REINHOLD ENVIRONMENTAL Ltd.

2010 APC Round Table
& Expo Presentation

July 18-20, 2010, in Concord, NC / Hosted by Duke Energy

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Efficiency Improvements and Operational Cost Reductions of a Dual Loop WetFGD Scrubber at Muscatine Power & Water Using TwinAbsorb® Nozzle Technology

Acknowledgments

- **Gary Seligman, Muscatine Power & Water**
  - Planning, Scheduling, & PDM Supervisor
- **Jay Freese, Muscatine Power & Water**
  - Assistant Operations Supervisor
- **Bernhard Barg, Lechler Gmbh**
  - Senior Sales Manager, Europe

Presentation Outline

- Plant Information
- Operational Issues
- Goals of modifications
- Plan execution
- Results of Changes
- Conclusion
- Current Status

Muscatine Power & Water Background

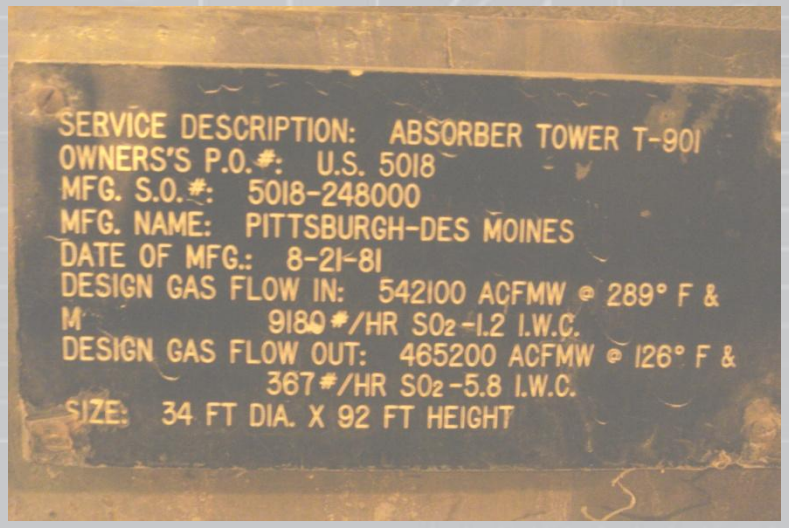
- Formed in 1922 in response to local concerns about poor service from privately held electric companies
- Largest municipal electric utility in the state of Iowa
- First scrubber in state of Iowa
- Reliability rate for owners/customers @ 99.99%
- 175.5 MW Nameplate capacity for MPW's Unit 9 coal-fired plant

Muscatine Power & Water Background

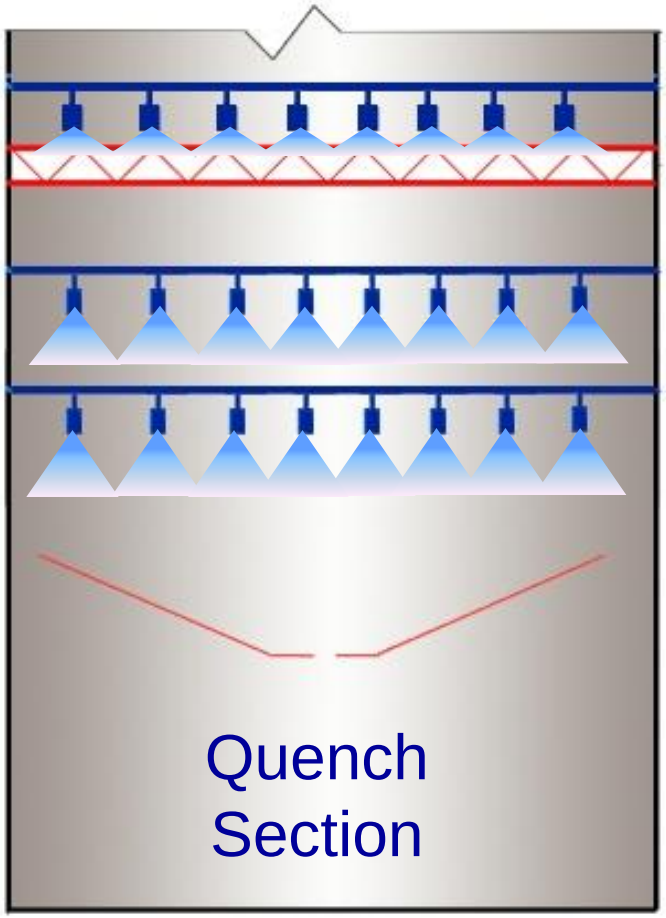
Located on the eastern border of Iowa on the Mississippi River

Boiler/Scrubber Information

- 175.5 MW Nameplate Generating Capacity
- (2) Research-Cottrell Dual Loop Scrubbers
  - One operational, one standby
  - Munters Mist Eliminator System



General Scrubber Layout

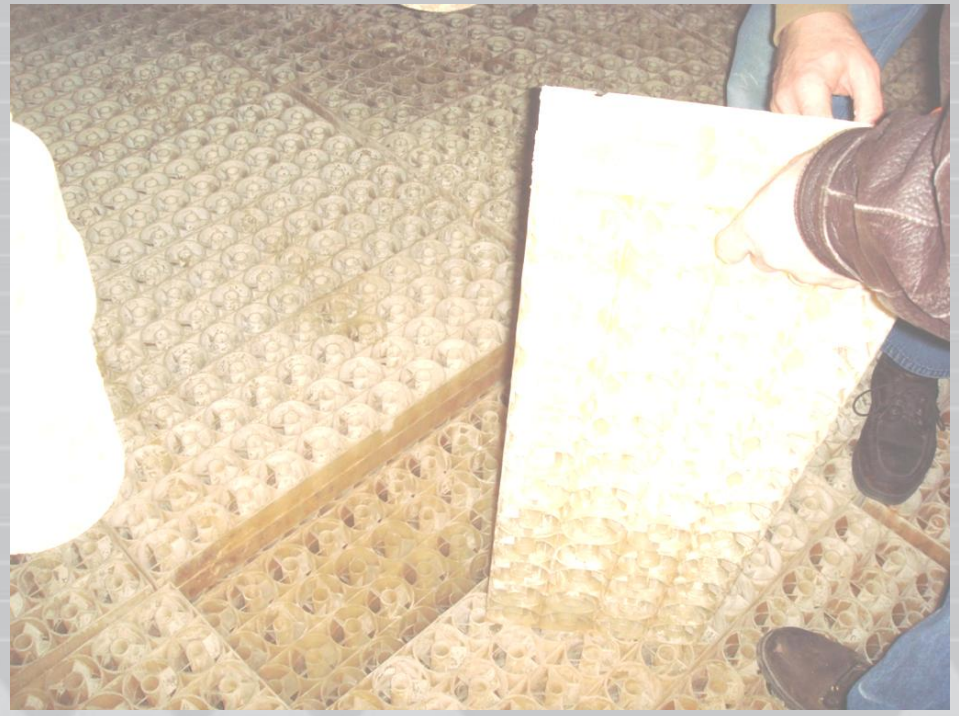


WFC Nozzles

Wet Film Contactor (WFC)

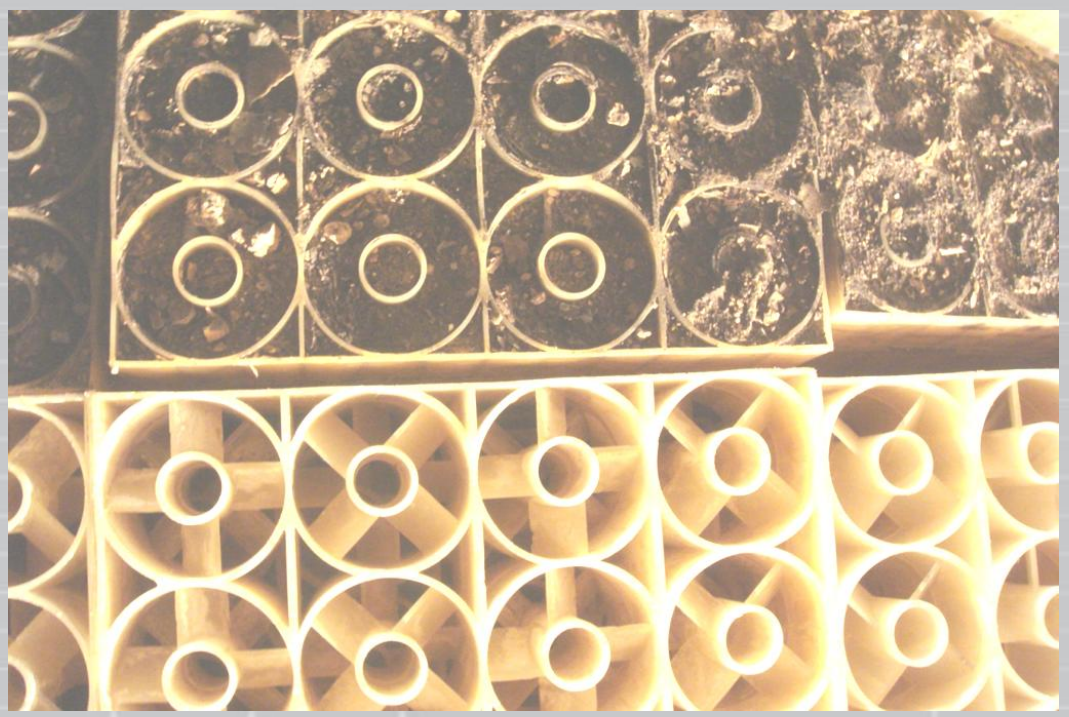
Absorber Nozzles

Wet Film Contactor (WFC)



- Prone to pluggage
- High pressure drop for ID Fan
- Required 2.5% open bypass
- Expensive - $300,000 for complete replacement

Wet Film Contactor (WFC)



- Comparison of clean and plugged WFC

Outdated Nozzle Technology

Nozzles Above WFC

- Prone to pluggage
- Minimal gas coverage
- Large droplets not ideal for SO_2 removal, however good for wetting of the packed bed

Outdated Nozzle Technology

Absorber Full Cone Nozzles

Operational Issues

- High fan requirements
- High maintenance costs
- Frequent unplanned outages
- Obsolete nozzle technology
- Limited SO_2 removal

MPW/Lechler Team Up

- **Goals of Retrofit**
  - **Eliminate need for WFC**
  - **Decrease outage frequency**
  - **Reduce maintenance costs**
  - **Reduce operational costs**

MPW/Lechler Team Up

- **Goals of Retrofit**
  - **Improve nozzle technology**
  - **Improve SO_2 removal**
  - **Seamless change to low sulfur coal (.60% to .29%)**

Scrubber Improvement Options

- Increase L/G
- Install Wall Plates
- Use acid enhancement
- Install trays
- Improve nozzle technology

Project: RC Scrubber
Company: Muscatine Power
attn.: Lechler Inc.
Date: October, 30. in 2006

printed by Lechler Inc.

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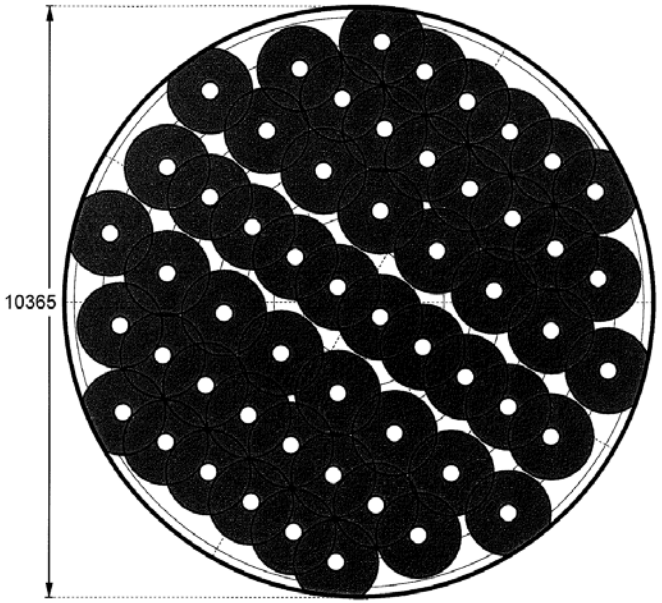
Plain No. 2



Spraying distance to plain:	762 mm
Number of nozzles:	54
Plain flowrate:	28753 l/min
Covered area:	85.3 %
Notes:	Elevation at 156'-8"

Nozzle Coverage (Original)

Obsolete Nozzle Technology

Fullcone Nozzles above WFC

Obsolete Nozzle Technology

Nozzles next to the wall

- *Low Spray Coverage*
- *Large Droplets*
- *Small Free Passage*
- *~ .75”*

Single Hollow Cone Technology

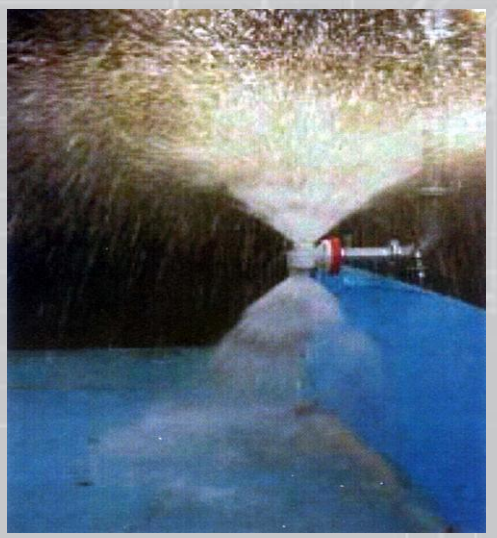
Hollow Cone Spray Pattern

- Smaller droplets for increased mass transfer
- Less prone to pluggage

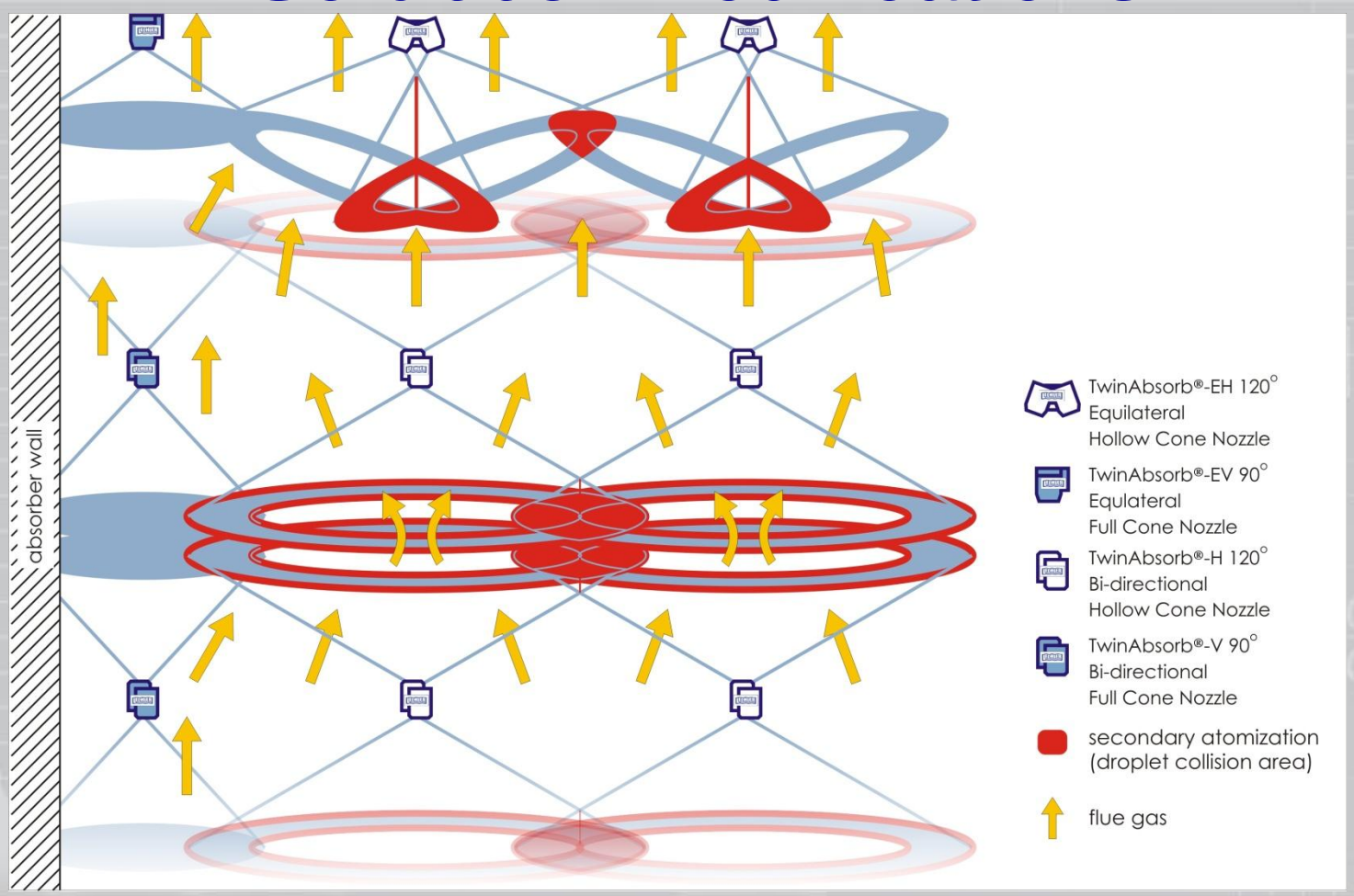
Spray Pattern Types

HollowCones

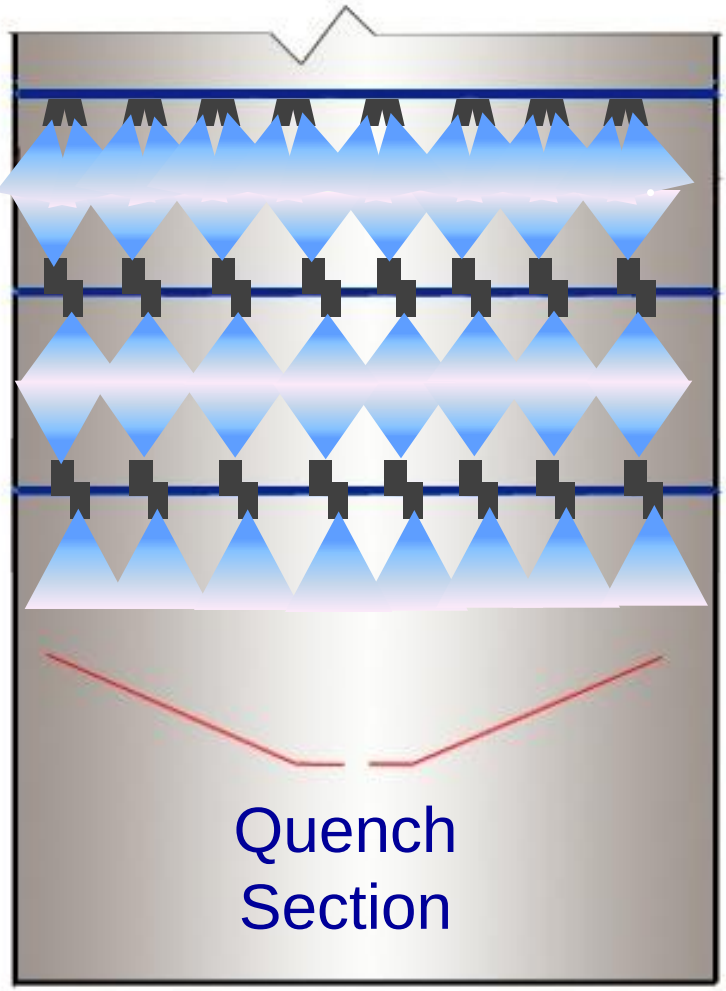
FullCones



Scrubber Modifications



Scrubber Modifications



TwinAbsorb ®
Equilateral

TwinAbsorbH ®
Up / Down Nozzles

Rotated Headers

Project: Muscatine C. .on1
Company: Muscatine Power
attn.: Lechler Inc.
Date: November, 13. in 2006

printed by Lechler inc.

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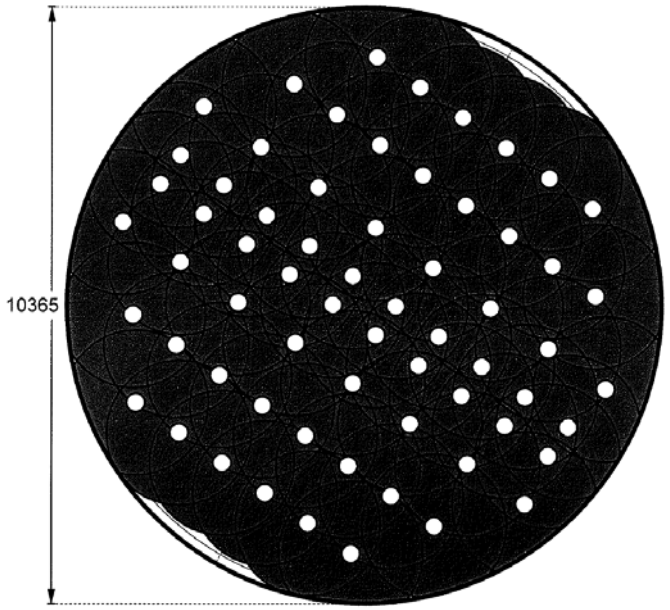
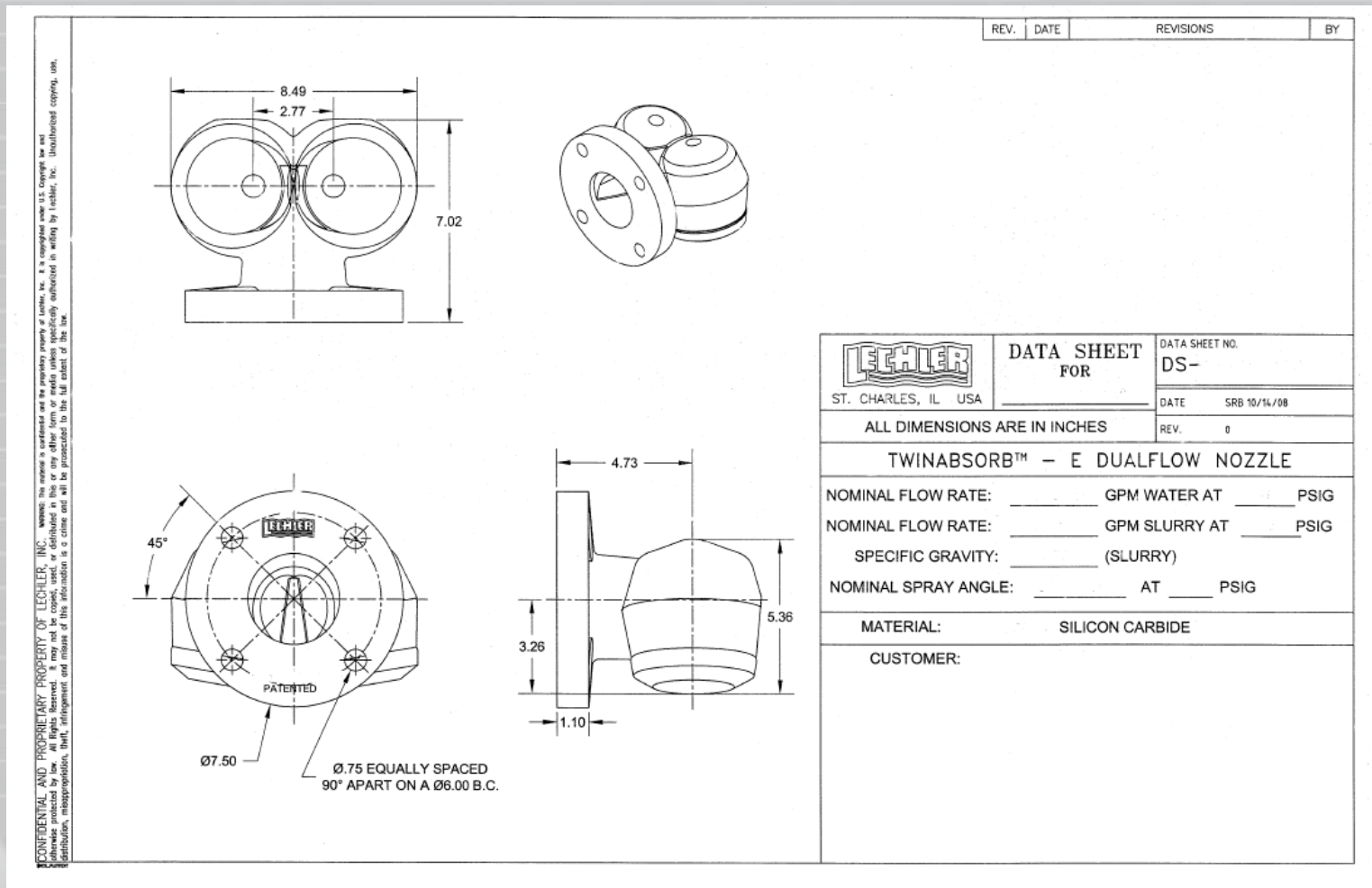
Plain No. 2



Spraying distance to plain:	762 mm
Number of nozzles:	64
Plain flowrate:	34078 l/min
Covered area:	98.3 %
Notes:	Elevation at 156'-8"

Nozzle Coverage (Proposed)

- *3” TwinAbsorb® Equilateral*
- *~ 1.5” Free Passage*



TwinAbsorb® Equilateral

Absorber Nozzles

Elimination of WFC

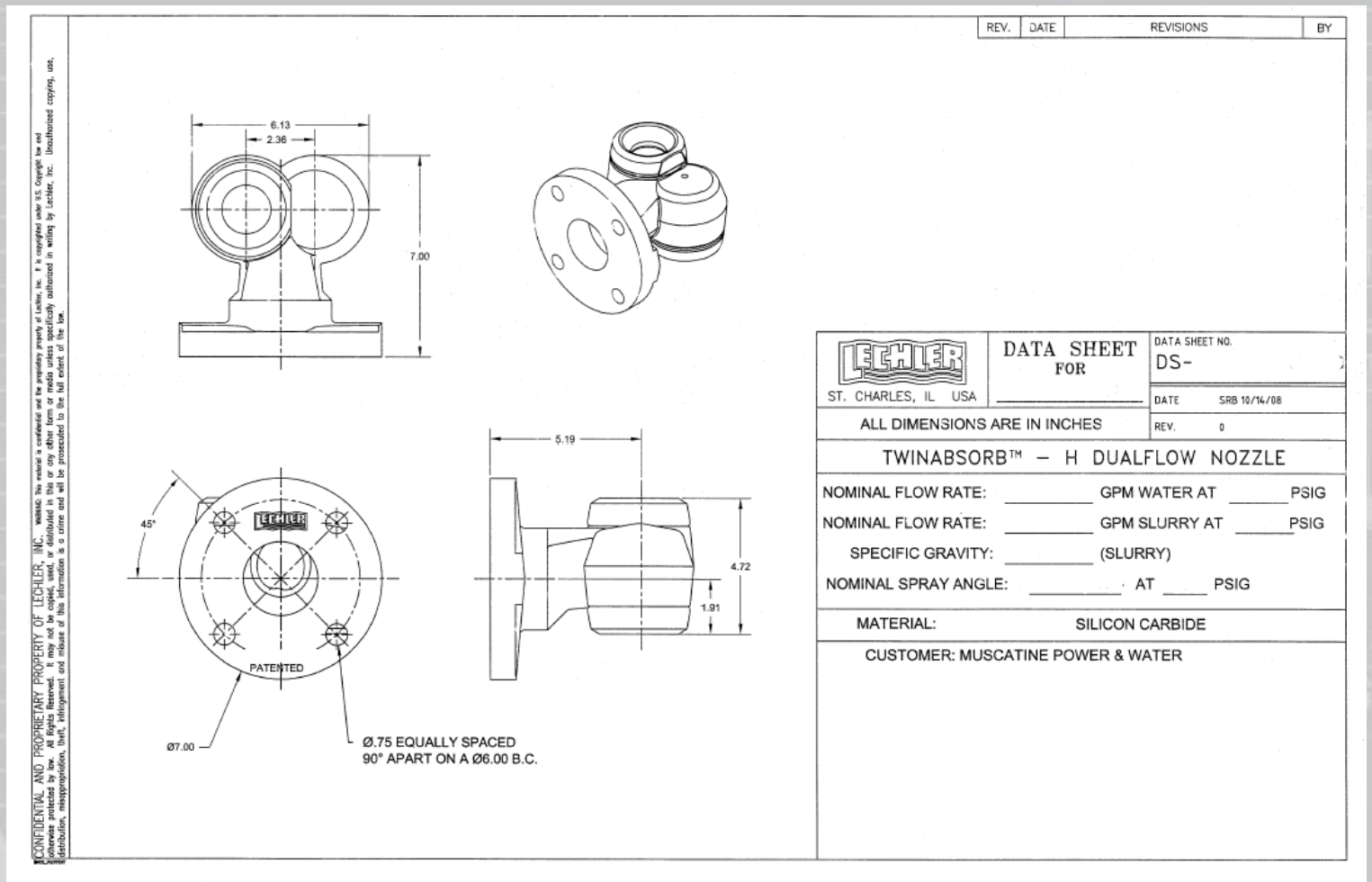
Nozzles Above WFC

- Improved Gas Flow
- Full Gas Coverage
- Optimum droplets for SO_2 removal
- Increased droplets and surface area for mass transfer

Absorber Nozzle Conversion

Absorber Nozzles

- *2-1/2” TwinAbsorb® Up/Down*
- *~ 1.5” Free Passage*

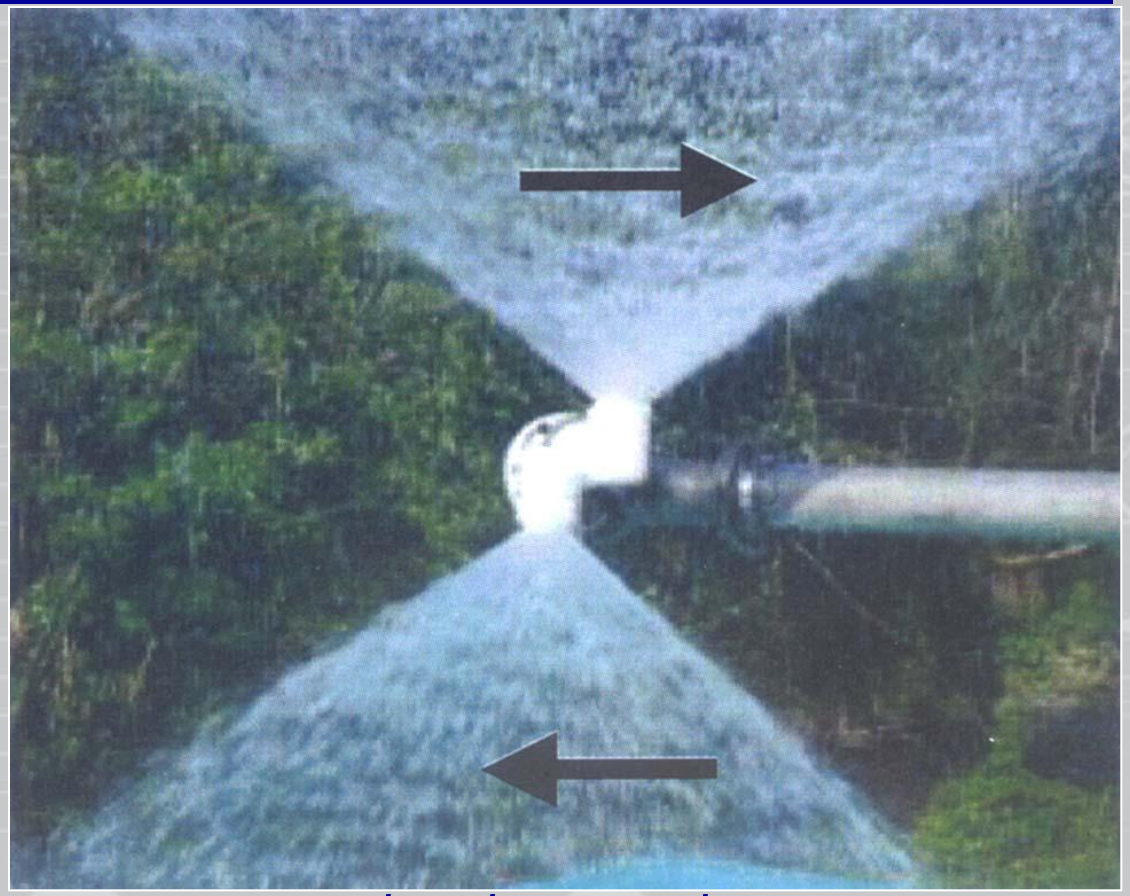


TwinAbsorb® H Up/Down

Increased Surfaced Regeneration

- Increased residence time
- Large free passage

TwinAbsorb® H Up/Down



Absorber Nozzles

TwinAbsorb® H Up/Down

Absorber Nozzles

Results

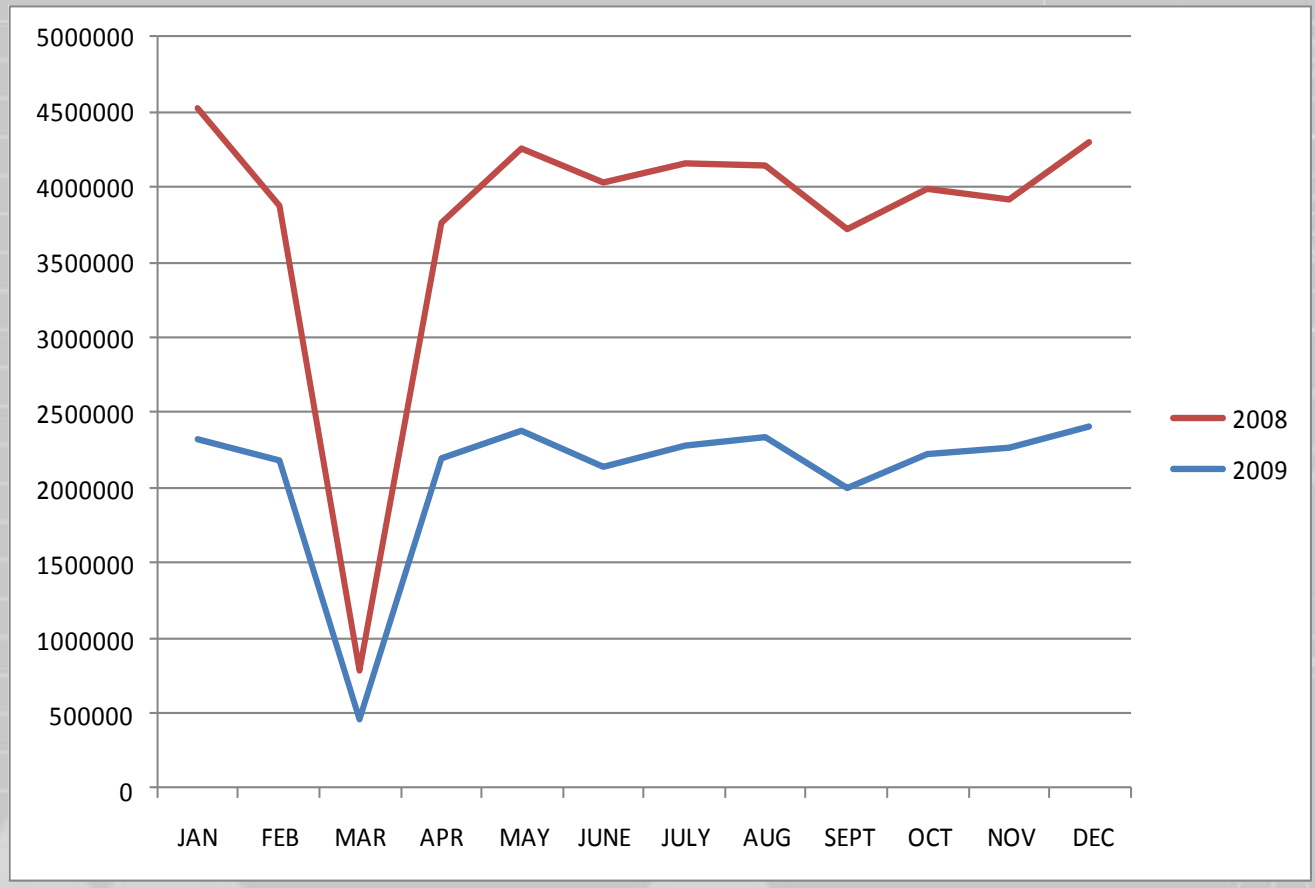
- Results of Retrofit
  - WFC Removed
  - Reduced outage frequency (2 year planned)
  - Maintenance costs reduced
  - Operational costs reduced
  - SO_2 removal (98-99%)
  - Bypass damper completely closed
  - Increased latitude on coal quality

Energy Reductions

- Fan input power decreased from 778 KW to 335 KW
- Decreased limestone usage
- Decreased ball mill energy usage
- Decreased waste equipment usage
- Decreased pump energy

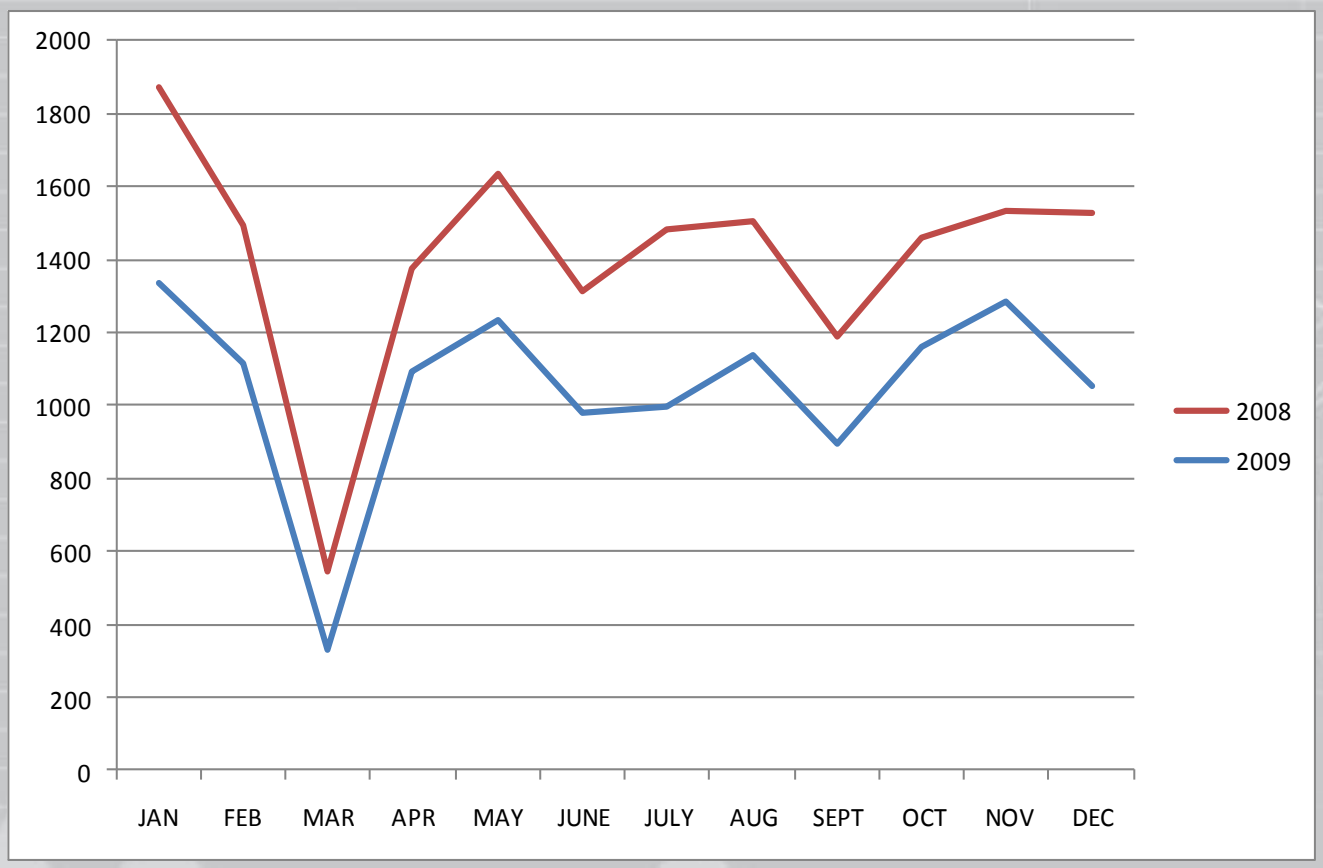
Energy Reductions

kwh



Limestone Usage

Tons



Cost Savings !!!

- **$ 1,226,000/year energy cost savings**
- **$ 300,000 packing replacement no longer required**
- **$ 41,000/year pump savings**

Conclusions

- All goals of the upgrade have been achieved
- Project was completed on time and on budget
- Project was performed at optimum time
- Plant extremely pleased with performance
- Plant ideally situated for low-demand environment

Utility Comment

"We switched to the new nozzle configuration and no packing on 1/14/09. We have over a year and 1/2 on the current tower with no problems to speak of.
A lot of the reduced costs are related to lower sulfur coal and reduced MWs due to a turn in the economy, but this packingless tower seems to working very well for us."

Jay Freese, Assistant Operations Supervisor – Muscatine Power & Water

Questions?

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