

Reinhold Environmental Ltd.



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Presentation***

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Flow Modifications and Delta Wing Technology To Improve ESP Operations

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Duke Energy

Duke Energy Belews Creek Stm Station

1997 ESP Condition

- Moderate SCA (300)
- Weighted Wire Chevron 25 yr old ESP
- Alignment Problem
- Poor Rapper Density
- 100° ESP Inlet Temperature Gradient
- Unreliable AVCs
- Unreliable SO₃ Conditioning (no NH₃)
- Obvious Gas Flow Issues (Largely due to 1989 Model Study)

Precipitator Improvements (Belews Creek 1997-2002)

- Improved Input Power
 - Reliable AVCs
 - Improved Gas Conditioning (Dual Conditioning)
 - Corrected Alignment Issue (best we could)
- Reduce Rapping Loses (New Rapping System)
 - Dual Conditioning
- Improved Gas Flow

Why?

(Did Gas Flow Mod Lower Opacity)

- Eliminated Hopper Sweepage
- Minimized Rapper Re-entrainment Spikes
- Minimized Duct Ash Fallout/Deposits
- Minimized Sneakage
- Reduced Ash Buildup (Plates & Wires)
- Improved Gas Flow Distribution
 - Minimize High/Low Velocity Zones (Not limited to IGCI criteria 85% V data \leq to 115% of the average V (1989))

Why are Flow Correction so Critical

- To Meet '70 New Source Standard (0.03 Lb/Mbtu)
 - Need 99.5% Collection Efficiency
 - $< 0.5\%$ Collected Material Losses (Assuming ESP 100% Efficient)

Model Study vs Engineering Evaluation

- Model Study
 - Higher Initial Cost
 - Required for New Design
 - **Can** Have a Higher Probability of Initial Success
 - Can Lead to Less than Optimum Results
 - False Sense of Security
 - Can Lead to Future Unnecessary Upgrades
 - Experience / Success History Paramount
 - Must Inspect after Installation to Verify Success (must get dirty)

- Engineering Evaluation

- Lower Cost Option

- Unit Must Be Off (and you have to get dirty)

- Is a Trial and Error Method

- Experience can improve initial success

- Used experience with internal baffling from other sites as a starting point (Nels and TRK / DE - MS)

- Success is Easily to Verified

What Worked at Belews Creek

- Kept Constant Porosity Inlet (50%)
- Changed Outlet to (<30%) Perf Screens
- Hopper Baffling (can create hopper evacuation issues if not done correctly)
- Walkway Baffling
 - Height (4') (36' tall collecting plate)
 - Solid (2') / Perforated (2')
 - Tied to hopper baffling
- Increased Outlet Baffling (2' to 6')

Precipitator Rebuild

(Due to the SCR Installation)

- Four Internal Chevron Duct for SCR Support Columns / Also an Outlet False Floor to Eliminate Ash Fallout (Bob Crynack – EPSCO- facilitated the Design)
- Rebuilt the ESP (Kept 300 SCA)
 - Used Weighted Wires to reduce costs
 - Split High Voltage Frames to Sectionalize
 - Doubled number of TRs
 - Improved Rapping Density
- Reduced Temperature Gradient from Airheater
 - Used Delta Wings (from +100° down <20°)
- Upgraded Gas Conditioning
 - Dual Conditioning New Lance Design with Delta Wings

Reducing SAH Gradients

- SCR Shortened Distance between Airheater and ESP (Less Conditioning Treatment Time)
- w/ Potentially Higher SO_3 - Minimize Gas Resistivity Variations @ ESP Inlet
- Used Delta Wing Technology (over traditional technology – interior ducts or tubes)
 - Lower Pressure Drop
 - Creates Desirable Turbulence
 - Can Direct Flow
 - Can be used to Eliminate Ash Piles

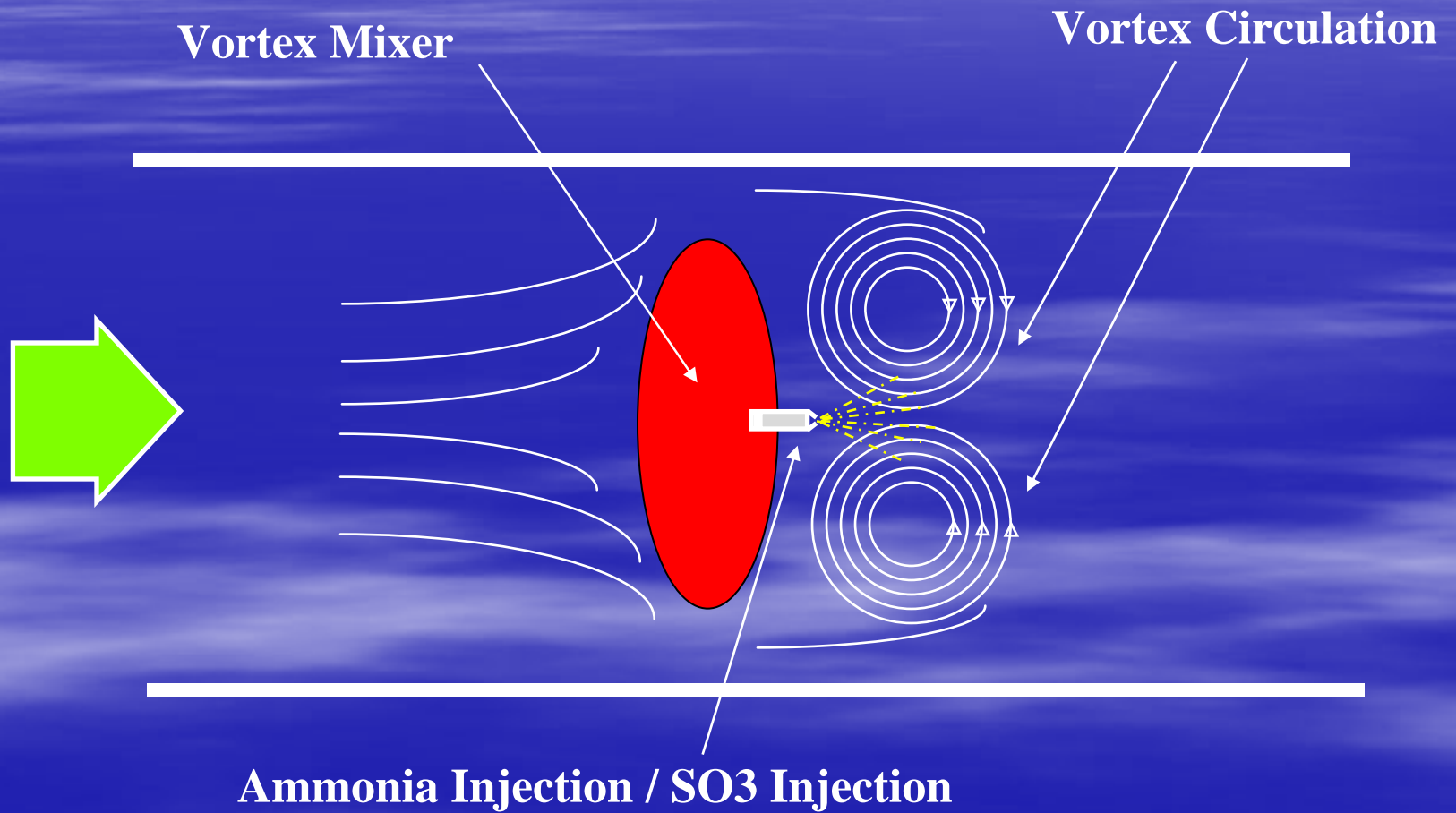
SO₃ / NH₃ Injection Distribution

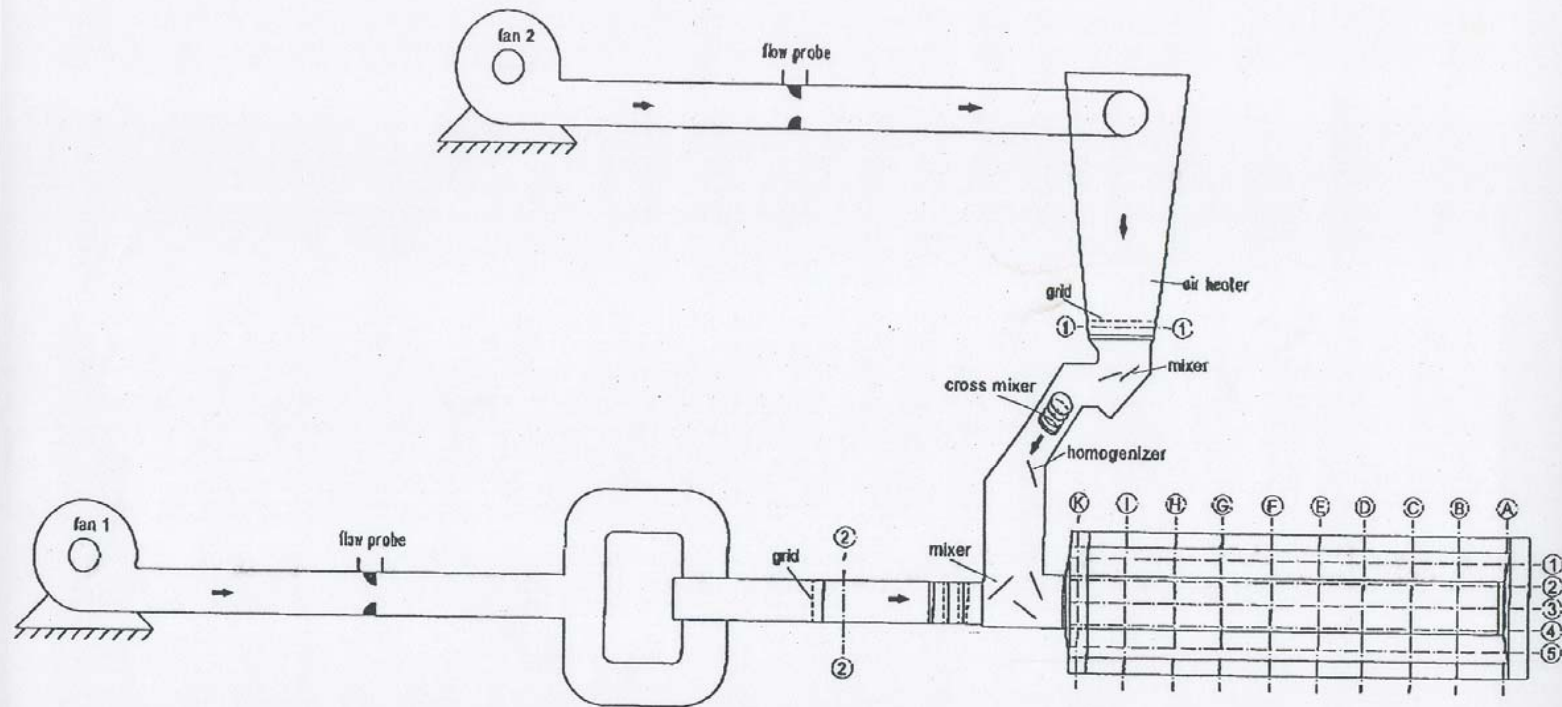
- Short Distance between Airheater and ESP
 - .5 seconds of treatment time
- Multi-port Injection Probe
 - Best to Bias Injection Lances to Temperature Gradient
 - Can Lead to Stratified Injection Flows
 - History of Plugged Nozzles
- Delta Wing w/ Large Injection Pipe No US Installations
 - Used with many SCRs
 - Efficiently Mixes Rich SO₃ Injection Flow
 - Mixes SO₃ & NH₃ (dual conditioning)

Delta Wing Conditioning / Gradient Mitigation Design Team

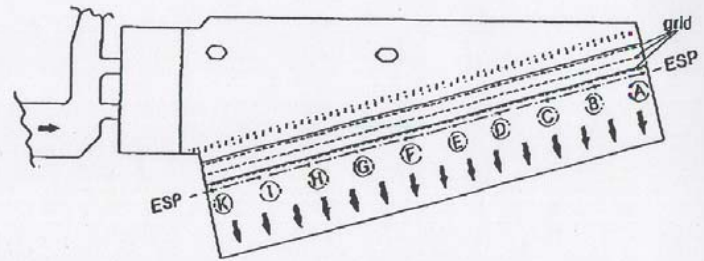
- Tom Keeler – TRK Engineering – Provided Technical Support (Specification, Design Review)
- Clay Ericson of Babcock Borsig Power (SCR supplier) – Assisted with Specification and the Design Contract
- Dr Ruscheweyh - BPI – Provided the DW Design and Modeling

“Delta Wing” Mixer

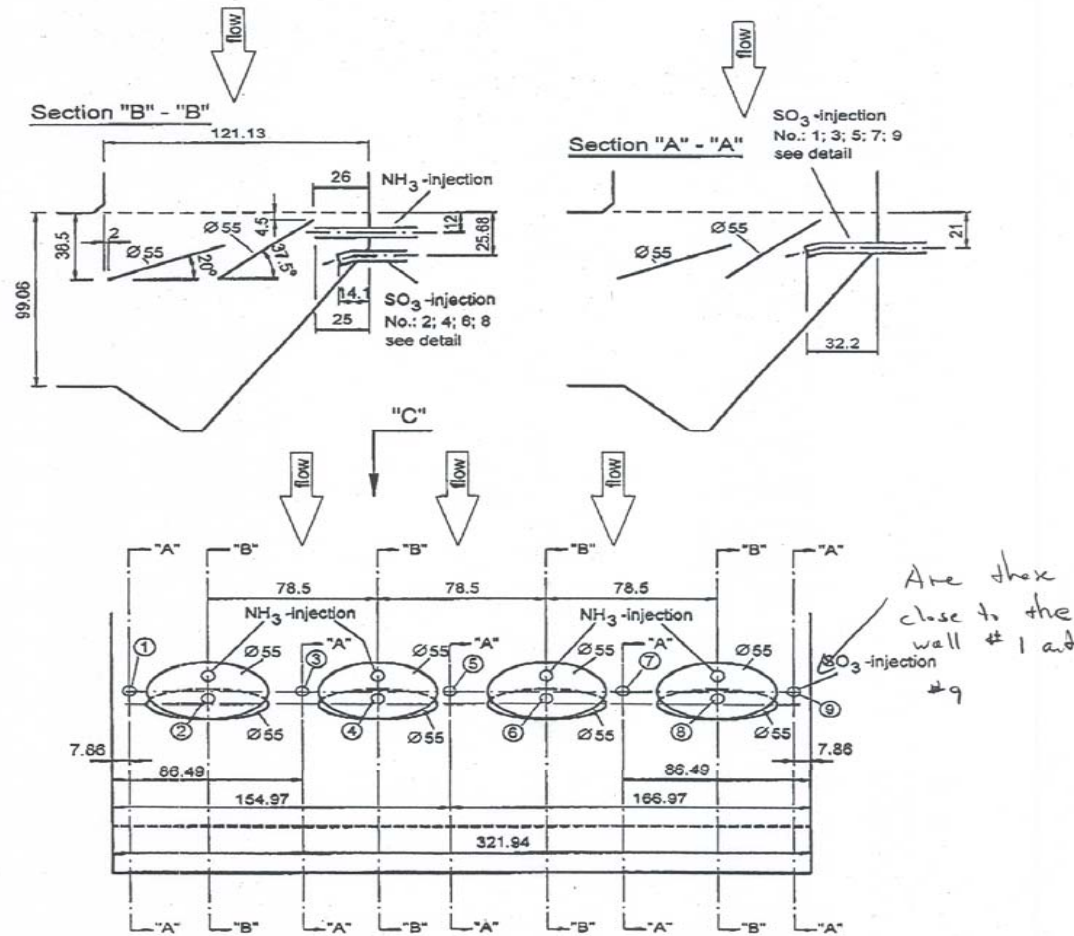




model scale 1 : 40
 dimensions in [mm]



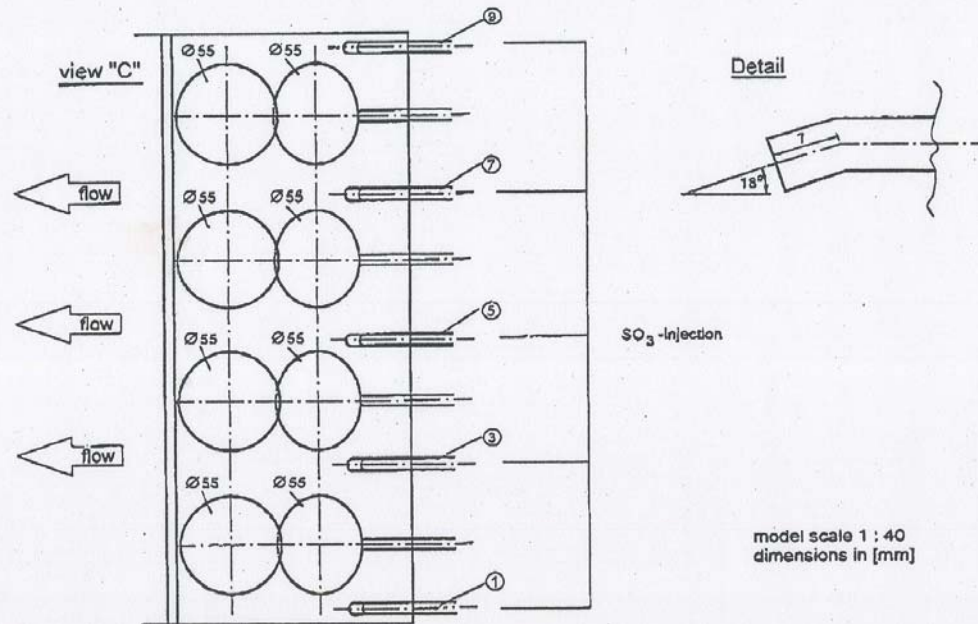
ESP Belews Creek



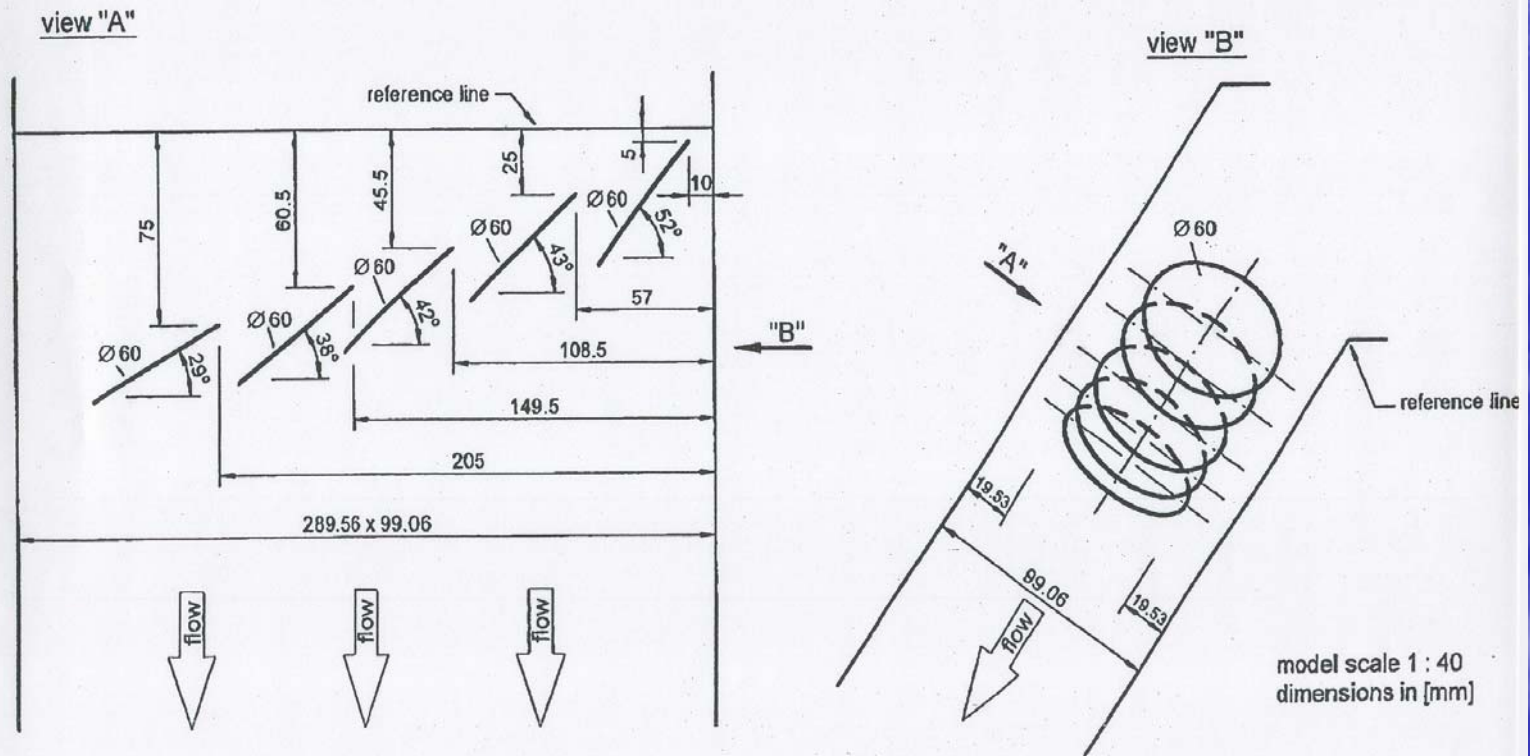
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Are they close to the wall # 1 and # 9

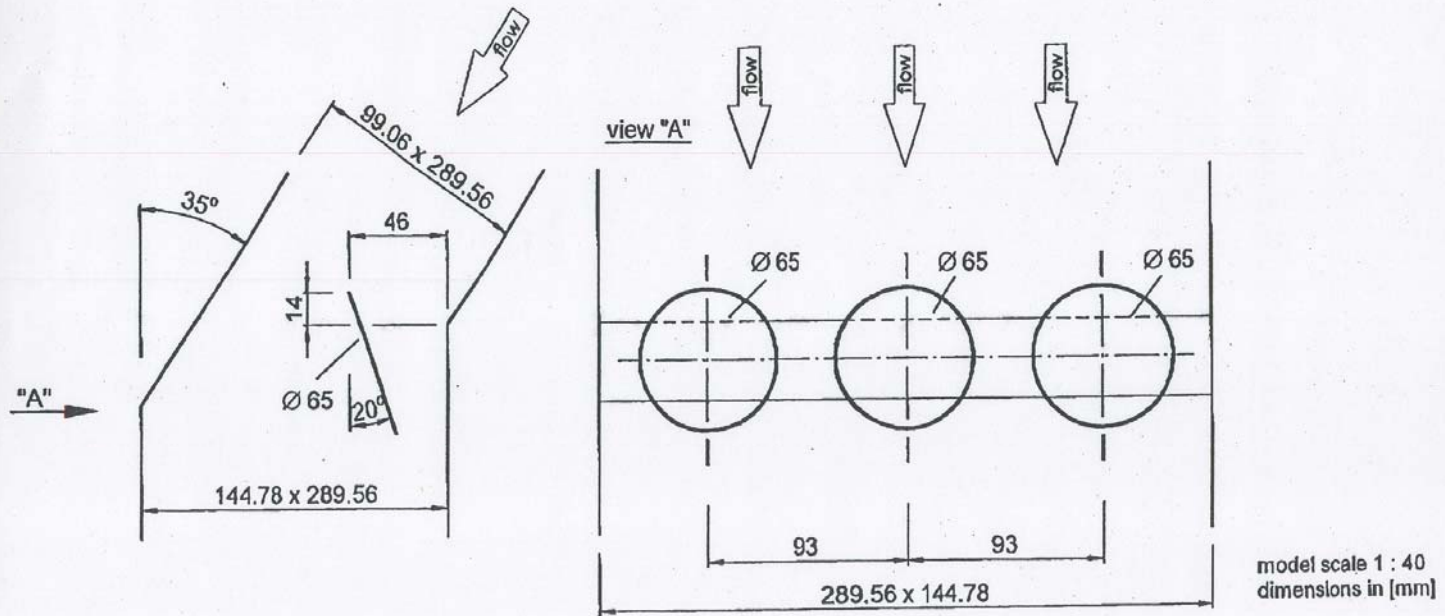
ESP Belews Creek



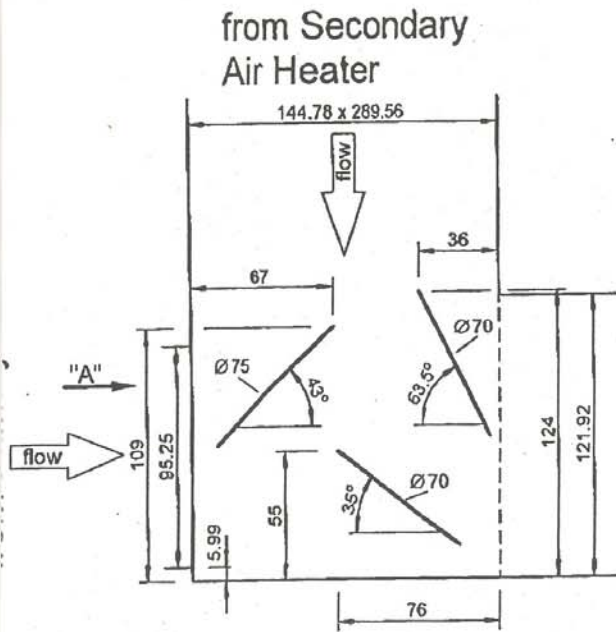
ESP Belews Creek



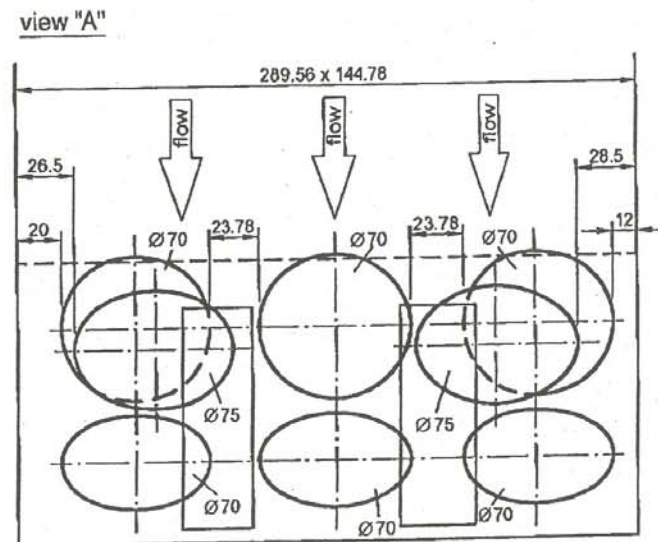
ESP Belews Creek



ESP Belews Creek



model scale 1 : 40
dimensions in [mm]





In Summary

- First make sure ESP Fundamentals are Good
 - Good Internal Clearances
 - Minimize Air Infiltration
 - Good AVC Control Adjustment
 - Resolve Equipment Reliability Issues
 - Good Control of Ash Resistivity
- Second
 - Improve Gas and Temperature Distribution
- Third
 - Consider Expensive Rebuilds and/or New Technology