance back-up***
- ***Peak Control***

Simple injection at air heater outlet

Thank you.

Questions?